ADVANCED
PARTIAL DENTURES

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PREFACE TO THE 2012 EDITION

The printed version of this book, intended for my grad students was published be Quintessence in 1999 and went out of print in 2008. The original printing had been sold out at that time and the publisher decided that with sales down to only a hundred or so a year that they would return my author’s rights and take the book out of print.

Since that time I have made the book available to any and all who were interested, and of course, my grad students with this “electric” version which I have just edited to bring things up to date.

The original book had only my drawings for illustrations as that has always been my favorite way of explaining things, taking artistic license to exaggerate as needed to make my point. Old age has taken some of the fun out of the drawings so I have included pictures, taken by my students, where they did a better job of explaining things. Unfortunately, the inclusion of some of these pictures has led to formatting problems, especially in Chapter 12, a new chapter to bring the book up to date. These problems are due to my lack of ability on the computer for which I can only blame senility.

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ADVANCED REMOVABLE PARTIAL DENTURES

Introduction

The removable partial denture has long been considered an inferior means of replacing missing teeth and associated structures when compared to the fixed partial denture. Some have even spoken of it as a stepping stone to a complete denture. The old rhyme, “Little RPD, don’t you cry, you’ll be a CD bye and bye”, may best express our feelings toward this treatment modality. Many surveys published over the years in our journals indicate that dentistry does a rather poor job with the RPD. These reports testify to the fact that most RPD’s are created entirely by the technician with a minimum of input from the clinician in the form of mouth preparation or design.

Dental schools make a serious effort to teach the subject and excellent texts for the undergraduate are available. None the less, the state of removable partial dentures seen in the commercial laboratories and in the cross sectional studies available to us, indicates that, in general, partials are poorly designed and constructed and poorly maintained.

Therefore it is no wonder that patients dislike their partials to the point of not wearing them and, if they can afford alternative treatment, request it routinely. It has been my experience that the patient who states, “I had a partial once and couldn’t wear it!” most likely had a substandard prosthesis and when treated with a partial denture that is made to the state-of-the-art, finds it tolerable and easily accepts the limitations of this form of tooth and tissue replacement.

Plainly stated, there is a dramatic difference between the standard RPD and the one that approaches the state-of-the-art as we know it today. It is in the attempt to create that quality removable partial denture that this manuscript is written. It is intended to serve as a guide to both graduate students in
prosthodontics and concerned general practitioners; to challenge them to think of the removable appliance as they would the fixed partial denture, with all the same considerations of soft tissue management, caries control, periodontal support, orthodontic therapy and implant involvement. In almost every clinical situation, the patient who requires a removable partial denture will have a need for some form of fixed prosthodontics as well, from a simple bonded rest to the most complex precision attachments extending from fixed units.

This work is not intended to be a textbook in the classical sense. It will not have a bibliography or extensive illustrations. It is, rather, a monograph on the removable partial denture, written with the expectation that the reader will already have covered the basics of the partial denture and is now ready to take a more sophisticated look at this treatment modality. Here, then, are my thoughts as they have evolved in over 50 years of practice and teaching in this fascinating area.

**PHILOSOPHY OF CARE**

What makes a successful RPD? At the risk of oversimplification, one could say that the successful removable appliance need be only six things: (1) strong; in that it does not wear, break, distort or come apart when worn, (2) stable; it will have maximum lateral contact with abutment teeth through parallel guide planes which will limit the path of removal to as close to 0˚ as possible, (3) retentive; so that it remains in position in the patient’s mouth during use and gives the patient confidence that it will continue to do so over the life of the partial, (4) esthetic; to satisfy the patient’s expectations without undue evidence of its presence, (5) comfortable; so that it will have the minimal amount of metal and resin necessary to support abutments and replace missing tissue and (6) pain-free; meaning that it does not cause discomfort when in the mouth for the short term and that it causes no long term damage to either hard or soft tissue over the life of the partial.

If these six requirements can be met, the partial stands a good chance of long term success. Unfortunately, the success of the partial in and of itself does not guarantee the long-term health of the remaining teeth and soft tissues. Maintenance therefore, becomes the primary factor in the long term
success of the treatment. The profession has usually substituted concern over the type of clasp to be used for the more fundamental requirements of regularly scheduled recall and appropriate maintenance. Preparing the mouth to its very best state of health before starting prosthodontic procedures and then keeping the tissues in that state of health over the life of the partial is far more important than any design considerations. It has become obvious to me that a partial denture in a healthy mouth, assuming that it meets our six requirements, will be successful regardless of its design. Rest placement and clasp design, interesting as they may be to argue over from a theoretical point of view, are simply not germane to the real question of what makes a successful removable partial denture. Suppositions derived from bench studies do not necessarily transfer to the clinical realities of long term care. We can think of the factors that compose successful RPD treatment in these percentages; Maintenance 50%, Mouth Preparation 23%, Construction 23% and Design the remaining 4%.

How long should a properly designed, constructed and maintained RPD last? Good evidence exists that this state-of-the-art partial could be expected to last a minimum of 10 years, assuming that the patient was seen at regular intervals and that both the mouth and the partial received the indicated maintenance. Partials providing good service for 20 years are not unheard-of, although the long-term maintenance requirements increase dramatically after 10 years.

The construction of the removable partial denture, more than any other form of dental therapy, is almost always delegated to the dental laboratory since the equipment required to produce an acceptable cast framework is not going to be found in the dental office. In many cases, the clinician may have never even met the technicians creating the prostheses. This fact requires that the clinicians maintain control by inserting themselves into the process at the critical steps in construction. These steps will be covered in depth in this manuscript. Since the actual construction is relegated, the average clinician is apt to have very little confidence or experience in these matters and is likely to take the technician’s view of the design and construction process, a view that will be more mechanical than biological. The wise clinician will make a point of remaining in close contact with the technician and bringing these auxiliaries into the clinical aspects of care whenever possible.
The modern removable partial denture combines fixed and removable prosthodontics with implant support when key abutments are missing and requires a thorough understanding of both aspects of care by the clinician and by the technician. Unfortunately, the evolution of the dental laboratory industry has separated technicians into often isolated specialties: complete dentures, removable partial dentures and fixed partial dentures and implant prostheses. The technician who is knowledgeable in all areas is a vanishing breed. In order to direct the construction of the most sophisticated restorations, the clinician must assume the responsibility of coordinating the laboratory phases. This text is intended to set standards of care for the comprehensive management of the partially edentulous patient who will require some form of a removable restoration.

Patient satisfaction with their removable partial denture has been studied and the following factors identified; age, general health, previous experience with a partial denture and the opposing dentition all have been shown to play a role in how the patient views their new partial denture. Older patients are more apt to accept the limitations of the partial. The better the patients overall health the greater their satisfaction with the same effect based on the amount of experience they have had. As could be expected, what they have in the opposing arch will be a factor as well. Having a removable appliance in both arches increases their dissatisfaction with their partials. These factors must be discussed with the patient as a part of their informed consent to treatment with removable partials and may well influence their decision to consider other forms of treatment, especially now when full implant options have become a clinical reality.
CHAPTER I

PATIENT EVALUATION, DIAGNOSIS AND TREATMENT PLANNING

The obvious first step in treatment for the partially edentulous patient is the phase that includes the gathering of diagnostic data and those diagnostic procedures commonly grouped under the heading of treatment planning. These procedures must also address the prognosis, with and without treatment, of individual teeth as well as the mouth as a whole. An integral part of the required diagnostic data will be that information gathered from a diagnostic wax-up and set-up that includes a tentative RPD design as well. It may well be that the diagnostic phase is second only to maintenance as an indicator of long term success.

INITIAL EXAMINATION

The following sequence represents the basic information that must be obtained before treatment planning can occur:

Identification of the patient’s chief complaint.
Evaluation of existing prosthesis (if available)
Head and neck examination.
TMJ evaluation to include sounds and mouth opening.
Intraoral examination of both soft and hard tissues with emphasis on cancer screening.
Accurate and complete charting of:
   Caries.
   Existing restorations.
   Periodontal tissues to include pocket probings and mobilities and general bone levels.
   Pulp testing for vitality, especially on potential abutment teeth.
   Radiographic evaluation of both periapical films and a pantograph (in cases where jaw discrepancies and malocclusions are obvious, a lateral head film with tracing and evaluation can be requested with orthodontic consultation).
   Occlusal contacts, centric and eccentric.

Additional procedures sometimes indicated.
Diet analysis.
Caries risk assessment.

Impressions for diagnostic casts.
Inter-occlusal jaw relation record (if indicated).
Shade and mold selection.

The need for this diagnostic data should be obvious to any clinician, unfortunately, the planning for the average RPD seldom includes all these issues and, as a result, the treatment is compromised from the very beginning. There is no point even considering the “design” portion of the treatment plan until this information is available and has received some consideration and reflection.

DECISION MAKING for RPD TREATMENT PLANNING

A series of questions (in no particular order) must be addressed as part of the evaluation of the gathered data.

Is a removable partial denture indicated/necessary for this patient at this time?

Would the patient be better served with a fixed or an implant-retained prosthesis and can the increase in cost of care be justified?

What prosthodontic/restorative needs are apparent in the opposing arch and how will their treatment affect the removable partial denture?

Are the hard and soft tissues that would relate to a removable appliance acceptable (in an ideal state of health) at this time or will they require pre-prosthetic therapy? This could include everything from orthognathic surgery to a bonded metal rest. Will the abutment teeth provide all the required support or will additional support be required from the soft tissues of the edentulous areas (stress relief)?

Are the patient’s expectations achievable?
Will the patient be able to provide the required level of home care that will be necessary for long-term success?

Should ideal treatment be modified because of age, chronic systemic disease or psychological factors?

Most, if not all, of these questions should be addressed as a part of the initial examination. Some will require direct questioning of the patient. Others may only need to be a part of the clinician’s thought process but should be considered while the patient is still present. Some questions will result in referrals to other specialists and/or additional diagnostic tests.

The wise clinician will not give the patient any definitive plan or fee at the time of the initial examination. It is far better to tell the patient that no intelligent response can be made until all of the diagnostic data has been evaluated and any required consultations obtained.

_The fact that many patients can not afford what we may feel is indicated will require us to think in terms of “Treatment Plan C”, which is apt to be more of a challenge than the ideal._

**PRELIMINARY IMPRESSIONS**

The quality of the initial impressions and the casts that result from them, although diagnostic only, need to be of far higher quality than that normally seen. Most every specialist in removable prosthodontics has had the experience of attending a meeting or seminar when someone asks for help in treatment planning a case. A plaster cast, pulled from a pocket, usually without a decent base, full of blebs and voids and with no evidence of ever having been on a dental surveyor and then, “I apologize for this cast but can you help me with a design?”

The preliminary impression and resultant cast should be of the same quality as the final impression as far as extensions, hard and soft tissue details and integrity of the occlusal surface are concerned. This impression should be considered as a trial impression for the final. Tray size is evaluated, patient compliance with instructions noted, ease of placement discovered and the patient’s ability to sit still during the set of the alginate evaluated.
Everything that can be learned from this impression will aid the clinician in making an accurate final impression.

Sometimes no stock tray will adequately fit the mouth, indicating that a custom tray will have to be included in preparation for the final impression. Modification of the stock tray with wax or compound may be necessary to allow the impression of border tissues or high palatal vault. All these issues must be evaluated at the preliminary impression so that in the final impression the clinician can concentrate on those factors related to accuracy of the impression of the hard tissues.

Alginate can be expected to give overextended borders due to its consistency when properly mixed. Under no circumstances should the powder/water ration be changed to reduce the viscosity of the mix. Rather, the amount of alginate required to make a quality impression should be carefully estimated and only that amount placed in the tray. Alginate must be placed into the critical areas: occlusal surfaces, marginal gingival crevices, soft tissue undercuts, etc. One cannot count on the material flowing to these areas of its own accord. The material can be placed with the finger or injected using a syringe but in no instance should the tray be placed in the mouth until all critical areas are wiped with alginate. Borders should be filled using a syringe. The critical areas are buccal to the tuberosities and the retromylohyoid space, places where voids are often found in the completed impression. Another advantage of placing alginate in the mouth before seating the tray is that less material need be placed in the tray resulting in increased visibility for tray placement.

Whenever possible, the stock tray is modified by adding wax or compound to allow a minimum of $\frac{1}{4}$” of alginate around all critical structures. A common problem with alginate is overseating of the tray resulting in less than the required $\frac{1}{4}$” of material over the occlusal surfaces. Stops can be placed in the tray using hard wax or dental compound to restrict the overseating. Unfortunately, the area of the stop will often be distorted due to the minimal alginate present. The required occlusal spacing may be obtained by placing the empty tray in the mouth, seating it to contact with the occlusal surfaces and evaluating the relative position of the handle to the lips when the tray is lifted the $\frac{1}{4}$.” In making the impression, the tray is seated to that lifted position and held in place until the impression is set.
When the impression is removed from the mouth it must be rinsed and lightly dried and then inspected for tears, for alginate will usually tear before it distorts. Visual inspection will also show any evidence of the material breaking free from the rimlock or retentive holes. When using a rimlock tray, excess alginate should be cut from the borders with a sharp knife so that the edge of the tray can be seen and the retention of the alginate verified.

Alginate is clearly an abused impression material but it is the material of choice for both preliminary and final impressions for the removable partial denture. Seldom is the alginate mixed for the manufacturer’s recommended time. Likewise, it is often not allowed time for a complete set before removal from the mouth. Many inaccurate impressions can be traced to the patient’s inability to remain motionless during the setting phase. When the time in the mouth has been altered by using very cold water or not mixing for the usual 60 seconds, the patient is forced to remain motionless for longer than necessary. Since alginate sets, not all at once but in scattered islands of setting material, any movement by clinician or patient during the setting period runs the risk of reorienting the partially set material, producing a distorted impression. Ideally, the set should begin promptly after the tray is in its proper position and any border molding has occurred. Alginate mixed with the proper measure of room temperature (65°-70° F) water will allow roughly a minute for loading the tray and placing it in the mouth before the set begins. Optimal gelation time should be between 3 and 4 minutes using 68° F water. The patient is instructed to remain motionless during this time. The initial impression gives the clinician the opportunity to test the patient’s ability in this regard to increase the probability that the final impression will be accurate. Should the patient move during the final impression it must be remade and the patient informed again of his part in this procedure.

If the mixing of the alginate is incomplete, a reduction of up to 50% in the strength of the gel can be expected. On the other hand, alginate mixed beyond the manufacturer’s stated time will have reduced gel strength since the forming gels will be broken. Mechanical mixing devices, including vacuum mixing, are more apt to give consistency and thereby accuracy and should be considered as essential instrumentation. Hand mixing for the full minute required by most manufacturers is not that easily accomplished and, as a result, the mixing time is seldom fully utilized.
Alginate adhesives must be considered essential for all final impressions but since they are not easy to remove from the tray they are not required for the diagnostic impression. When a stock rimlock tray is used, however, care must be taken to force the alginate into the rimlock with the spatula when loading the tray. Once this has been done, the alginate is not likely to pop free of the lock. Nevertheless, the impression should be carefully inspected before pouring so that if a separation has occurred the set alginate can be replaced in the lock of the tray. While this maneuver would be unacceptable for a final impression, it will normally produce a cast that is accurate enough for diagnostic procedures.

Once the impression has been removed from the mouth the following series of steps, performed in the following order will maximize chances for an accurate diagnostic cast:

1. Rinse the impression under running water.

2. Using a cotton tip, gently clean the tooth impressions. (Plaque and other oral debris, if left in the impression, will reduce the surface hardness of the resultant cast since the surface hardening agents in the alginate must come into contact with the dental stone to gain the maximum quality of cast).

3. Blow excess fluid from the impression and evaluate the impression under good light for tears and defects.

4. With an indelible pencil or other marker, the clinician will trace the outline of the proposed denture on the alginate. Since the patient is still in the chair, extensions can be quickly verified. Should contours seen in the mouth and essential to the construction not be present in the impression, the decision to remake the impression will not require an additional appointment. Attempts to identify denture base extensions from a stone cast days after the impression was made often lead to problems with extensions and will never be as accurate as those determined via this method of drawing on the alginate impression.
5. The technique used to pour the preliminary impression is immaterial and any approach that results in a dense cast with no voids and a base suitable for mounting in the dental surveyor will suffice for diagnostic purposes. As a minimum, the cast should be trimmed so that a land area of 3 mm is established and any and all blebs removed since this cast may well be seen by the patient as well as by the technician. My experience has been that a neat diagnostic cast with a careful design, properly drawn, goes a long way to indicating that the clinician really does know what the standards are and that technicians are impressed when they see a quality diagnostic cast.

PRE-PROSTHODONTIC THERAPY

One of the essentials of the state-of-the-art removable partial denture is the level of mouth preparation that is required before the actual partial is constructed. Mouth preparation is, unfortunately, usually interpreted to mean only the creation of rest preparations on some of the remaining teeth. Unfortunately, reviews of cases submitted to the dental laboratories show that many mouths have not even this level of mouth preparation.

For the modern RPD, mouth preparation will cover any and all therapy required to bring the mouth to optimum health and to modify tissue in such a manner as to make the final prosthesis ideal. Obviously, a removable appliance can be made accepting the mouth as it presents. In fact, most of the RPD’s seen in any review of prosthetic treatment will fall into this category, with little or no recontouring of teeth, occlusal plane discrepancies, malocclusions and the like. A discussion of the basic therapies for mouth preparation at this point in the treatment planning process is necessary to fully develop the concept of ideal mouth preparation.

While the sequencing of the actual care is a critical issue, the sequencing of consultations is not. The prosthodontist will almost always manage the restorative dental examination and caries risk assessment. Nutritional evaluation for those patients with obvious active caries may be referred to a nutritionist although there are computer software programs available so that a diet survey, completed over a 5-day period by the patient, can be analyzed without special training in most cases (e.g., Food Processor Plus 6.0 ESHA Research, Salem, Oregon).
The periodontal examination is a different matter since most prosthodontists work with a circle of periodontists with an exchange of referrals. No matter how the data is gathered, a baseline of pocket depth, furcation involvement, plaque scores, mobilities and general periodontal soft tissue conditions must be made. Baseline data of this magnitude provides the clinician with a starting point for referrals as well as protection for medical-legal matters.

Endodontic referrals are apt to be more common, especially those regarding existing endodontic restorations. Re-treatment decisions can greatly affect the treatment plan, both in regard to abutment selection and to total cost of care. Root canals exposed for any reason for more than a few weeks should be treated before definitive care is undertaken as a protection against failure after crowns have been cemented.

Orthodontic and oral and maxillofacial surgical consultations are almost always case specific and may not always be necessary, although to plan treatment without them the clinician must be assured that they cannot contribute to the care of the patient. A large number of cases will require minor tooth movement to align the arch and to establish the ideal occlusal plane. Often these consultations can best be done after a preliminary treatment plan and design has been established.

Along with the periodontal examination, the evaluation of existing restorations and tooth contours is critical to our treatment. In far too many instances, restorations of marginal quality are left in the mouth and the partial built around them.

A critical component of treatment planning involves the use of dental implants. Obviously, patients with unlimited funds can avoid a removable partial entirely except for immediate and temporary restorations used initially in treatment. There will be situations where implants cannot be placed, usually in very complex treatments. Implants and considerations for their use will be discussed later in this book.

Once the above information has been gathered, the clinical findings can be summarized as a part of the patient’s record and included in the treatment plan letter and a diagnosis and prognosis of the mouth with and without treatment established. At this point, the diagnostic casts, x-rays and perio charting are reviewed together and the cast “surveyed” to determine the
RPD options. The treatment plan and the patient’s informed consent letter can only be completed after the tentative design of the final appliance has been established.

Is all this really necessary? Must a written treatment plan and consent letter be given to the patient? Should we make an orthodontic consult a part of our chain of diagnostic procedures? The answer to these and similar questions is, of course, most certainly yes! The type of treatment described in this book, the partial denture at the most advanced level, does require more work, both in planning and execution. The results are, very obviously, worth our time and our best efforts.
Chapter II

RPD Design

Ever since the publication of Dr. W. Frantz’s study of the variations in partial denture design (J Prosthet Dent, 1973), I have been troubled by the seemingly total lack of consensus on the design of a conventional partial denture. I can understand that there would be some different approaches to any partial design but to find that there is apparently no commonly held approach to the design that would result in a minimum of variations is troubling. It may well be that the average clinician simply does not have sufficient repetitions of similar partially edentulous situations to develop a consistent philosophy for designing a partial denture.

For any situation where there are inadequate repetitions or where the consequences of overlooking a particular step are unacceptable, the development of a checklist, not unlike that used by the pilot of an airplane is in order. The checklist that I have used and taught for these many years is based on what I believe to be the most logical approach to determining the design of any removable partial situation. It focuses on clinical rather than laboratory decision making and is broken down into the following categories, always in this order since it ranks the components by clinical importance.

Elements of Design

- Abutments and Rests
- Connectors, Major and Minor
- Resin Retention and Reinforced Acrylic Pontics (usually single teeth)
- Retention, Clasp or Attachment

Design concepts

- Abutments and rests

As described under “Philosophy of Care”, a removable partial denture need be only SIX things to be successful: strong, stable, retentive, esthetic, comfortable and pain-free. The relationship between the abutment tooth
and the framework is the most important of all design and construction considerations. In keeping with this thought, the selection of the remaining teeth to be used as abutments becomes critical. We would define an abutment as any tooth that bears the vertical and oblique loads placed upon the partial through positive rests. Positive rests are defined as rests that form acute angles with the minor connectors that connect them to the major connector. With a rest/connector angle of less than 90°, the partial framework, if it really contacts the abutments, cannot get away from the tooth and the tooth cannot move away from the partial. **Fig. 2-1** The proximal rest form is used as well for the foundation of the lingual ledge rest on a fixed restoration.

![Cingulum, Occlusal, Incisal, Proximal (crown)](image)

**Fig. 2-1**

Whenever possible, missing anterior teeth are to be replaced with fixed partial dentures, leaving the RPD to replace posterior teeth. Attempting to replace both anterior and posterior teeth on the same casting is a compromise that may affect both esthetics and abutment stability. As an additional benefit of anterior fixed replacements, the abutment castings will be given ideal contours to support the posterior partial and to allow the elimination of buccal clasp arms. A variety of precision attachments can be added to these abutment crowns to eliminate anterior clasping as well.

Selection of the abutment teeth begins with an evaluation of the strength of the tooth. As a general rule, we must consider the strongest remaining teeth first and then progress to weaker teeth as we decide upon the number of teeth necessary to support the partial. Whether or not a tooth is ultimately selected to be clasped as well as rested is immaterial at this time. It is always preferable to include more abutments rather than fewer since the only down side of extra abutments is to make the casting more complex in geometry and thus decrease the likelihood of a perfect fit. Obviously, the
number of teeth to be replaced is related to the number of abutments needed for support. **Clinical research has shown that long term health is directly related to the number of abutments.**

The choice of rest preparation that is placed upon the selected abutment tooth is generally obvious: occlusal rests for posterior teeth and cingulum rests for incisors. Since there is often inadequate enamel present for cingulum rests, especially on mandibular cuspids and incisors, these rests are most likely to be made with either bonded etched metal, bonded composite or pressed ceramics.

A tooth that is contacted by the partial but not through a positive rest cannot be considered an abutment. A good example of what might happen in this situation can be illustrated by a Class I mandibular partial where a lingual plate is used as the major connector and, after a period of time, a clinical evaluation shows that the incisors have moved out of contact with the plate. The effect of a positive rest can be obtained with minor connectors (guide plates) only if they touch the tooth on opposing sides and above the height of contour since the tooth is not able to move away from the partial. This situation is rare and usually limited to the management of existing crowns with porcelain occlusal surfaces where preparing an adequate rest may damage a crown that need not otherwise be replaced. **Fig. 2-2**

![Fig 2-2](image)

A factor that will affect the selection of abutments is the quality of the remaining tooth, both restoratively and periodontally. Teeth that have multiple old restorations with marginal leakage must be considered for crowns. Teeth that are healthy but mobile may need splinting, especially if
they are terminal abutments. Teeth that are unlikely to remain for any reason for the expected life of the partial, i.e., 10 years, must either be extracted before definitive care begins or the framework must be designed with their replacement in mind.

Teeth that are malaligned relative to the plane of occlusion may also be considered compromised abutments and will often require minor tooth movement to make them adequate supports for the partial.

Endodontically compromised teeth that require post and cores must have adequate tooth structure to allow at least a 2 mm ferrule effect. A tooth that will be the terminal abutment in a Class I situation will require a greater ferrule. Any previously treated tooth that has had the fill exposed to the oral cavity for any reason must be considered for retreatment before being accepted for use as an abutment. **Fig. 2-3**

Once the abutments have been selected and the need for restorations (if any) verified, we move on to the second design consideration, that of choosing the connectors, both major and minor. Since the options for the major connectors are arch specific it is best to consider them independently.

**Maxillary Major Connectors**

The major connector of choice is one that will, whenever possible, cover neither the anterior nor the posterior palate. Studies have shown that the connector commonly called the broad palatal strap is the one most acceptable to the patient. This connector crosses the palate in the area of the mesial of the second bicuspid to the distal of the first molar and must be a minimum of 15 mm to have sufficient rigidity without being too thick. **Fig. 2-4.**
A broad palatal strap measuring, for example, 15 mm in width and having a cross sectional thickness of 0.5 mm will, for all practical purposes, be rigid in normal function. Unless anterior teeth are being replaced by the partial, this design is compatible with all posterior replacement situations. In situations where an isolated lateral incisor is being replaced, the casting can be extended as a cantilever from the cuspid so as to keep the anterior palate (speaking area) uncovered. **Fig. 2-5**

It is essential that the cuspid have a very positive cingulum rest to support the cantilever against lateral forces.

In distal extension situations, the lateral extensions of the major connector are brought posteriorly to flow into the hamular notch area, thus assuring maximum coverage of the edentulous ridge. An alternative design often employed for the maxillae is the anterior-posterior bar which, I believe, places metal in the least acceptable portion of the palate. The anterior bar will be in the speaking area and the posterior bar will often be too far posterior for patient comfort. The resulting open central palate will have an extended border that can lead to excessive food collection under the partial.
Potential further tooth loss within the life of the partial must always be considered in the major connector design since the teeth in question need to have a lingual plate contact with the casting if they are to be easily added to the partial without affecting the quality of the prosthesis. A laser welded component can always be added but at a sizeable additional cost.

**Mandibular Major Connectors**

Designing a major connector for the lower jaw should be far easier than for the maxilla. Choices are limited to: lingual bars, sub-lingual bars, lingual plates, dento-lingual bars, some combination of these four and, in very isolated instances, labial bars. The connector of choice will be the one that covers the minimum amount of soft tissue. The standard lingual bar does have space considerations that must be observed. The superior border of the bar must be 3 mm from the gingival margin of the remaining teeth to minimize soft tissue irritation. There must be 4 mm of space for the casting below this point in order to have a rigid major connector with minimum bulk. The commercial clasp patterns used by our laboratories are very close to 4 mm in width. Therefore, 7 mm of space between the gingival marginal tissue of the remaining teeth and the functional depth of the floor of the mouth is essential if a lingual bar is desired. When less space than this is available, the clinician must choose either a lingual plate or the dento-lingual bar, where the superior border is above the level of the cingulum and contacts the remaining anterior teeth or the sub-lingual bar. This connector has the same relationship with the gingival tissues of the remaining teeth but the bar is rotated 90° and placed on the anterior floor of the mouth. **Fig. 2-6a**
The dento-lingual bar as almost the same dimensions as the conventional lingual bar with the only difference being the simulation of lingual anatomy.

Fig. 2-6a

Fig. 2-6b shows the dento-lingual bar used as both the anterior and posterior major connector for this Class III RPD for the mandible while Fig. 2-6c show the same type of connector used in the posterior teeth of a maxillary Class IV. The dimensions are suggested by the size of the abutment teeth. With these connectors, the soft tissues can be left uncovered when 4-5 mm of space remains in the coverage area. The dento-lingual bar may appear to be too narrow to have sufficient rigidity but its use in Class III situations is appropriate and much appreciated by the patient.

In the very few situations where the remaining mandibular teeth are severely lingually inclined, the entire major connector can be brought out into the labial vestibule. The dimensions of the bar must be increased for rigidity since the arc will be longer. The soft tissues are given the same 3 mm clearance as in the lingual bar.
Minor Connectors

The ideal minor connector relationship will be one where the marginal soft tissues will be uncovered whenever possible. 6 mm of clearance from the marginal tissues in the maxilla and 3 mm in the mandible are considered adequate. The minor connectors are to be placed onto prepared tooth surfaces whenever possible in order to act as guide planes and restrict the path of removal and will take the form of guide plates and rest struts and, where necessary, lingual plates. Numerous studies have shown that soft tissues that are not covered by the partial will be healthier than those that are covered, regardless of the oral hygiene of the patient. Metal dimensions for minor connectors that end in occlusal rests are based primarily upon having enough metal present (> 1.25mm) so that the rests will not fracture with time at the marginal ridge. The guide plates can be quite thin (0.5 mm) since they take little or no flexing stress and are not apt to be in occlusal contact. The approach arm of the minor connector must have a minimum of 1.5 mm of metal, both mesial distally and buccal lingually, to insure adequate strength.

Whenever possible minor connectors in the form of guide plates should contact paralleled guide planes prepared on enamel, augmented with bonded metal or composites or in the contours of crowns. They will most likely be found on the proximal surfaces of abutment teeth adjacent to edentulous areas. In special situations they are added to lingual surfaces of teeth to isolate the path of insertion/removal. This will most often be done when teeth remain on one side of the arch only as in maxillary obturators for hemi-maxillary resections. The use of multiple guiding planes and the guide plates of the framework that actually contact them greatly increase the stability and the frictional retention of the RPD.

Resin Retention

The third element of removable partial design is one that is almost always left to the laboratory technician to select, even though it is a decision that is clinically based. For the most part, the choice of retention for the denture teeth and associated base resin is simple. When it is certain that the edentulous area will need to be relined during the life of the partial, then the standard raised mesh is selected. These situations will be limited to those
involving distal extension bases and areas of recent extraction. In every other instance, a metal base with appropriate retentive lugs or loops is indicated. The internal finishing line for these metal bases will be a butt joint slightly to the buccal of the ridge crest and the external as shown below. Fig. 2-7

The reason that the metal coverage is preferred is that it places highly polished metal over the gingival marginal tissue rather than the thin flash of resin that is commonly found with the standard raised retentive mesh. When mesh must be used, the laboratory must be instructed to use a minimum of one thickness of baseplate wax as the relief pad rather than the usual 24 to 28 ga wax. The angle of the internal finishing line is a critical component of the retentive mechanism. For the raised mesh, the internal line is formed by the shape of the wax relief pad. Fig. 2-8

For an ideal internal finishing line, the angle formed in the wax must be acute so that the resultant contour in the casting will trap the resin in place and reduce the percolation that occurs with thermal changes. Resin bonding agents, properly placed, will overcome the potential for resin-metal separation but their use is not presently a part of the normal processing protocol in most dental laboratories. The external finishing line must also provide an acute angle so as to lock in the resin and reduce leakage. The finishing line must extend from the appropriate line angle to the occlusal surface so that the denture tooth can be placed in a normal position with a small amount of resin between it and the finish line.

For the single tooth replacement, there are various options available to the clinician and the technician. Most commonly, some form of reinforced acrylic pontic is chosen. These can be best described as metal ridge
coverage with a post extending into the denture tooth. Additional metal beads will enhance the retention. **Fig. 2-9**

![](image)

Under no circumstances should raised mesh retention be selected for the single tooth as the amount of retention created in the constricted mesh space is inadequate to retain the denture tooth.

When space is lacking, a metal backing, waxed as part of the casting but having the attributes of the lingual aspects of a fixed pontic, is indicated since additional support is required against the forces of incision. This “pontic” is then veneered with a composite resin. **Fig. 2-10**

![](image)

**Fig. 2-10**

When the occlusal surface of the pontic is an integral part of the casting, the opposing cast, if there is any, must accompany the master cast to the laboratory. When the opposing occlusion is a denture tooth, the anatomy of the occlusal surface of the metal pontic should mimic the selected denture tooth.

The most efficient way to manage the single tooth replacement is to select the denture tooth before the master cast is sent to the lab for the framework. The tooth is ground in to fit the edentulous area, an esthetic try-in is arranged, if appropriate, and a matrix, made of either firm putty or of plaster, formed to positively position the denture tooth on the master cast. The technician will utilize the matrix and the denture tooth when waxing the framework and the result will be a retentive form keyed to the ideal tooth position. Obviously, this technique is most often needed for the replacement of anterior teeth and is essential when two or more adjacent
anterior teeth are being replaced on the partial. On some occasions when a denture tooth cannot be found that matches the shade of the adjacent natural teeth, a composite veneer (Visiogem or similar material) can be placed in a properly designed metal pontic. These materials can be blended and stained to match almost any tooth. They are, however, quite brittle in shear and, as a result, should have metal at the incisal to protect the veneer. The partial denture casting can be .3 mm thick at the incisal or occlusal and still be rigid enough to withstand incising forces. Whenever possible, the single tooth replacement should be planned to exit from the tissue as a fixed pontic, without any resin flange. When two adjacent teeth are replaced, a very short flange may be required to provide for the interdental papilla. **Fig. 2-11**

Often this short flange can be kept very thin and made to closely match the surrounding attached gingiva with a minimum of tinting of the base with the Kayon resin (Earl Pound Technique). For heavily pigmented gingiva, the flange can be packed in clear resin with appropriate tinting so that the patient’s gingiva can be seen through the very thin flange. The red fibers normally found in standard denture resins must be removed by sifting the polymer through a 2 x 2 gauze since the presence of the fibers in the area of the attached gingiva can never be anatomically correct and will spoil the esthetic effect of even the most carefully tinted resin.

**Clasp Retention**

The forth, and final, consideration in the design of the removable partial denture is that of “spring” retention, usually a retentive clasp arm. Clinicians have often felt that clasp selection was by far the most important consideration in design. Clasp types, be they “I” bar, wire or cast, circumferential or reverse back action, or any other of the many clasps that have found a place in prosthodontics, do not appear to have any clearly defined affect on the clinical success of the partial denture. What is more important is that the clasp be properly made to be strong, retentive, esthetic
and to do no harm. We will base our selection on these factors alone and will consider the type of clasp the least important component of our advanced partial denture.

Since the laboratory plays such a large role in the design of the standard RPD, it is not at all strange that the laboratory may emphasize clasp construction. Our technicians are often forced to create castings with little or no evidence of preparation of the remaining teeth. The undesirable undercuts that may exist force the technician to devise ways to work around them, resulting in clasps that are excessive in number and generally unaesthetic. A laboratory designed RPD will usually have more retentive clasps than one designed by a prosthodontist, since careful mouth preparation can be expected to create parallel guiding planes that will give frictional retention. The number of clasps, especially those that might be esthetically unacceptable, can also be reduced by the way the casting is managed when fitting, finishing and polishing. These techniques will be fully discussed later in this text.

When retentive clasps are contemplated, their length, taper and cross sectional width-thickness ratio must be taken into account as well as the alloy from which they are made and the degree of retentive undercut in which they are placed. All these factors will describe a retentive clasp arm of any configuration that can be expected to function below its proportional limit. Factors that result in a distortion of the clasp arm from any cause must be altered so that the clasp will perform as desired for the life of the partial.

**Clasp Forms**

Given a mouth that has had ideal mouth preparation, either subtractive or additive, there are only 4 forms of retentive clasp arms that need be used. They are as follows:

**Circumferential Cast Clasp**

This clasp is the most commonly used of all the clasp forms and is easily constructed by the laboratory and adjusted by the clinician. While it is strong, it is also rigid and potentially unaesthetic. It is therefore indicated
for the posterior part of the mouth and, because of its rigidity, best used in tooth-borne situations. A modification of the circumferential clasp commonly found in a variety of situations is the embrasure clasp, which is nothing but two circumferential clasps back to back. This clasp, used primarily in fully dentate sextants is unnecessary in conventional RPD’s but does have a place in some maxillofacial prostheses. The amount of retention gained from the anterior projecting arms of the embrasure clasp is usually excessive and when that anterior component is on a bicuspid it will become quite rigid due to its reduced length. The buccal clasp arm is apt to be unaesthetic as well. In the well-prepared mouth, the posterior component on the molar provides adequate retention for the conventional partial. The embrasure clasp passing through a contact area is a clasp that often breaks in service. The reason for this is that there is seldom enough space created through the contact areas of the two teeth at the embrasure. As a result, the clasp is often found to be in hyper-occlusion. The adjusting of the metal to allow tooth contact with the opposing arch weakens the clasp by making it thinner at the buccal extension of the marginal ridge than it is further along the clasp arm. This thin area sets up a flexure point in the clasp and after repeated movement of the clasp arm in function a stress fracture develops. Repair of this broken embrasure clasp is difficult, if not impossible, to accomplish with any hope of long term success. To create adequate space for the most commonly used clasp pattern, the clinician must prepare a channel measuring 1.5 mm by 1.5 mm for one clasp coming through the embrasure and 1.5 mm by 3.0 mm if two clasps are run through that same embrasure.

Fig. 2-12

The cast circumferential clasp pattern that should be requested when maximum flexibility is required is one with a width/thickness ratio of near 2/1 (Howmedica pattern 3MA40, is an example).

Fig. 2-13
The 1:1 ratio clasp is a 1BA55 and is about 3x as stiff as the 2:1 clasp.

The conventional approach to the cast circumferential clasp requires that a bracing arm, theoretically placed more gingivally on the tooth, be used to provide reciprocation. The need for this bracing arm, customary since the days of banded clasps made of plate gold where both arms entered undercuts, has never been clear to me, especially if the clasp pattern had the same width/thickness ratio as the retentive arm and was of similar length. The ideal bracing arm should be made from a pattern having a width/thickness ratio that approaches 1 to 1.

There are other ways to achieve reciprocation that are not clasp dependent. These would include precise guiding planes on the minor connectors to the rests as well as the natural contact of the tooth to the adjacent tooth. In order for the so-called bracing arm to function as it has been proposed it should, it must contact the abutment on a surface parallel to the path of insertion in such a way as to hold the abutment tooth in position as the retentive clasp arm passes over the height of contour and the rest seats fully. This situation normally only occurs when a milled surface has been prepared on a casting for the abutment since the natural tooth is unlikely to have parallel walls opposite the retentive clasp arm. Once the partial is fully seated the prepared guiding planes provide lateral bracing for the partial in a way that clasp arms never can. Fig. 2-14
**Circumferential Wire Clasp**

The “wrought wire” clasp, as it is universally known, has long been considered the clasp of choice for Class I and II partial dentures, especially for the mandible. It is obvious that a structure that is cold rolled, as all wires are, is going to be more flexible than a cast clasp of similar dimensions. In addition, because it is round, this clasp will be roughly 3x more flexible than a ½ round cast clasp when loaded other than horizontally as it would be as the prime retentive element on a lower bilateral distal extension partial. The retentive properties of wire are dependent on alloy, length of the active clasp arm and gauge.

The means of attachment of the wire to the framework also has an effect on the flexibility of the clasp, with the most ideal situation being one where the wire is attached some distance from where it is expected to flex. This would normally be on the resin retention area 1/3 of an inch back from the tooth. Both precious and non-precious wires can and have been used for retentive clasp arms. There is generally one gauge difference between a precious wire and one that is an alloy of Ni-Cr or similar material with the non-precious wire being stiffer. The Jelenko Standard wire has proven to be the clasp wire of choice (Au 63%, Ag 11%, Pt 10%, Pd 2% and Cu 13%). Since it is no longer made other wires, with similar composition, must be used and can be expected to show a similar performance.

In order to get maximum flexibility from the circumferential wire clasp, every effort must be made to keep the bend placed in the wire in two planes. Historically (and before mouth preparation) wires took the place of plate gold clasps. They were bent to conform to the un-modified tooth contours and, as a result, were bent in the three planes of space as the clasp made an abrupt bend from the marginal ridge towards the gingival and was then contoured around to the mesial of the tooth to enter the undercut. As each successive bend was made, the wire flexibility was reduced.

Accurate tooth modification to reduce the undercuts on the proximal 2/3 of the buccal surface allow the clasp to exit from the flange area close to the gingiva and enter the retentive area in the terminal 1/3 to a depth of 0.01” to 0.15”. **Fig. 2-15**
The selection of gold wires is based primarily on active length according to this simple rule which allows each wire to perform below its proportional limit: clasps with an active length of $<7$ mm should be of 20 gauge, those with a length of 8 to 10 mm will be of 19 gauge and those $>10$ mm will require an 18 gauge wire. At these distances and these gauges, the wires will give approximately the same amount of retention and remain below their proportional limit. While it may be possible to place some wires into undercuts of $>0.15”$ and still have them function without distortion, there is no clinical evidence that this increase in undercut depth is of any value. The wire clasp can be used successfully on the lingual surface of most mandibular bicuspsids, in conjunction with a distal guide plate that extends slightly beyond the distal facial line angle and a mesial rest or positive contact with the adjacent tooth, to provide retention without any display of buccal metal. **Fig. 2-16**
In these situations, the clasp arm will be very short and must therefore be of 20 gauge or finer. The major connector would normally be a lingual or sublingual bar, at least in the area of this clasp, so that the requirement for 3 mm space at the superior margin of the bar can occur. In the maxilla, the major connector is opened to the lingual as a matter of course whenever possible so that finding a lingual surface for the wire retentive clasp arm is not normally a problem if the tooth contours provide any retentive areas of 0.010” or greater. There is no need for a buccal bracing arm in these situations. When the major connector cannot be opened, for any reason in either arch, it is still possible to utilize only a lingual circumferential retentive clasp arm if sufficient tooth height exists to permit the wire to sit on the occlusal border of the lingual plate at the level of the height of contour and then enter the undercut at the terminal third where the lingual plate dips below the 0.010” undercut. The only disadvantage to this design is the very slight opening of the major connector beneath the clasp tip. 

Unlike cast clasp arms that can be expected to break if they are deformed and then recontoured more than a few times, wire clasps (especially those of high gold alloys) will withstand repeated re-adaptation without any change in their retentive properties. Since these clasps are more flexible, they have the disadvantage of being far easier for the patient to deform if they are used as handles to remove the partial from the mouth. Patients must be warned that deformation of a properly placed wire clasp can only occur if the wire is loaded beyond its proportional limit and that will not happen if the clasp is not distorted by the patient. Some patients insist on biting their partials to place rather than placing them with the fingers of both hands. Patients must be shown that they can use the flanges of the denture base as a purchase point for removing the denture. Sometimes the placement of a simulated Class V cavity on a denture tooth will give the patient a purchase point to apply a dislodging force. When the clasp has been placed on the lingual surface the patient is unable to use the clasp arm as a lever and the clasp is likely to remain in position.
Infrabulge Clasps

Infrabulge clasps have long been advocated as an alternative to the wire circumferential clasp for Class I and II situations. They have been proposed as a more esthetic alternative to the cast circumferential clasp as well. These clasps can come in a number of forms and can be either cast or wrought. The most commonly used infrabulge clasp has been the “I” bar, which was to be placed at the greatest convexity of the tooth mesial distally as seen from the horizontal (there is no clinical evidence that this precise placement makes any difference). When combined with a proximal guide plate at the edentulous side of the prime abutment and a rest at the other end of the occlusal surface, no bracing arm was required since the tooth cannot be displaced by the action of the retentive clasp arm. Depending on the contact of the guide plate, stress relief can be created with this system for the Class I situation. When the “I” bar clasp is made of a suitable length and gauge of wire, additional advantages are possible. Since the wire is added to the casting by soldering after the frame has been finished and polished, it is possible to place the clasp arm very close to the buccal extension of the guide plate. Fig. 2-18

![Fig. 2-18](image)

With this distal positioning, the clasp arm becomes shorter and must therefore be of a higher gauge to retain flexibility (normally a 20 ga. wire will be chosen). The guiding plane and plate must extend fully to the line angle and a positive rest on the opposite side of the abutment must be used to provide reciprocation if the distally placed “I” bar is on a terminal abutment. If this type of clasping is used on the anterior abutment of a Class III partial denture, the need for precise reciprocation is not as great since the posterior abutment will restrict distal movement of the partial.

The contact between the “I” bar and the retentive area must not be a point contact. Instead, the wire is contoured in such a way as to present a line
contact or a surface contact. When a cast “I” bar is used, the surface contact is created in the blockout and waxing of the framework Fig. 2-19

![Fig. 2-19]

These expanded contact areas provide a margin of error for the technician since placing a clasp tip at point contact on a repeated basis is an unreasonable request.

While the “I” bar clasp is by far the most common of the infrabulge clasps, there is an occasional need for an “L” bar when the only available usable undercut is immediately adjacent to the edentulous area and where even a light wire “I” bar will be too short and therefore too rigid. By bringing the approach arm up to the mid buccal of the tooth and then bringing the base of the “L” distally to the retentive area, sufficient clasp length can be developed in most situations. Fig. 2-20

![Fig. 2-20]

This clasp form can be created in either cast metal or with wire, again remembering to choose the appropriate gauge based upon the active length of the clasp.

Other forms of bar clasps have been advocated over the years, primarily the “T” bar and occasionally a “U” bar. These forms have no place in the modern RPD and are generally unaesthetic and difficult, if not impossible, to adjust, especially if they are made in cast metal.
There is one major contra-indication for the infrabulge clasp. The height of contour of the soft tissue in the area of the proximal approach arm and the degree of soft tissue undercut can make the bar clasps unacceptable. If the height of contour is very close to the buccal marginal tissue, the approach arm will have to stand out from the tissue since it cannot be in an undercut relative to the path of insertion as determined by the guiding planes. If that soft tissue undercut is severe, the clasp may abrade the buccal mucosa in normal function.

Even the most casual glance at any text on removable partial dentures will identify many other clasp forms: ring clasps, back action clasps, “C” or fish hook clasps and on and on. These clasp forms have all been created to work around contours that have not been adequately modified with appropriate mouth preparation or, in some cases, teeth that need minor orthodontia to return them to a normal position in the arch. If there is no useable mesial undercut for a circumferential wire clasp, undercuts on the lingual surface will have to be used or the tooth modified with some form of additive mouth preparation. Given quality mouth preparation, no other clasp forms, beyond the cast and wrought circumferential clasps and the “I” and “L” bar clasps, either wrought or cast, are indicated.

There are two other general categories of cast retentive elements that will be considered later in this monograph, the rotational path of insertion partial and the hinged connector (commonly referred to as a “Swinglock”). These two special types of frameworks may include conventional clasping in addition to their special retentive devices.

Attachments, whether precision, semi-precision or resilient, obviously take the place of the retentive clasp and are described in detail later in this manuscript.

DESIGN SPECIFICS CLASS I-IV

With an understanding of the component parts of the partial denture, we can now look to specific design considerations for each of the four basic classifications of the RPD. There will be many areas of overlap in design, but the intent of this section will be to identify basic principles of design for
each class independently, keeping in mind the four component parts of partial denture therapy.

Before any specific designs can be established, a quality diagnostic cast must be available for surveying. The cast must accurately represent all remaining teeth and those soft tissue covered areas that will be within the denture space. This would include retromolar pads, frenum extensions, and vestibules when bar clasps are being considered.

**FINDING THE PATH OF INSERTION**

The first step will always be to determine the path of insertion and removal. Here the emphasis is on the path of removal since the goal will be to limit the possible directions that the partial can exit from the mouth through preparation of hard tissues. The path of insertion is, of course, the reciprocal of the more important path of removal and is most often presented as being of some importance. In all but one instance, the path of removal should be parallel to the long axis of the prime abutment(s). There will be occasions, usually in Class IV situations and especially in those where a rotational path of insertion is planned, when the path of removal is primarily determined by the soft tissue height of contour.

The path of insertion/removal is frozen in space by the prepared guiding planes and the cast plates (minor connectors) that touch them. Undercuts on hard or soft tissue exist only relative to that path, so tilting the cast on the surveyor in order to alter the relative heights of contour to obtain retention will not produce real undercuts unless the path is controlled by the planes. Given the frictional retention that parallel guide plates can provide, there is seldom any need to be concerned about retention. If there are no usable retentive areas anywhere on the desired abutment teeth, then they must be created by either subtractive or additive mouth preparation.

**Class I RPD**

The Class I RPD implies that the partial denture will be both tooth and tissue supported so maximum support, of and on the remaining abutment teeth, is essential. Provision must be made to allow or create stress relief in
the casting, especially on the mandibular arch, so that some support can be placed on the edentulous ridges to dissipate the load of heavy mastication. This can only occur if the casting allows some degree of rotation around the terminal axis when loaded.

**Abutment selection and rests**

Only when the cuspid is the prime abutment (i.e., the abutment adjacent to the distal extension base) should a single abutment be chosen for the Class I partial. A first bicuspid used by itself as the only abutment does not provide sufficient support to replace the missing molars and the second bicuspid. When the first bicuspid is the prime abutment, then that tooth must have an occlusal rest and the adjacent cuspid either a distal incisal or a cingulum rest (for the mandible, this rest cannot be made deep enough and kept in enamel so either bonded metal or bonded composite or pressed ceramic must be used to create the rest seat). Since it is rare to replace only a second molar on a Class I RPD the only options we need concern ourselves with are those mentioned above. The Class I RPD will have a single abutment if that tooth is the cuspid and two abutments if the first bicuspid is the prime abutment. If the second bicuspid is the prime abutment, then there will be either two or three abutments, based upon the level of bony support. **Fig. 2-21**

The position of the occlusal rests on the bicuspids is immaterial although some would say that a mesial rest on the prime abutment is superior to a distal. While there may well be theoretical differences here, there appears to be no difference clinically in the well made and maintained RPD. The path of insertion/removal will be chosen to allow parallelism of the distal surfaces of the prime abutments with minimal subtractive mouth preparation.

The guiding planes created on the prime abutments require a basic decision. In order to allow some stress relief, two techniques have been proposed over the years. Kratochvil suggested that the guiding plane be prepared to be as long as possible with the stress relief coming from a functional relief of the casting before the altered cast impression was made. Kroll, on the other
hand, described a shorter guiding plane extending from the marginal ridge roughly 1/3 the way down the tooth with the occlusal limit of the guide plate being the gingival extension of this shorter guiding plane. **Fig. 2-22**

Here, the stress relief is created in the blockout of the undercut gingival to the guiding plane. The guide plate is effective in reciprocation but can also rotate into the undercut rather than bind on the guiding plane during loading of the posterior denture bases. There is no clinical evidence that would favor one of these approaches over the other. The decision may well rest on the quality of the laboratory support since the reduced length guiding plane/plate requires a greater attention to detail in both blockout and finishing of the casting.

*Another way of looking at the required length of a guide plane is to consider the distance the retentive area for a clasp on the prime abutment is from the height of contour. The guide plane length should be twice this distance to insure that the guide plates contact the guide planes long before the clasp tip reaches tooth contact.*

In either approach, the parallel guiding planes, contacted by the guide plates of the casting, restrict the path of insertion/removal to whatever angle of divergence was established in the mouth preparation phase of the treatment. The closer to 90° parallelism, the greater the frictional resistance to dislodgment with the potential for stress relief still viable. For the Class I partial denture, parallelism must be considered in another plane of space. In order for the partial to rotate freely around its fulcrum, the guide planes must be parallel to each other from the occlusal view as they are in the sagittal. That is to say that they must lie on the same plane across the arch so they can act in an identical fashion under occlusal load. **Fig. 2-23**

For any of the other classes, the effect of the planes is enhanced by being in different
planes as seen from the occlusal.

The same considerations exist for the opposite side of the mouth with the only compromise coming when the distal slopes of the two prime abutments are not parallel and cannot be made so through subtractive mouth preparation. When this occurs (usually when the cuspids are evolved as prime abutments), the best option is to favor the weaker of the two prime abutments. The other (stronger) abutment will be recontoured with additive mouth preparation to allow both sides to be parallel.

Connectors

As stated before, whenever possible, the maximum amount of soft tissue should remain uncovered by the RPD. This would require, for example, the use of the lingual bar over the lingual plate. If, however, there is inadequate space or if there is the potential for loss of some remaining anterior teeth during the life of the partial, a lingual plate or a dento-lingual plate will be the proper choice so that additions can be made easily. It may be possible to combine a lingual plate in the incisor area with a lingual bar distal to the cuspids instead of covering all the lingual surfaces. When space permits, this design is preferred since it offers the potential for lingual retentive clasping and no show of metal on the buccal surfaces of the abutments.

The maxillary Class I major connector varies in the placement of both the anterior and the posterior borders. As the number of teeth to be replaced with the partial increases, the natural inclination will be to increase the coverage of the major connector so that it approaches a complete denture outline. Since there can be no peripheral seal on the partial denture, there is little value in extending the posterior border to the vibrating line. The glandular portion of the posterior soft palate offers no real support to the partial and therefore should be left uncovered. The edentulous ridges, however, do support the partial and should always be covered to the hamular notch, either in resin or with metal. Anterior coverage is dependent on the teeth remaining. If only the 6 anterior teeth are left, going to full lingual coverage offers the option of easy addition of teeth should some be lost as well as providing the potential for additional frictional retention on any guiding planes that can be established. Finding tooth structure on the lingual of maxillary anterior teeth that can be prepared to parallel guiding surfaces is, unfortunately, uncommon. When the remaining 6 anterior teeth
are healthy and not mobile, it is certainly feasible to open the anterior area by projecting a cingulum rest onto a prepared acute rest prep from the distal. The anterior border must then blend into the anterior slope of the rugae area and end posterior to a major rugae. For this approach to be dependably successful, the cuspids must have sufficient distal structure to allow for guiding planes of at least 3 mm. **Fig. 2-24**

Minor connectors will be of standard dimensions with care taken to see that at least 1.25 mm of metal thickness at the marginal ridge is available to support the rests.

**Fig.2-24**

Resin retention

Since the need for periodic reline of the distal extension base is expected, especially on the mandibular arch, the resin retention of choice is a raised mesh retention which must have >1 mm of space for resin below the mesh. In some situations on the maxilla, where there has been minimum resorption of the edentulous extension (and therefore minimal room for the casting and the replacement denture teeth), a metal base with retentive beads as an integral part of the casting is the only viable option. Obviously, this base cannot be relined but in the mature edentulous ridge with the support of the palatal coverage no reline may be needed during the life of the partial

Modification spaces are managed with metal bases and bead or post retention wherever possible. Only very recent extractions could be considered for mesh retention but caution must be taken for a single tooth replacement since the amount of mesh retention available for the single tooth is often inadequate. It is generally wiser to add a tooth to the existing partial denture temporarily or to construct an interim partial for the initial healing period and then construct the new RPD with either a reinforced metal post or a veneered pontic form for the single tooth.
Clasping

The choice of the retentive clasp is determined by two factors: the availability of a retentive area on the tooth and the clinician’s preference. The options may be classified as follows:

Only a mesial buccal retentive area---wire circumferential clasp to 0.015".
Mid facial retentive area with appropriate gingival contour---”I” bar to 0.010" (either cast or wrought).
Only a distal facial retentive area---“L” bar to 0.010" (preferably wrought).
When no facial retentive areas are present or if esthetics is a real consideration---lingual wire circumferential clasps to 0.010" or recontour abutment with either subtractive or additive preparation.

In either arch, one retentive clasp per side will provide adequate retention if the maximum frictional retention is established through mouth preparation and careful fitting of the casting.

In choosing the retentive clasps for the mandibular Class I RPD, consideration must be given to establishing stress relief since the partial will always rotate in function. The maxillary RPD may show very little rotational movement due to the support of the hard palate and the generally superior ridge contour. The weaker the abutment teeth and the supporting ridge, the greater the rotational movement that must be allowed in the fit of the casting. This relief can be obtained in the blockout of the master cast or in the intraoral fitting of the frame (to be discussed later). Along with the fit of the frame, the flexibility of the retentive clasp arms selected plays an important role in stress relief so that a light wire retentive clasp in any of the appropriate clasp forms is indicated when the support is poor. This decision may sacrifice some retention and stability to relieve the abutment teeth from the full load of mastication.

In the Class I RPD, there is no need to consider the use of a so-called “bracing clasp” since the combination of rests/minor connectors and guiding plates and tooth contacts will provide the necessary reciprocation. Even if lingual circumferential clasping is chosen, complicating the casting and
showing unsightly metal using a buccal bracing clasp arm is unnecessary. **Fig 2-25.**

![Image showing unsightly metal using a buccal bracing clasp arm](image)

**Light wire soldered to Frame. 0.010” undercut**

**Fig. 2-25**

**Class II RPD**

**Abutments and Rests**

While the Class II partial design is often considered a mixture of the principles of Class I design and those of the Class III partial, special consideration must be given to the potential for rotation at the fulcrum line that will run from the distal-most rigid contacts of the partial with the abutment teeth on each side of the arch. One might imagine that rotation and the resulting stress relief will occur naturally without any effort. In truth, a decision as to the desirability of allowing motion around the fulcrum line must be made before mouth preparation begins. For the most part, there is no need to plan for stress relief for the Class II RPD since the remaining teeth, if properly contacted on prepared surfaces (and in particular on guiding plane surfaces) will be able to support the teeth being replaced as a cantilever. **Fig. 2-26**

![Image illustrating fulcrum line](image)

**Fig. 2-26**

Mastication will most often occur on the dentate (Class II) side due to increased efficiency in managing food particles so the distal extension side will receive minor loading only. Only when the abutments are weak and few in number must we consider reducing the
length of the guiding planes and functional relief of the casting to allow limited rotation and partial loading of the edentulous ridge. When the casting has been relieved, the support of the edentulous area is obtained through the altered cast impression. In the maxillary arch, additional support for the weakened teeth is obtained by covering a greater portion of the palate and an altered cast impression is normally not needed. In practical terms, however, rotation can occur only if the casting does not touch the abutments, a situation clearly not desirable from the standpoint of stability and frictional retention.

The distal extension side of the partial is treated exactly as in the Class I situation with no exceptions. The management of the tooth supported side offers a few options usually dependent upon the number, strength and position of the available abutments. When the dentate side is complete, i.e. no modification spaces, then an embrasure clasp on the first molar is the retention of choice. This clasp must be cast since the construction of an embrasure clasp made of wire is technically very difficult and the long term dependability of such a clasp very much in question.

The embrasure clasp is placed upon the first molar rather than the second since the mandible curves to the retromolar space starting at about the second molar and this requires that the major connector going back to a second molar stand far away from the tissue, creating a food trap that patients do not appreciate. **Figs. 2-27 & 2-28.**
The first molar is more apt to allow the placement of the major connector in a comfortable position. Under no circumstances should a bicuspid be used in place of the molar since any clasp placed upon it will be shorter and more rigid and is often unaesthetic as well.

The need for additional abutments on the tooth-borne side must be considered. At the very minimum, an additional minor connector and rest must be placed as far forward from the embrasure clasp as possible. This rest/connector combination has been called an indirect retainer and it was assumed that it would counteract the upward rotation of the edentulous base. This anti-rotation device springs from dentistry’s past, as far as partial denture design is concerned, when no mouth preparation for guiding planes was done. In the modern RPD, the guiding planes and the intimate contact with the casting through the guide plates prohibits rotation until the partial has moved beyond the contact of the guiding plane and the associated guide plate. Only at that point could the denture rotate and the “indirect retainer” come into anti-rotational contact. So, while true indirect retention is a thing
of the past, the use of an additional rest/minor connector some distance from
the embrasure clasp is essential to provide a third point of reference for
seating the framework during fitting of the frame, making the altered cast
impression, and for re-relating the framework during future relines of the
distal extension base.

The cingulum of the mandibular cuspid and the distal of the maxillary first
bicuspid are often used for this third point of contact. The mesial of the
mandibular first bicuspid might be more ideal from a geometric standpoint
but, unfortunately, the amount of tooth structure at the marginal ridge often
does not allow the preparation of an ideal, acute occlusal rest.

When a modification space(s) is present we have the potential to develop
additional frictional retention and reciprocation by maximizing the guiding
plane surfaces adjacent to the edentulous space(s) through either subtractive
or additive tooth preparation. At the very minimum, a rest and guiding
plane would be placed upon the isolated molar abutment and the tooth at the
anterior extension of the edentulous space. Additional abutments would be
added as required if the support from the two original abutments appeared to
be inadequate.

Guiding planes for the Class II partial denture should be as long as possible,
provided that the casting is planned as a cantilever. If stress relief is
indicated, the casting will be adjusted intraorally.

Connectors

Major and minor connector design on the dentate side of the partial will be
that of the Class III RPD. Every attempt is made to cover as little gingival
tissue as possible. The dimensions of the castings and their relation to the
soft tissues are the same as for the Class I situation, while the third point of
contact (indirect retainer) may require it to be moved towards the anterior.
In the maxilla, the minor connector to that rest must blend into the rugae
area of the maxilla so that the speaking area is not compromised. Placing a
small part (1/5) of the major connector onto the slope of the anterior palate
and the remaining 4/5 on the more posterior horizontal palate will
strengthen the casting as the corrugation in the metal allows for a thinner
casting with the same rigidity. **Fig. 2-29**
Modification spaces for missing anterior teeth present a special problem in that they complicate the design of the casting and often require that metal be placed in the speaking area of the anterior palate. When a lateral incisor is missing, it may be possible to cantilever it off the rest and minor connector on the cuspid but when central and lateral or two central incisors are missing, a full anterior casting will be required.  

![Fig. 2-29](image)

The veneered incisor can be made in a number of ways; a RAP (reinforced acrylic pontic, usually a denture tooth with a custom post), a laser welded custom component, either using a Ni-CR casting welded to the framework and then veneered with composite or a ceramo-metal restoration, laser welded after porcelain application.

![Fig. 2-30](image)

A better solution to this problem is to replace missing anterior teeth with fixed or bonded partial dentures and leave the RPD to replace only posterior teeth.

**Resin Retention**

The resin retention for the tooth-borne side of the Class II RPD favors the use of metal coverage of the ridge whenever possible according to requirements mentioned earlier. If only a single tooth is being replaced,
special consideration must be given to metal retention since the space is often restricted. Usually some form of a retentive post is designed to fall within the denture tooth. When the desired tooth position is obvious, then the post can be randomly placed by the technician. When the tooth needs to be in some irregular position due to esthetic requirements or abnormal occlusal relations, then the denture tooth must be ground into place by the clinician, verified in the patient’s mouth, and sent along with the master cast in some sort of matrix so that the technician knows exactly where the tooth must be placed.

A final consideration for the Class II mandibular RPD is the potential for conversion after additional tooth loss. The isolated posterior abutment on the tooth-borne side is often a weakened tooth, both restoratively and periodontally, and may not last the life of the partial. In anticipation of the loss of this tooth, the partial should be designed as if it were a Class I RPD, that is to say, with raised retentive mesh, and a mesial rest on the bicuspid that would become the prime abutment on that side of the arch with the potential for flexible clasp on the prime abutment. In addition, the internal and external finishing lines must be positioned as if the posterior abutment did not exist, i.e., at the distal lingual of the bicuspid that will become the prime abutment. The retentive mesh, suitably reinforced, then runs distally to the isolated molar and its clasp assembly. Fig. 2-31

When the molar is lost, the rest, clasp and guide plate are cut off and the resin base extended to cover the total denture space during reline/rebase procedures.

Unfortunately, the maxillary arch cannot be treated in the same fashion for conversion since the major connector in the maxilla will not have a finish line assembly that can be converted to a Class I. Attempts to solder on finishing lines and associated meshwork are technically very complicated and the cost seldom justifies the conversion.
Clasping

Again, the clasp requirements for the distal extension side of the Class II are identical to those of the Class I. On the tooth-borne side, there is a major decision to be made. Since it is rare to find a mandibular situation where more than one clasp per side is needed for retention, the clinician should choose between clasping on the fulcrum line or anterior to it. In most cases, the posterior abutment on the tooth-borne side will be a molar since if it were a bicuspid the case would be considered a Class I. The advantages are clearly on the side of clasping on the fulcrum line, i.e., the molar on the tooth-borne side and the terminal abutment on the other side. Clasp selection for the molar is generally limited to a circumferential clasp, either cast or wire, with the lingual arm being retentive since the retentive area is most apt to be found on that side of the tooth due to its natural inclination in the arch. Since this clasp will be the terminal of the RPD, some reciprocation will be required to maintain the tooth in the arch and prevent it from moving away from the partial. This can be done in two ways: either with a conventional guide plate/rest and bracing arm combination or with the use of an extended guide plate (one that extends slightly from the mesial to the buccal and lingual surfaces) combined with an oversized occlusal rest that extends to the distal fossa. This long rest has the additional advantage of allowing the restoration of the plane of occlusion with the rest if the distal abutment has indeed migrated mesially and lingually. Fig. 2-32

![Occlusal plane](image)

Fig. 2-32

Should the molar be so severely tilted that the retentive area is very deep and very near the occlusal surface, with minor orthodontics not an option for whatever reason, consideration should be given to not clasping that tooth but retaining the guiding plane and the extended occlusal rest and moving the retentive clasp anterior to the fulcrum (to the bicuspid). The clasp choice in this situation can be either a circumferential clasp or an infrabulge clasp. Since the retentive arm will be anterior to the fulcrum, a
wire circumferential clasp arm is selected over a cast one since the potential for greater movement of the partial in function in that area dictates a more flexible clasp. As in other esthetic areas, a wire “I” bar clasp, set to the distal, may be the best choice. Lingual retentive circumferential wire clasps offer the option of eliminating the visible clasp arm.

In the maxilla, a case can be made for the use of three retentive clasps since the force of gravity adds another dimension to the retentive requirement. Here, the molar clasp will most likely be a cast circumferential and the clasp on the distal extension side an “I” bar, since this clasp is less likely to be visible when the patient smiles and speaks. The “I” bar clasp has been presented as having to be placed midway on the tooth mesio-distally in order to function with minimum stress on the abutment. While this may be true on the mandible, there is not enough movement possible on a well-fitting maxillary casting to make any clinical difference. For this reason, the “I” bar clasp can be set as far to the distal as possible as long as there is a mesial rest and a distal guideplate. If a wire “I” bar is used, it is possible to place the clasp almost in contact with the buccal extension of the guide plate since this clasp is added to the framework after the frame has been finished and polished. A cast infrabulge clasp must be placed farther away from the guide plate so that space is available to finish and polish the clasp, making the clasp potentially more visible on the tooth. The third clasp, placed on the anterior abutment on the tooth-supported side, should also be a wire “I” clasp for the reasons given.

**Class III RPD**

This classification of partial denture could really be called a “removable fixed bridge”. In most situations, it uses the same abutments as would a fixed partial denture replacing the same missing teeth. The design options, at first glance, might appear to be endless but in truth can be reduced to only a few basic options as long as the clinician is willing to prepare the mouth ideally. The reasons for choosing the removable partial denture in the Class III situation rather than a fixed partial denture can be reduced to four obvious treatment considerations. The first and most powerful reason is financial. The second relates to those situations where the length of span of the edentulous area and the periodontal support of the remaining possible abutment teeth combine to bring into question the long term success of a
fixed partial denture. The third reason to select the removable partial over the fixed is strictly one of esthetics. The need to replace the interdental papillae in the anterior of the mouth may make a fixed partial denture a questionable solution. While it is true that ridge augmentation in any of its many forms can create an adequate gingival base, the restoration of the papillae is not always possible. Lastly, there will always be those situations where the loss of teeth was accompanied by traumatic loss of the alveolar process as well. In these cases, the need to replace missing soft tissue requires the use of a flange of such dimensions that the appliance be removable to allow the patient access for proper hygiene. The goal of removable partial denture treatment for the Class III patient must be to make the appliance conform to the principles of fixed partial dentures as much as possible.

Abutment Selection

The choice of abutments is generally obvious: one abutment on each end of an edentulous area. This general statement is modified by adding abutments when the potential support of the teeth is in question. Whenever this question arises, it is better to add another abutment since additional frictional retention can be obtained. Unlike the case of the fixed partial denture in which splinted abutments bring potential problems of embrasure access and connector rigidity, double abutting in the removable partial situation causes no particular problems. Remember, abutments must have positive rest preparations to maintain contact between the partial and the teeth over the life of the partial. These ideal rest shapes can usually be created with subtractive mouth preparation in the posterior of the mouth but additive mouth preparation is often required for the anterior teeth.

As well as selecting the abutments and planning their rests, the potential for parallel guiding planes must be evaluated through careful consideration of the path of insertion/removal. The goal of the mouth preparation for the Class III case is to maximize the frictional retention of the guiding planes/guide plates to totally eliminate the need for any anterior clasping. Posterior clasping, one clasp on each side, is more than sufficient when the anterior portion of the partial is controlled by the guiding planes. This partial denture cannot rotate out of the mouth, but must travel down the guiding plane until the posterior retention is no longer effective. Fig. 2-33
For this reason, the guiding planes created on the abutment teeth must be as long as possible in the all tooth-borne case.

Connectors

Major connector design for the mandibular Class III RPD remains basically the same as for the other classes. Again, whenever possible in the mandible, the lingual bar is selected over the lingual plate to reduce the amount of soft tissue coverage. As in the Class II, consideration must be given to the conversion of the casting to a distal extension base when the choice of a posterior terminal abutment is questionable.

Selecting a design for the maxillary connector that will provide adequate strength without bulk and give the patient maximum comfort is more of a challenge. The broad palatal strap design forms the basis of all maxillary major connectors. Modifications will depend on the number and position of the edentulous areas. Major connectors can be kept to a thickness of 0.5 mm if they are planned so that they cover a portion of the slope of the rugae area as well as the vault of the posterior palate, forming a corrugation in the basic form which increases the rigidity of the connector. Again, cantilevers from more posterior rests can be used to replace single anterior teeth and still leave the speaking area of the palate open.

Resin retention

Since there is seldom any need to reline a Class III RPD, ideal resin retention will be metal ridge coverage with retentive beads, loops or posts and the occasional metal pontic. These metal pontics can be veneered or, in the posterior where they will not be visible, left in metal. The full metal pontic should not extend buccally as it would if it were being veneered. By keeping it lingual to the buccal line angle, its presence can be disguised.
Clasping

Clasping is limited to the posterior abutments of the Class III RPD whenever possible since the potential for parallel guiding planes adjacent to the edentulous spaces is great and will eliminate the need for anterior clasping in all but those situations where the clinical crowns are so short that no adequate guiding planes can be created. As the crowns get shorter, the need to have very parallel planes increases, a real challenge in subtractive mouth preparation. Guiding planes that are additive have the advantage of allowing machined milling to create “perfect” parallelism. The clasp of choice for the posterior will be the cast circumferential placed into a 0.010” undercut for the terminal third of the active clasp arm. The need for anterior clasping can best be determined after the casting has been fitted. Should retention appear inadequate at that time, one or more distal wire “I” bars can be added to the framework into a 0.010” undercut.

Class IV RPD

The Class IV partial denture patient classification represents a group of patients for whom the advent of osseointegrated implants has greatly reduced the reliance on the removable partial denture. Many of these patients go through a stage of treatment where a cast partial denture may be employed even though the final prosthesis is implant-supported and retained. The cost of a casting is insignificant when compared with the possible problems of long term all-resin provisionals. For these patients, as well as for those for whom no implant-support or fixed prosthodontics is possible or affordable, the Class IV RPD represents a challenge both in design and construction. Some special types of partial dentures that are used almost exclusively in the Maxillary Class IV, namely the rotational path of insertion partial and the “staple” partial have great potential in this situation and will be addressed later.

Abutment selection and Rest Placement

For the most part, the patient with an extensive anterior edentulous space will need the support of all the remaining teeth. Those with smaller edentulous areas will require at least the teeth adjacent to the edentulous
area and the first molars. Again, the more teeth being replaced on the partial and the weaker the quality of the abutments, either periodontally or restoratively, the more teeth that must be involved as abutments. For the other classifications, the path of insertion/removal was planned to be in the long axis of the abutment teeth so as to load them vertically as much as possible and to reduce the amount of tooth structure lost to mouth preparation for guiding planes to the very minimum. For the Class IV situation, consideration must be given to the undercuts in the flange area since, if a full flange is desired, these soft tissue undercuts will have to draw with the posterior guiding planes. It is often impossible to make this alignment without crowning the abutment teeth. Another solution is to plan on a short flange only, one that extends just to the height of contour of the edentulous ridge when the path of insertion/removal favors the abutment teeth. Decisions on this dilemma are often based upon the need for a full flange to restore lip support. Clasping the posterior abutment on both sides with a conventional circumferential cast clasp that extends distally from a mesial rest is the norm.

A more dependable option is to utilize the distal surface of the most posterior teeth with a guide plane that is, of course, parallel to the plane on the mesial of the most anterior remaining teeth. These parallel planes/plates effectively lock the remaining posterior teeth together and offer positive resistance to the tendency of the edentulous area to drop. This approach is indicated when the remaining posterior teeth are mobile. Stability can be increased if continuous occlusal rest is added to the frame. This rest will run from the distal of the most posterior tooth to the mesial of the most anterior. A lingual or a distal buccal circumferential cast clasp, approaching from the distal, is usually the only retention that is required due to the restriction of the path of removal generated by this system of connected guide planes. (See Fig. 2-34 below)

Connectors

Mandibular major connectors for this classification offer the same options as the other lower designs. They are more apt to be full lingual plates since the necessary additional frictional retention can be obtained from the preparation of parallel guiding planes on the lingual surfaces of the remaining teeth. The continuous lingual plate gives the maximum contact
with these surfaces. When the remaining teeth are crowned the lingual plate can lie on gingival rests milled into the lingual surfaces of the crowns (the lingual plate now is more properly called the dento-lingual bar). \textbf{Fig. 2-34}

A waxed dento-lingual bar for a mandibular RPD.

The transition from the bar to the edentulous area begins at the distal of the tooth adjacent to the edentulous area to allow enough metal for a proper external finish line. (See 2-6c for a similar design for a maxillary Class IV).

Maxillary major connectors will often differ somewhat from those used for other classifications. Since the edentulous area is apt to be extensive, i.e., greater than that which would normally be replaced with a fixed partial denture, rotational movements around an axis that will run between the most mesial rigid contact of the framework and the anterior abutment on each side can be expected. As rotation of the base towards the tissue takes place, any portion of the major connector that is posterior to this fulcrum will have a tendency to move away from the tissue. \textbf{Fig. 2-35}

The further posterior the casting extends, the greater the potential for breaking contact with the soft tissue. The space that may be opened up here can act as a food trap.
during mastication. To reduce this rotational opening, the posterior extension of the major connector should be limited and should never extend beyond the posterior clasping.

While it may appear that the open oval or anterior-posterior bar configuration is appropriate for the Class IV situation, the palatal extension of the anterior segment can still interfere with speech unless it is carefully blended with the contour of the anterior rugae area.

The special design options require additional decisions on major connector design.
(See Chapter IX.)

Resin retention

Most Class IV cases will require raised mesh retention since the edentulous spans are apt to be extensive and therefore may need future relines to keep the partial stable. Since the external finishing line of the maxillary partial will lie in the speaking area, some consideration should be given to blending the junction of the metal and the resin in such a way as to eliminate a ridge in the area where speech is formed. This may require moving the finishing line posteriorly or bringing it almost to the denture teeth, depending on the palatal contour.

Clasping

A conventional Class IV partial will have its primary retention on the molar teeth (usually the 1st molars), one on each side. These clasps will often be cast circumferential, either coming from a modification space or as an embrasure clasp. In the maxillary arch, the anterior edentulous area often requires an additional clasp to offset the pull of gravity and sticky foods. When long parallel guiding planes are obtainable adjacent to the edentulous area, the casting may be retentive without the third clasp. Since the anterior clasp is likely to be visible and possibly unaesthetic, the casting should be evaluated without the anterior clasp. Should additional retention be required, the third clasp is added as a wire “I” bar soldered to the casting or placed on a lingual surface as a circumferential wire.
The mandibular Class IV will not usually need a third clasp if guiding planes are well-planned and executed. If the guiding planes are inadequate, the same approach for the third clasp or the distal guide plane options is indicated.

The rotational path of insertion/removal relies on a rigid projection of metal into an anterior undercut area and cast circumferential clasps, one on each side, on the posterior molars, which will be discussed later.

The use of attachments for the retentive elements have little effect on the principles of design since they serve only as substitutes for the retentive clasp and are placed on proximal surfaces adjacent to the edentulous area or in a pontic, should one exist, in posterior fixed restorations.

A final consideration for those situations when the incisors are missing but the cuspids remain as an option to a fixed partial denture is to crown the cuspids and run a bar between them which can be milled on its lingual surface to gain additional parallelism for the RPD. This design reduces the cost of treatment when compared to a 6 unit FPD.

CONCLUSION

The basis of removable partial denture design has been covered. The keys to success are careful and exacting preparation of a healthy mouth and control of the tooth-frame relationship through attention to detail in the laboratory. The clinician who follows the principles established here will find design decisions reduced to a minimum. The anatomy of the mouth and the number and location of the missing teeth will greatly influence the decision, leaving personal preference as only a modifying factor. Prosthodontists do not, as a rule, wear removable partial dentures and so have no feeling for the patient’s response to the addition of so much material in the mouth. The clinician can, however, make a casting or two to fit their mouths and at least evaluate the placement and configuration of the major connector. Many of the ideas expressed here have come from just that experience.
Chapter III

Mouth Preparation

Mouth preparation, as described earlier on, covers everything we do to prepare the mouth for the actual construction of the removable partial denture. Restorative procedures associated with the remaining teeth are obviously a responsibility of the primary clinician but most other areas of mouth preparation fall under the management of specialists or general practitioners with expertise in the areas of periodontal therapy, endodontics, orthodontics and oral and maxillofacial surgery.

For the most part, mouth preparation is looked upon as preparing a few rest seats, perhaps a surveyed crown or two and then getting on with the final impression for the casting. Since mouth preparation is the foundation of all we plan to do later on, it is essential that a planning phase be developed. All possible changes required to bring the mouth to an optimum state of health must be identified with the remaining dentition properly aligned and positioned so that the resulting partial denture can be as ideal as is humanly possible. Mouth preparation for the state-of-the-art RPD requires diagnostic procedures that include, but are not limited to, the following:

Survey of the diagnostic cast with selection of the path of insertion/removal.
Reshaping of stone abutment teeth to ideal contours for subtractive mouth preparation.
Creation of a preparation guide for guiding planes with subtractive preparation.
Diagnostic waxing of any areas requiring additive mouth preparation.
Diagnostic set-up of teeth to be replaced.
Orthodontic set-up for teeth requiring minor tooth movement.
Ridge mapping for gingival surgery and implants.
Creation of a preparation guide (vacuum formed) for surveyed crowns.
Centric relation records and mounting of diagnostic and opposing casts (where indicated).
Impressions, jaw relation records and esthetic set-up of opposing arch (if totally or partially edentulous).
Only when these extensive diagnostic procedures have been completed, the definitive treatment plan developed, a treatment plan letter for informed consent written and signed by the patient and all consults finished, should the actual irreversible mouth preparation begin.

Surveying the Diagnostic Cast

When the diagnostic cast has been mounted in the survey table, the easiest way to begin the survey process is to stand over the cast and, using the parallax of your eyes, attempt to look down the long axes of the abutment teeth. The prime abutment(s), should they exist (as in Class I and II situations), will determine the path of insertion/removal for the partial since the guiding plane established on the distal surface of the prime abutment will be the key to the remaining mouth preparation. This position is found by tilting the cast in the sagittal plane. Once the anterior-posterior position has been determined, possible retentive areas can be equalized by tilting the cast in the frontal plane. Before tripoding the cast, all proximal surfaces that will have guiding planes and all potential retentive undercuts are verified using the analyzing rod in the surveyor. Minor adjustments to the tilt are then made and tripod marks placed on the cast. The tripod marks should be in such a position that they can all be seen at one time. Vertical markings on the sides of the land areas, while they do allow accurate repositioning, are much more difficult to use since they cannot all be seen at one glance. When the marks are widely spread out, one on the lingual of the anterior area and the other two on the lingual lateral surfaces of the retromolar pads or tuberosities, the cast can be easily repositioned by clinician and technician alike.

At this point the lead is placed in the surveyor and the entire height of contour of all teeth that will possibly be contacted by the partial is marked. Edentulous areas require the identification of their heights of contour as well. Without information on both hard and soft tissue undercuts, there is insufficient data on which to base the design and the mouth preparation that will be needed.

A reasoned design needs to be carefully drawn on the diagnostic cast before diagnostic mouth preparation can begin. It makes sense to use a color code which is familiar to your laboratory. Making a neat and precise drawing on
a stone cast is not as easy as it would appear and most diagnostic casts seen in the dental laboratory will have drawings that are childish at best. None of us has a natural talent for drawing in three planes. All our previous efforts in drawing have been done on the two dimensions of a piece of paper. In order to simulate the two-dimensional drawing with which we are familiar, the cast is braced against the clinician’s stomach and rotated with one hand while the other hand draws. In this way the pencil stays in the comfortable two-plane position while the third plane is managed via the rotation of the cast. Just a little practice will allow even the “non-artist” to make a credible drawing. There is an added value to having a neatly constructed design drawing; technicians are much more likely to give their best effort when the materials submitted to them are of the highest quality. The well drawn design on the diagnostic cast reinforces the level of quality desired in the final prosthesis.

Diagnostic mouth preparation

Perhaps the most important step in the construction of a removable partial denture is the preparation of the diagnostic cast. The process is broken down into subtractive mouth preparation, that is, the reduction of existing tooth contours to some predetermined ideal state and additive mouth preparation, the diagnostic waxing of contours that must be altered with fixed appliances, be they crowns or bonded contours.

Subtractive mouth preparation is done first, using the same instrumentation that will be used in the actual tooth recontouring. The armamentarium will include:

- Preparation guides to parallel guide planes
- Both tapered and non-tapered diamond cylinders of medium/fine grit for the preparation of the guiding planes.
- Round diamonds for occlusal rest preparation in either 8D, 10D or 12D.
- Inverted cone for cingulum preparation in 37 or 39 size.

Construction of preparation guides

Creating parallel guide planes on more than one abutment tooth with subtractive preparation is next to impossible without individual preparation guides. These are formed on the diagnostic cast once the path of insertion
has been chosen and the abutments selected. A resin separator is painted on the tooth(teeth) to cover the proposed guide plane areas and on other surfaces that will be needed to stabilize the guide. A pattern resin (GC Pattern Resin or Duralay) is placed on the stone tooth and the pattern removed once the resin is set. Fig. 3-1, 3-2

![Fig. 3-1](image1)

![Fig. 3-2](image2)

The cast is then placed in a milling device of some sort and the estimated guide plane(s) milled in the stone. A commercial dental milling unit, a drill press or a device that clamps on to the vertical arm of a dental surveyor to hold a dental lab handpiece can all be used to create parallel guide planes on the stone abutment teeth. Fig. 3-2

The second step in the construction of the prep guide is to color in the prepared guide plane with a dark colored pencil that will make the guide plane visible as the pattern resin is milled away. The milling of the pattern is extended to the periphery of the resin to act as a parallel guide for the
placement of the bur during actual tooth reduction. Once the colored stone becomes visible through the resin the remaining resin over the stone guide plane is broken out of the pattern and the preparation guide labeled with the tooth number. When these guides are placed on the natural tooth the portion of the tooth to be removed in the creation of the guide plane extends through the hole in the pattern making it easy to remove the enamel parallel to the periphery on the pattern adjacent to the hole. **Fig. 3-3, 3-4**

![Image](image1.png)

**Fig. 3-3**
This periphery should be marked with a black felt tip pen to immediately identify bur cuts that might not be parallel.

![Image](image2.png)

**Fig. 3-4**
Since the preparation guides are made to parallel surfaces on the diagnostic cast there is a very good chance that the actual guide planes, prepared with their use, will be very close to parallel to each other. Fixed restorations, that will always be made after the subtractive mouth preparation, are now easily made parallel to those guide planes on the natural teeth.

Using the actual clinical diamonds on the stone teeth does not harm the diamonds and offers the opportunity to actually practice the preparations.
The stone teeth are to be prepared to ideal contour even though it may not be possible to do so in the mouth. Once the practice subtractive mouth preparation is completed, a decision is made on a tooth-to-tooth basis on the clinical possibility of creating the same preparation on the natural tooth. Obviously there will be many instances when compromises will have to be made between the ideal and the possible. For some of these situations, the actual design may be changed, orthodontic minor tooth movement required, or additive mouth preparation undertaken in order to achieve the ideal situation.

The sequence of subtractive mouth preparation must always be guiding planes first, followed by rest seat preparation. Once the stone teeth have been prepared, the design is redrawn to its original state. Dimensions and depths of rest seat preparation should be ideal, once again, with possible compromises or changes in design coming after intraoral reevaluation.

Additive preparation follows with the diagnostic waxing of crowns and bonded contours. The surveyor blade is used to create “milled” guiding plane surfaces on the wax-ups, again, to ideal contours. When full crowns are desired for the abutment teeth in Class III and IV partials, the proximal guiding planes will be extended as far as possible so that maximum frictional retention can be obtained. Fig. 3-5

The contours of bonded restorations are waxed directly on the diagnostic cast. The design of the base of these units will be identical to those of the bonded fixed partial denture (Maryland Bridge or Rochette). Retentive areas for clasps are to be brought as close as possible to the gingiva, leaving a minimum of 1 mm space between the proposed clasp arm and the soft tissue, a task easily accomplished in the waxing of a crown but not always possible in natural tooth structure or bonded restoration. Since the crown gives us the potential for creating the ideal abutment contour, thought must be given to the timing of the undercut.

The relationship of the height of contour to the desired undercut depth determines the quality of retention that will occur when the retentive clasp
dislodges from the tooth. If there is some distance (a gradual transition) between the height of contour and the desired undercut (0.01’”-0.015’”), then the resulting retention will be apt to be weaker but last for a longer time as the clasp moves towards the height of contour. If the undercut is steep, that is with little distance between the 0.01” point and the height of contour, then the initial retention is apt to be greater but it will not last as long. **Fig. 3-6**

The gradual undercut is best suited for a distal extension situation (Class I) in the mandibular arch. This will allow a certain amount of stress relief in the clasp-tooth relationship. The steeper undercut area is more apt to be used in a tooth-borne situation in the maxilla where the patient will appreciate maximum retention against the force of gravity. These decisions on contour are made at this time so that a diagnostic record of the ideal contour of the abutment teeth will be available throughout the treatment phase and not have to be redesigned at each subsequent step in treatment.

The final step in the diagnostic preparation of the mouth is to position the replacement denture teeth. Since the denture teeth will have to be ordered from the dental manufacturer at some time during treatment, the earlier the better. The criteria for shade selection will be the same no matter when the selection is made. The mold can best be determined from an analysis of the diagnostic cast as soon as it is recovered. The definitive denture teeth can therefore be readily available to the clinician at the time of diagnostic mouth preparation. An alternative is to use teeth from a mold guide for diagnostic procedures and bring in the actual denture teeth later on but, if some tooth modification is necessary, the continued recontouring of the mold guide teeth may be unacceptable.

A quick wax procedure for isolated missing teeth can be accomplished by selecting a tooth from the mold guide and impressing it in alginate. When the alginate is set the denture tooth is removed and molten wax poured in
the mold. The wax tooth is modified to fit the edentulous area on the cast and waxed to place.

With the denture teeth in position, the diagnostic procedure is complete and the patient can be shown the recontoured cast as a means of describing the treatment plan (another reason for a quality drawing and a clean and neat cast!).

**Clinical Mouth Preparation**

**Subtractive Mouth Preparation**

The actual subtractive mouth preparation is begun using the diagnostic ideal mouth preparation from the cast as a template. The creation of preparing parallel guiding planes without the use of custom preparation guides can only be accomplished with practice. Clinicians trained in the era of multiple pin ledge restorations will recall the paralleling devices that were attached to teeth not involved in the restoration so that the contra-angle handpiece could be kept in the same plane throughout the preparations. That type of device is not usable for the preparation of guiding planes since teeth on both sides of the arch are involved. After all the guiding planes have been prepared, an alginate impression is made and poured in fast set plaster to serve as a check cast. This cast, when recovered, is placed on the surveyor and the guiding planes are evaluated for parallelism. Any discrepancies are adjusted on the cast and then corrected in the mouth.

Remember, guiding planes for Class II, III and IV should be as long as possible vertically without compromising the enamel. In some situations in the older mouth, the guiding planes can be taken into dentine. By preparing the teeth without anesthesia the patient can indicate when the tooth becomes sensitive and the extent of the guiding plane can be re-evaluated. The buccal-lingual dimension of the guiding plane in these three situations should extend just around the line angle in most cases. This slight extension, the turning of the “corner,” will greatly enhance reciprocation and provide the bracing component that used to be dependent on the bracing clasp arm. **Fig. 3-7**
The only exception to the buccal extension of this plane would be on the mesial proximal surface of a tooth in the anterior portion of the mouth where the guiding plate of the partial could be seen and be unesthetic (most likely in the Class IV).

For the Class I RPD, the clinician will have to choose between the shorter guiding plane with the stress relief “built-in” and the long guiding plane that will require function adaptation of the guiding plate on the casting for the same amount of stress relief. The Class IV situation has often been described as a Class I in reverse and, if stress relief is indicated (when the remaining abutment teeth are less than ideal supports), the decision as to the prime guiding planes on the mesial of the most anterior teeth will have to be made on the same basis as for the Class I. However, when a rotational path RPD is planned, the proximal undercut must be maintained thus eliminating the guiding plane adjacent to the edentulous area.

Once the guiding planes have been prepared and verified, the occlusal rest seats are prepared. The tendency has always been to make the rest seats too small and to leave them with sharp angles or with undercuts to the path of insertion/removal (especially in the case of the isolated lower molar where, while the rest may draw by itself, usually to the mesial lingual, it will not draw with the other guiding planes resulting in a casting that will not fully seat). The rest seats are to be 1/3 the buccal-lingual dimension of the tooth. The rest seat must be deep enough to allow for 1.25 mm of metal in the rest. Select a round diamond having the same diameter as the desired rest seat. The occlusal rest has historically been presented as needing to be “spoon shaped”, meaning that the seat was deeper in the center of the tooth than it was at the marginal ridge. This has resulted, unfortunately, in a marginal ridge without adequate space for metal and in a casting that will eventually break right at the marginal rest, a difficult repair situation. The rest seat on any isolated tooth, and especially on a single mandibular molar, should extend to at least the center of the occlusal surface so that the rest can direct the occlusal forces down the long axis of the abutment. Fig. 3-8
After the bulk of the occlusal rest seat has been prepared, attention must be paid to the junction of the guiding plane and the rest seat. The sharp line that results from the intersection of the two surface reductions must be rounded.  Fig. 3-9  To leave this sharp angle is to risk a casting that will not fully seat since the thin sharp edge is unlikely to stand up in the refractory. If even a slight defect in this area is created during the formation of the refractory cast or in the waxing of the framework a positive bleb will result. Clinical studies of the fit of partial denture castings indicate that the marginal ridge area is where the greatest amount of contact can be expected.

When placing occlusal rest seats in amalgam restorations, there is always the possibility of weakening the alloy in the depth of the rest or along the vertical walls. Should the amalgam appear to be compromised, it must be redone with greater extensions. An alternative would be to consider a casting. If there is no opposing occlusion or if the occlusion is with a denture tooth, the rest preparation can be extended to go beyond the margins of the old alloy and the depth of the preparation reduced.  Fig. 3-10

The demands of the thickness of the rest remain but this space can be developed at least in part at the expense of the opposing denture tooth. Occlusal rest preparations in existing crowns are another area of concern since there is no way of evaluating the thickness of the occlusal metal or metal/porcelain. The patient must be informed that if a perforation occurs during mouth preparation, the crown must be remade. Sometimes a design change can eliminate the need to prepare a certain tooth. Often, though, the treatment plan will have to include the new crown as a distinct possibility.
Incisal rest seats are prepared in the same manner as for the occlusal rest although they are now seldom used because of the public’s increased concern about “esthetics”. The diamond of choice is the tapered cylinder rather than the round bur since the ideal incisal rest is one that is rounded both mesial-distally and buccal-lingually, without undercuts of course, to the path of insertion/removal. Here again, the junction of the seat with the guiding plane must be rounded. **Fig. 3-11**

![Incisal rest seats](image)

**Fig. 3-11**

Cingulum rests, limited to maxillary cuspids for the most part, are prepared with a diamond inverted cone. **Fig. 3-12**

![Cingulum rest](image)

**Fig. 3-12**

The size of the cone is determined by the bulk of enamel in the cingulum. The greater the amount of enamel, the larger the rest seat can be. It is also possible to augment the rest seat with a bonded material to create a rest with a floor of 1.5 mm. The reason a diamond is chosen over a carbide inverted cone is that the diamond leaves a more rounded internal angle than does the carbide. The same problems can arise from having this sharp area as with the marginal ridge. The shape of the rest seat as seen from the lingual is one of an inverted “V” which follows the natural shape of the cingulum and requires the minimum reduction of tooth structure.

Cingulum rest seats on maxillary anteriors are often required and, if sufficient enamel exists below the contact of the lower incisors, they are
prepared with the same inverted cone as the cuspid, the only difference being the shape of the rest. It is more apt to be straight or semi-lunar as it follows the natural contour of the lingual gingival surface. These rest seats often require augmentation.

Additional reduction is often required on the buccal and lingual surfaces of posterior teeth to drop the height of contour closer to the gingiva (especially on lingually inclined mandibular posteriors). The approach arms of minor connectors will need a minor guiding plane gingival to the marginal ridge for additional frictional retention. When circumferential clasp arms are planned, the proximal 2/3 must lie at or slightly above the height of contour. Since the tooth at the line angle normally has the contour rising to the marginal ridge, reduction in this area is required to bring the proximal portion towards the gingiva and out of possible occlusal interference. Fig. 3-13

These contours are best reduced with a non-tapered cylinder. As guiding planes enter the lingual embrasures on their way to the supplementary rests, it may be necessary to change to a finely tapered, diamond cylinder just to get into the constricted space. The guiding planes can still be kept parallel to the proposed path of insertion by slightly tilting the handpiece so that the tapered cylinder cuts at 90° (parallel to other guiding planes).

Embrasure clasps require additional preparation in addition to the rest seat. Depending upon the contact area of the marginal ridges and the opposing occlusion, an access must be established for the clasp arm to both enter and exit the rest area. The exit to the buccal surface is usually the most critical. In either case a minimum of 1.5 mm of space, both vertically and horizontally, must be created. A tapered diamond cylinder is used to create the space, cutting at a dimension of 1.5 mm on the cylinder for automatic control of the dimension. The lingual approach to the marginal
ridge offers the possibility of a minor guiding plane which should be always be used since the embrasure clasp assembly offers no other possibility of a guiding plane. **Fig. 3-14**

![Embrasure rest, 3 x 1.5 mm](image)

The rest seat area is to be shared between the two adjacent teeth to conserve tooth structure and still have adequate space for the rest. Under no circumstance should the contact actually be broken. Should it occur by mistake a restoration will have to be placed on one of the contacting teeth to restore contact. When a restricted space is left for the embrasure clasp fracture of the retentive clasp arm can be expected. The dimensions of the plastic pattern used to wax the clasp have a cross sectional measurement of approximately 1.5 mm and should any reduction be necessary on the occlusal portion of the clasp an area of stress concentration will occur and after repeated flexure fracture can be expected. A repair of a broken clasp arm is most difficult in embrasure area and cannot be depended on.

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The preparation of guiding planes on anterior teeth is not normally done since the reshaping of the proximal surfaces alters the shape of the tooth to the point where esthetics is compromised. Occasionally, a minor guiding plane can be created on lingual surfaces where gingival recession or crown lengthening leaves the full anatomic crown exposed.

When inadequate space is available for an anterior replacement the adjacent teeth may be recontoured to equalize the pontic space with the adjacent teeth. When the space is so constricted that an esthetic result is not attainable then orthodontics or a fixed partial denture replacement may be the only options.

At the completion of the subtractive mouth preparation the surfaces that have been recontoured must be finished and polished. Since these prepared surfaces should be the only areas where contact between the tooth and the
frame takes place there are significant advantages to having a surface that has been polished with either a fine diamond or fine white stone followed by rubber points and disks. The chances of alginate sticking and tears are reduced. Since the refractory material for stellate alloys is large grained the exact duplication of irregular surfaces is not possible so that the resultant casting will not have the best internal surface.

**Additive Mouth Preparation**

Before any preparation is undertaken for additive contours the subtractive component of the mouth preparation must be complete to include final polish. It should be obvious that it is much easier to create a crown casting that is in harmony with the contours already established on the teeth than it would be to make the casting first and then try to create guiding planes on the teeth to match those on the casting.

Additive mouth preparation can be broken down into three different approaches to obtaining ideal contours; bonded contours, and more traditional surveyed crowns and pontics. The actual contours established using these modalities are the same, only the means of connecting them to the abutment teeth differ. Both bonded metal contours and crowns require mouth preparation of enamel surfaces as a part of their construction. All bonded restorations require the presence of sound tooth structure, preferably enamel, to which to bond.

**Bonded Metal Contours**

Rest seat areas, guiding planes and attachments all lend themselves to bonding to enamel. They offer a high level of predictability but are technique sensitive. The more the attention to detail during the preparation of the enamel the greater the long term success.

The cingulum rest seat, to be placed on the lingual slope of a mandibular cuspid is the most commonly used bonded contour. The mouth preparation for this restoration is limited to a horizontal notch cut in the enamel in the gingival third of the lingual slope. This miniature cingulum rest serves as a vertical stop when seating the casting at cementation and as a positioning device to relate the restoration in its proper position. Since the enamel on the lingual of the mandibular cuspid is thin this groove will not be more
than 0.5 mm in depth to be certain to stay in enamel. Although not really necessary, one can reduce 0.2 mm of enamel overall and leave a finishing line so that the resultant casting, which will be approximately 0.4 mm, will have a smoother interface with the surrounding tooth structure.

When guiding planes are incorporated on the casting, micro groove preparations, as recommended by Schärer and Marinello, are placed in the enamel using the smallest diameter slightly tapered carbide bur. **Fig. 3-15**

![Paralleled surface](image)

These grooves offer lateral resistance to dislodgment and have been shown to greatly increase the successful bond between casting and tooth. (Precision attachment castings will be discussed later on in this manuscript.) **Fig. 3-15**

Final impressions for bonded castings are made in either silicone or polyether since they are poured in the refractory material that is compatible with the alloy to be used. *These refractory materials do not, as a rule, set against alginate.* The impression need not be full arch but must contain the other prepared abutments so that any guiding plane area on the casting can be made parallel with the existing guiding planes. If the base of the casting extends to the gingival, a retraction cord should be placed to assure accuracy in that area.

The borders of the casting are outlined and a small piece of sheet wax, available from Kerr Laboratory Products Division at 0.5 mm thickness, adapted to the outline and waxed to place by adding a small amount of very hot wax all around the border. To this wax base the contours of the restoration are added. For a cingulum rest it must be remembered that the base is to have a width of 1.25 mm with a rounded internal angle. The rest must form an acute angle to the path of insertion/removal so that the rest will be “positive”. Decisions on the contour and extent of any guiding
planes must be made relative to the classification of the edentulous situation and the established contours of the other abutment teeth.

The waxup is sprued with a round wax sprue attached to the lingual surface of the cingulum. As a final addition for a metal rest, a plastic bristle from a tooth brush is attached near the incisal or occlusal margin to act as a holding device for the casting during finishing and cementation. **Fig. 3-16**

Since the pattern is waxed against a refractory cast no attempt is made to remove the pattern. The refractory model is cut with a die saw so that only a minimum of stone is present and the sprue attached to the base of a casting ring and the second stage of the investment poured. The material of choice for the bonded metal casting is some form of Ni-Cr alloy (Rexillium or similar alloy).

The completed casting is finished and polished and, if it has a guiding plane, returned to a master cast for final milling using a milling machine. It is then prepared for either micro retention through a etching process (as for a Maryland Bridge) or for macro retention using countersunk perforations (Rochette). Either electro chemical or acid preparation of the internal surface is acceptable to etch the metal. Care must be taken not to contaminate the etched surface once the etching is complete. The holding device, cast from the plastic bristle, is used to hold the casting during cementation with a chemically cured composite (Comspan or similar). Light cured composites can be used with the perforated design. Once the resin is cured, under rubber dam, the holding device is cut from the casting and that area stoned and rubber wheeled to finish the restoration.

**Bonded Resin Contours**

Rest seats and guiding contours can also be established in composite alone. While it may appear that a restoration formed in composite would be likely to fracture from the tooth when stressed repeatedly our experience of over 15 years has shown this not to be the case. In that the rest may chip but does
not separate if the bonding procedure is carried out according to standard practices. When the abutment tooth has been properly managed, under rubber dam, and the composite placed according to the manufactures directions this becomes a viable and less expensive alternative to the bonded cast contour.

The rest and/or guiding plane can be prepared in a bulk of bonded composite, as if it were enamel, or a template can be formed from the diagnostic wax-up to shape the composite as it is being bonded to the tooth. To create a working template the diagnostic wax-up is duplicated in dental stone using alginate or reversible hydrocolloid. On the resulting cast a vacuum formed clear plastic template is adapted and trimmed to contact the abutment tooth as well as adjacent teeth on at least one side to allow precise positioning during composite placement. A stone core is poured against the outer surface of the template to be used to force the template to place once it has been filled with composite.

After placement of the rubber dam the tooth is etched and prepared according to the directions for the specific light cured composite being used. The template is filled with composite to approximate the amount required to create the restoration and forced to place using the stone core. Fig. 3-17

Once the template is fully seated the core is removed and the composite cured using an intraoral light source through the template. The template is simply peeled away when the curing cycle is complete and the excess composite removed and the borders finished and polished. Use of the template results in a superior finish since the bulk of the restoration will not need to be touched after curing. For a single simple cingulum rest seat however, shaping a bulk of previously bonded composite is the most practical way to create the desired form.

When the composite used for these restorations is a micro fill the potential for wear is reduced. Unfortunately all composites are somewhat brittle and
therefore when the abutment tooth is mobile the bonded metal restoration is chosen over the all composite since the bulk of the all composite restoration is more likely to fracture when the tooth is loaded as in incision. The rest will be held by the partial denture while the tooth will be apt to move in the direction of the force applied with the result of increased fracture caused by a shear of the bulk of the composite through the rest seat itself.

Pressed Ceramic Contours

Success with the pressed ceramics for veneers and crowns has led us to consider using them for bonded contours to support the partial denture. There are two options for creating the patterns for rests and guide planes when using these materials. Because of the extreme thinness desired in these units it is difficult to control the wax pattern during shaping and investing if it is not supported.

The first solution, often employed for the bonded metal contour, is to pour the master impression directly in the investment recommended for the ceramic. The resulting cast can be placed on the surveyor and any guide planes made parallel in the wax with rest contours added. The completed pattern is sprued and then the refractory is trimmed to a small shape just slightly larger than the pattern and then invested as a RPD frame waxup would be. (Note: the impression material used must be compatible with the refractory. For example, often refractory material will not set against an alginate impression).

The other option is to lay down a very thin layer of pattern resin on the master stone cast to the outline of the desired contour. Once set the resin is removed from the cast and carefully trimmed to that outline. This resin shape is then attached to the cast with a small amount of sticky wax at the occlusal/incisal margin. Casting wax is now added and contoured to create parallel guide planes and a wax sprue added to a non-critical area. The sticky wax is released and the pattern removed and invested.

For both these techniques the sprue should be left in place during the finishing procedures and only removed after the casting has been bonded. That area of the unit is then finished and polished. **Fig. 3-18**
All of these bonded options offer a relatively non-invasive approach to ideal mouth preparation with excellent reports of longevity for low cost. As previously stated, they require ample enamel for quality bonding.

![Image of Tooth Preparation](image)

**Fig. 3-18**

**Surveyed Crowns**

The third and final form of additive mouth preparation is with the “surveyed crown”. This descriptive term has long been applied to any crown or pontic specially contoured and placed in conjunction as an abutment for a removable partial denture. Unfortunately, the crown, as obtained from the dental laboratory, is very likely not to have the desired form, as far as the partial denture is concerned, even though it may be ideal as a single tooth restoration. The technician(s) who construct the crown most likely will not have had partial denture experience and so will favor the contours of the natural crown. The modifications required by the ideal abutment may not be a part of that technicians training and since the partial denture casting may well be constructed in a different laboratory it will be the clinician’s duty to control the contour of the crown.

Before beginning the mouth preparation phase of crown construction the clinician must have gone through the diagnostic process of developing the ideal contour for the abutment tooth in question. The clinician must then prepare the tooth as if no crown were to be constructed, that is, to cut a guiding plane, prepare the rest seat and make all other modifications of contour. Only then can the actual crown preparation begin. The initial subtractive mouth preparation will insure that there has been adequate tooth
reduction to allow the formation of the ideal contours in the final crown without compromising the restorative materials. **Fig. 3-19**

![Diagram of area of additional preparation and original contour with preparation outline]

**Fig. 3-19**
As a general rule, for veneered crowns, a disappearing margin or a metal collar should be used rather than a porcelain butt margin for the crown since additional forces will be placed upon the crown by the partial denture. Again, it is essential that all aspects of ideal soft tissue management be employed for the “surveyed crown”. Margin placement at or above the gingival margin, respect for the biologic width and careful manipulation of retraction cord must be a part of the treatment.

The final impression for the crown will need to include more of the mouth than would the usual single tooth impression. The entire denture bearing space must be available on the master cast. This will insure that the plane of occlusion can be established independent of the maxillary teeth in CD/RPD situations by using the junction of the middle and distal third of the retromolar pad as the posterior determinate of the plane of occlusion. The full cast will also allow the creation of a stable record base for jaw relation records should that be required. Obviously, all other abutment teeth must also be present on the master cast so that the additive mouth preparation can be in harmony with the previously completed subtractive preparation.

The only restriction on the dimensions and contour of the master cast is that it must fit into the survey table. Often this demand creates a problem when the distance of the base of the cast to the mounting ring is great, making the use of the dental surveyor and possible the milling machine difficult if not impossible to use. Some modification of standard techniques is generally
required, especially if the final impression is sent to the dental laboratory rather than being poured in clinic.

There is a distinct advantage however, to pouring the cast, trimming the die(s) and mounting this type of case in the dental office since it allows the repositioning of the master cast for final determination of the path of insertion/removal and the placing of the three tripod marks on the cast. To expect the dental laboratory to complete all these steps and not lose control of the case requires a high level of experience and excellent and long term communications between clinician and technician.

Until such time that a specific dental technician has been suitably trained and has demonstrated compliance with the requirements of a specific clinician the “surveyed” crown is to be waxed to full contour and returned to the clinician for the actual shaping of all areas of crown-partial denture contact.

Since the ideal contours of the surveyed crown have been established in the diagnostic waxing phase of treatment planning it should be a simple matter to copy the contours. Because of the critical nature of the “surveyed” surfaces in the long term success of the treatment it is essential to review the modifications to the full contour wax up usually required to create the ideal crown. The first step is to reposition the master cast in the dental surveyor and reestablish the tilt of the cast to the original path of insertion/removal. It is to this path that we must evaluate the contours of the crown as returned from the laboratory. Dusting the wax with zinc stearate (or baby powder) will allow the analyzing rod of the dental surveyor to create an easily seen height of contour.

Using the blade that is normally a part of the components available for the surveyor or a wax milling bur in a dental milling device the guide planes are established parallel to any previously prepared planes in the enamel of the non crowned teeth. Guide planes can be cut as flat planes with or without a gingival ledge. The advantage of using the gingival ledge is that it functions as a rest and eliminates the need for an occlusal rest preparation. This is of particular value when esthetic demands require full porcelain occlusals. The guide plane is not restricted to the proximal surface. In fact, the greater the extension of the guide plane onto the lingual or buccal
surface for reciprocation the greater the frictional retention possibilities. Fig. 3-20

Only after all guide plane surfaces have been contoured can we proceed to the placement of rest seats and retentive contours. It is essential that the junction of the guide plane and the rest be rounded and that sufficient wax has been removed to allow a minimum of 1.25 mm for any clasp/rest assembly. Rest preparations in crowns should be 1/3 the occlusal table which will often make them larger than they would be if cut into enamel. The larger and smoother the rest preparation the greater the chance that the partial denture will be in solid contact with it. One of the problems we face with every crown that will have a conventional clasp arm or arms is the determination of just where the height of contour is to be located in the wax up. It is most desirable that any circumferential clasp lie as low on the tooth as is possible, both for esthetics and to maximize the retentive nature of the clasp arm. Since the die stone that represents the gingival marginal tissues has been removed from the die an untrimmed second pour of the master impression is needed so that either clinician or technician can know the relation of the margin of the crown to the gingiva. We would like to place the inferior border of any circumferential clasp a full millimeter above the marginal gingival tissue. The average cast clasp arm measures 1.5 mm occlusal gingivally so that the height of contour must be at least 2.5 mm above the tissue. Since we have the opportunity to make the crown contour truly ideal a clinical, not laboratory, a decision must be made as to the relation of the survey line to the final position of the clasp when the partial is fully seated. The greater the distance of the height of contour from the final clasp position the longer lasting the retentive effect of the clasp will be. The flexing of the clasp will be more gradual, both on insertion and removal but the initial retention will be reduced. It would seem then, that for all tooth born partials the height of contour should be close to the final position, perhaps 3 to 3.5 mm from the marginal tissue. This position will give a retentive force that is shorter acting but of greater initial value. For those situations where some level of stress relief is desired
it makes more sense to raise the height of contour to 4 to 4.5 mm from where the marginal tissue is known to be. **Fig. 3-20**

![Fig. 3-20](image)

In addition to the creation or verification of the height of contour, the clinician must also determine the margin of the cut back for porcelain application. It is essential that a margin of metal exist beyond any extension of the partial framework so that guide plates, rests and minor connectors contact only the metal of the crown, not the porcelain. This margin need only be 0.3 mm. The resulting margin of the cutback will not be where it would be placed on a standard ceramo-metal restoration so the technician needs to know exactly where to start the removal of wax. The clinician must outline the margin with an explorer so that there is no misunderstanding. **Fig. 3-21**

Since the cutback will be a uniform reduction of the wax, allowing a uniform thickness of porcelain it is **essential** that the wax crown has the exact contour desired in the final surveyed crown.

Even if the original contour was ideal and the cutback properly done the application of the porcelain veneering, since it must be done to excess because of the shrinkage factor, offers another opportunity to alter the height of contour and potentially render the crown unusable. For that reason it is advisable for the clinician to evaluate the crown after the porcelain is contoured at the bisque bake stage. Minor corrections of contour can easily be made by adding additional porcelain before final stain and glaze. The porcelain must be very smooth from the height of contour down to the final position of the clasp. If it is not a dark line often becomes visible as the porcelain wears the metal of the clasp through repeated
insertions and removals. Obviously, once the clinician and technician really understand each other the technician can simply create an exact copy of the diagnostic wax up.

The clinician has two options relative to combining these crowns and the partial denture framework. The crowns can either be cemented permanently before the final impression for the framework or they can be picked up in the final impression (which must then be made in a firm setting elastomer like Impregum F). Resin dies must be constructed and be inserted into the crowns in the impression before it is poured so that they will be present on the master cast. These dies are made by lubricating the inside of the crown, partially filling the crown with fast setting resin, adding a dowel pin into the resin and completely filling the crown.

For the single surveyed crown it is impractical to include the crown on the master cast but for those situations where there are multiple surveyed crowns and bridges with precise milling of their guiding surfaces, it is essential that the crowns be present on the master cast. The master cast will serve as the milling cast so that a stable base is available on which the final milling of the guide planes is completed. The accuracy of the refractory cast is increased since the actual crowns, not stone replicas, were available for duplication. The final fit of the partial framework to the milled surfaces should therefore be enhanced. These special impression procedures are essential to the use of fixed restorations with precision attachments and will be discussed further under the chapter on attachments.

Mouth preparation, in the largest sense, well planned and executed, will simplify the actual construction of the advanced partial denture and insure its long term success. It is unfortunate that the great majority of removable partial dentures are made with little or limited regard to this crucial component of care. It is essential to first establish all aspects of mouth preparation on the diagnostic cast before any attempt is made to go to the mouth.
Chapter IV

Final Impressions and Master Casts

Final impressions for removable partial denture frameworks are made in irreversible hydrocolloid in either modified stock trays or in custom trays. Alginate is preferred over silicone or polyether materials since it will tear rather than distort. Remember, the silicone type impression materials were designed for the impression of prepared teeth where a minimum of undercuts will be found. The removable partial denture impression will often include unprepared teeth that may be severely tipped or rotated, leaving large undercuts which could well distort by tearing the impression material from the tray and never be noticed until the casting does not fit the mouth. Since the contact surfaces between RPD and teeth are to be smooth, rounded and well polished there is no need to reproduce minute detail as with the fixed prosthodontic impressions materials. In order to utilize this tear phenomenon, the clinician must carefully evaluate the final impression under good light. As described under “Preliminary Impressions”, in Chapter I, the final impression should be relatively easy since the majority of potential problems were identified during these first impressions. Using the diagnostic cast, the adaptation of the stock tray can be evaluated and if the mandatory ¼” is not available, a custom tray is made with adequate relief to assure the ¼” of alginate. All custom alginate trays must have multiple retentive holes placed in them using a #8 or #10 round burr. These retentive holes combined with alginate adhesive will assure the retention of the impression material. It is obviously more important to mix the alginate properly, place it into critical areas and allow the complete set of the material when making the final impression than for the preliminary. If the preliminary impression is taken seriously, however, there will be no difference in the techniques employed to obtain an accurate master cast.

Before pouring the final impression an outline of the critical soft tissue contours should be marked on the impression with an indelible pencil or a commercial marker (Thompson Dowel Marker) while the patient is still in the dental chair. The placement of this line forces the clinician to evaluate all extensions for their accuracy to be certain that all critical areas will be transferred to the master cast. Areas of possible overextension are measured in the mouth with a perio probe and transferred to the alginate. This is of
particular importance when determining the placement of major connectors since an overextension in the casting creates a major problem.

The final impression is to be poured using the double pour technique. This approach offers the best chance of pouring a master cast without distortion of the alginate. Since only a small amount of stone is added in the first pour, there is a minimum load placed on the alginate as compared to boxing and pouring the entire cast at one time. The first pour must extend to cover the line placed on the alginate. Once the stone has reached the initial set, the addition of the base presents no opportunity for distortion. The only potential problem arises when inadequate retentive blobs of stone are placed on the first pour. **Fig. 4-1** Without this retention, there is a possibility that the master cast will separate in the flask during boilout and flask opening.

*Fig. 4-1*

If a vacuum mixing device is available to the operatory, the clinician can pour the first pour right at the chair and thereby assure that the impression has been correctly managed. The impression with the first pour should be placed in a humidor of some type for the initial set. The base can be added any time thereafter. Die stone is indicated for the master cast, not for any increase in accuracy but for greater resistance to abrasion.

When the cast is recovered, it should be trimmed as soon as possible so that any blebs can be removed easily. When the cast is shaped with the model trimmer, thin slurry inevitably covers the cast and, if it is not removed, will affect the accuracy of the cast. The slurry can be removed with a soft brush and running water and should be done immediately. Dies or other critical areas can be protected from the slurry by covering them with a latex or silicone material before trimming the cast. The cast should be trimmed to the smallest possible dimension without compromising the critical areas. The smaller cast will allow a greater bulk of duplicating agar in the flask. Undercut areas, blebs or other rough areas on the tongue side of the
mandibular cast should be removed to reduce the possibility of tearing the agar. The distal extension edentulous areas that will require an altered cast tray should have been outlined with an indelible marker while the patient was still in the chair so that the technician will know exactly where the borders of the tray will end.

A final task that is unique to the maxillary master cast is that of beading the outline of the major connector. In order to reduce the tendency for food to impact beneath the major connector, a bead line is scraped into the cast following the outline. In general, a width of 1.5 mm and a depth of 1 mm will suffice to insure a positive contact with the underlying soft tissue. The beading extends to within 4-6 mm from the marginal gingival tissues and there phases out completely. The bead line is to be rounded rather than sharp and is usually created with a discoid carver or a rounded curette. The decision as to where to place the borders of the major connector should have been made as a part of the diagnostic phase.

The master cast must be resurveyed and, depending upon the arrangement with the laboratory, the design of the framework neatly drawn. If the clinician is unable to make a very precise drawing of the desired framework, then it is better to leave the master cast unmarked except for the tripod marks and send the diagnostic cast as a reference for the technician along with the work authorization form. Work authorizations vary depending on custom and jurisdiction but the more thorough the design and instructions, the greater the likelihood that the technician will be encouraged to return a casting of the highest quality.

For the most part, jaw relation records are made on the framework after it has been fitted to the mouth. There will be occasions when the master cast must be mounted before construction of the framework can begin. These situations always involve occlusion, especially when the space available for denture teeth is limited or when components of the framework must be in contact with opposing teeth. When anterior teeth are being replaced with the partial denture and a steep vertical overlap exists without any significant horizontal component, mounted master casts are essential.

Whenever possible, the master cast should be related to the opposing cast without the imposition of any recording material and the casts mounted by the clinician to assure accuracy. When insufficient teeth remain for positive
positioning of the casts, a record base is constructed and a record made, usually in centric relation, using a recording material that is completely plastic when the record is made and has a final set that is rigid. Superbite (ZnOe) or Blue Mousse are most often used. If the master cast is sent to the laboratory without being articulated, then witness lines are placed between teeth of the master cast and the opposing cast when the casts are in the desired occlusion. At least two marks per side are required to allow the technician to place the casts in the exact same position. Any mounted cast must have had notches placed on the base of the cast to allow the cast to be repositioned on the mounting plaster since the master cast will have to be removed for blockout and duplication.

The construction of a record base for a partial denture master cast is not without some risk of damaging the abutment stone teeth. A combination of wax blockout, plasticized PMME and autopolymerizing orthodontic resin, used with the following technique will permit the construction of an accurately fitting base without injury to the master cast.

First, the master cast is surveyed and soft tissue undercuts, if they exist, identified by circling them with a pencil line. The outline of the desired record base is also drawn. It is not essential that the base contact all the remaining teeth but some points of tooth contact are critical, at least three, widely spread when possible. A very small amount of baseplate wax is flowed into the gingival crevice of the teeth to be contacted. Any undercuts in the denture base area greater than 3 mm are also blocked out with wax. The cast is then re-hydrated by placing the base of the cast in water and allowing the moisture to penetrate the entire cast. The cast must not be submerged in water as the accuracy of the tooth portions can be altered with the dissolution of the stone. Once the cast is hydrated, tinfoil substitute, diluted two to one, is painted on. Caulk’s Lynal or similar plasticized resin, is added to any undercut areas and around the necks of the teeth that will be contacted by the record base. The Lynal is mixed thicker than is recommended by the manufacturer, to the consistency of peanut butter, so that it will stay where placed. Orthodontic resin is immediately added in a salt and pepper technique to complete the record base. **Fig. 4-2**
The autopolymerizing resin will bond to the Lynal and the resulting record base will be retained by the intrusion of the plasticized resin into the undercuts. There is no need to place the cast in the pressure pot for curing.

The base can be removed as soon as the resin is hard and trimmed. A wax rim can be added with the intent of having a supporting table of wax 2-3 mm out of occlusion. The recording material is mixed and placed upon the table and a centric record quickly made. The casts can be mounted on the articulator or submitted to the laboratory with the record for articulation. The laboratory technician can make a mounting record from the articulator to enable the mounting of the refractory cast to the opposing cast for the waxing of the occluding portions of the framework.

There is one other component of the final impression that must be discussed, although it is made only after the casting is finished, the altered cast. The altered cast impression is an attempt to combine the support of the abutment teeth with the support that can be obtained from the edentulous ridge. Originally, altered cast impressions were made on any edentulous area that had no posterior abutment, either maxillary or mandibular. Since the maxillary RPD is so well-supported by the major connector, little additional support is gained with an altered cast impression for a maxillary distal extension area, especially if the final impression was made in a custom tray. The difficulty of capturing the total denture space of the mandibular distal extension in the final impression has made the altered cast impression essential for most all mandibular Class I and II situations. With the use of an altered cast impression, the clinician need not be overly concerned with the accuracy of the edentulous areas and can concentrate instead on making the best possible impression of the hard tissues. It is essential that the full extent of the denture space in the distal extension of the edentulous ridge be captured so that the outline of the desired altered cast tray can be drawn as a part of the design. The technician can then return the framework with the altered cast tray in place, with its borders 2-3

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Fig. 4-2

Orthodontic resin

Lynal

Wax

The autopolymerizing resin will bond to the Lynal and the resulting record base will be retained by the intrusion of the plasticized resin into the undercuts. There is no need to place the cast in the pressure pot for curing.
mm short of the desired final extension of the denture base in the edentulous area.

The altered cast tray is constructed on the master cast tray after the casting has been completed. One thickness of baseplate wax, the same as for the relief for the retentive mesh, is adapted to the master cast to the outline of the desired altered cast tray extension. The retentive mesh area is heated over a Bunsen burner and the framework seated onto the cast. The hot metal of the mesh must melt the relief wax and allow the casting to fully seat. With the tip of a spatula, the wax that extruded up through some of the mesh holes is removed to allow the resin of the tray to lock onto the framework. The tray resin is mixed and a small amount removed from the mixing jar and immediately placed into the retentive holes that have been cleared of wax. The fluidity of this resin would not allow it to be used as yet to form the tray but it will flow into the retentive areas easily and provide the required retention. The remainder of the tray resin is added when it is no longer tacky and the tray formed. The tray must be kept to the dimensions of the ideal denture base. In order to form the ideal denture border, the tray must be uniformly short and be slightly under-contoured to make space for the impression material to capture the border without becoming bulky. When the occlusal portion of the tray is kept thin, it will occasionally be possible to make the final jaw relation record at the same appointment as the altered cast impression. If at that time the patient is unable to close the teeth into the desired occlusion for the record because of the thickness of the tray or the general lack of interocclusal space, then the jaw registration must be made at a separate appointment.

The altered cast impression is made only after the framework has been fitted to the mouth and the full seating of the casting verified (the actual fitting of the frame will be discussed later in the manuscript). With the framework seated firmly on the abutment teeth, the extensions of the altered cast tray are evaluated. They are to be 2-3 mm short of the reflection of the border tissues. When the tray is properly extended, there is no need for border molding as a separate step. The wash impression will also give ideal borders if the tray is in the proper position relative to the tissues.

The choice of impression material to be used for this impression does not appear to be critical. Early studies indicated that mouth temperature wax impressions placed the denture base tissues in their most supportive state.
This material is seldom used since it requires a good deal of experience to read the quality of the impression. Polyether impression materials offer the option of varying the viscosity by blending high and low viscosity material into one mix. The firmer the underlying tissue, the higher the percentage of high viscosity impression material. When a good deal of unsupported soft tissue is found on the ridge crest, the mixture is altered to use a greater proportion of low viscosity material. While a wash of all low viscosity will make an impression of this unsupported tissue with a minimum of pressure, it will have a tendency to have poorly rounded borders since it is not thick enough to create the best border contours.

Excess saliva is to be removed from the mouth but there is no reason to have the mouth totally dry. The tray is loaded with just enough material to make up for the spacer and an additional 20% added to assure full border contours. There must not be any excess of material at the internal finishing line since this material can flow up into the guiding plate area when the frame is seated. When placing the framework in the mouth, the clinician must make sure that the frame is fully seated and that no pressure is placed upon the tray itself. The fingers are placed upon three widely separated rests to maintain the frame in its optimum position while the borders are developed and the material sets. When fully set, the impression is removed from the mouth and trimmed to remove any excess impression material. There will normally be a thin extension of the material into the retromolar space on lower impressions and an extension of material onto the soft palate for the occasional maxillary impression. Since it is almost impossible to fully border mold the retromolar space on the altered cast tray, the determination of the extent of the resin border in this area is arbitrary. Remember that there is no need for full extension into the retromolar space in the removable partial denture as there would be for a complete denture. The retention of the partial denture is not dependent upon this border. If a large undercut exists distal to the mylohyoid ridge, the denture base may be prohibited from entering the undercut, as it might in a complete denture, since the guiding planes determine the path of insertion. There is no reason for the lingual extension of the flange not to terminate at the soft tissue height of contour as determined by these guide planes. The patient will be more comfortable with less resin in the mouth and the support of the extension base will not be compromised since it is the ridge crest and the external oblique ridge that are the supporting structures for the distal extension.
Any borders of insufficient width can be recreated in wax if they are extended to the predetermined limits. Since this border width is arbitrary in the removable partial denture, there is no need to confirm the width in the patient’s mouth at this time. Should excess wax flow onto the internal surface of the impression when the borders are being created, the wax can easily be removed without damaging the accuracy of the impression.

A final verification of the distal extension impression must be made after the base is trimmed and shaped. At this time the clinician must be confident that the frame fully seats and that all impression material that has flowed onto the frame work has been removed. Special consideration must be given to removing any material that extends beyond the internal finishing line. A very sharp blade should be used to trim the material in this area so that no pulling or tearing of the impression material occurs. At this point a jaw relation record can be made if required and if adequate space for the record exists.

Pouring the altered cast impression can be delegated to the technician but the clinician must verify that the framework is fully seated on the master cast and that sticky wax has been added to hold cast and frame together during the boxing and pouring of the stone. This means that the original edentulous portion of the master cast must have been removed earlier and that adequate retention has been cut into the remainder of the master cast. Rather than go through an elaborate boxing process, the clinician may elect to pour the altered cast impression in two stages, much as was done for the master cast. The border roll of the altered cast impression must be preserved in the boxing and pouring of the impression. A line is drawn on the impression with an indelible marker just at the point where the border contour is complete. Boxing material is placed at this line to create a land area of 3 mm and the impression filled with vacuum mixed stone and retentive blobs placed. Fig. 4-3

The base can be added later, after the initial set, without fear of disturbing the tooth-frame relation. The altered cast impression is poured in standard yellow stone rather than in the same die stone as
was used for the original master cast. The softer yellow stone is far easier to
remove from the processed denture base with the walnut shell blaster and
stone solvent than is die stone.

When sufficient inter-occlusal space exists, it makes good sense to make the
jaw relation record before pouring the altered cast impression, thus saving
the patient an additional visit. The recording material of choice is again one
that is completely plastic to start and that sets hard quickly. The occluding
surface of the tray is prepared by cutting a few crossing grooves in the resin
or, when a great deal of space exists, adding a wax occlusion rim to reduce
the space for the recording material. Since there will be natural teeth in
contact in all dentate cases, only a very small amount of recording material
need be placed. Three well-defined and widely separated points of positive
contact will allow accurate articulation of the casts. Once the stone has set
and the base completed and trimmed the cast with the framework and tray in
position is articulated with the opposing cast and mounted in the articulator
before the impression is separated from the cast. When the opposing arch is
a complete denture, the jaw relation records are made at a separate
appointment since there are other procedures that must be completed as a
part of this patient treatment.

While it is essential that the clinician master the technique of the altered cast
recent clinical studies have shown no difference in the health of the
supporting tissues, hard or soft, after one year of wear between a RPD with
an altered cast and one made on the original one piece master cast if the
impression of the distal extensions was fully extended and the ideal borders
transferred by marking the impressions with the indelible marker. There will
be many clinical situations where this ideal master impression cannot be
made and in these instances it is essential that the impression of the
abutments take priority over that of the edentulous ridges which are
captured at a later date as described.

No compromise in the quality of the final impression or that of the master
cast can be allowed. The clinician must be prepared, and must prepare the
patient, for the inevitable remakes that will occur. Once the patient
understands that only perfection is acceptable at this critical stage they will
see that it is in their best interests to cooperate fully. In addition, the
technician must feel comfortable in telling the clinician that an apparent
error has been identified on the master cast. Their advice must always be
welcomed even if the natural reaction to a requested remake is one of some irritation. It is through this team approach that partials of the highest quality are made on a routine basis.
Chapter V

Laboratory Construction of the Framework

The laboratory phase of removable partial denture construction is just as important as the clinical. Because of the very expensive equipment required to cast stellite alloys, the clinician is totally dependent upon the dental technician to construct the framework. As a result of this situation, dental schools do not prepare their students to make frameworks and, unless the clinician has had laboratory experience before dental school, he or she will not understand the procedures necessary to create quality frameworks except in the most basic sense. None the less, the clinician bears the ultimate responsibility for the quality of the prostheses placed in the mouth and so must carefully interface with the laboratory to maintain this standard.

Clinicians have, unfortunately, often used the laboratory as a scapegoat for problems that arise during treatment. Problems in clinic-laboratory relations can most often be traced to lack of communication and the unwillingness of the clinician to review the laboratory procedures at the appropriate stages in construction. For example, the clinician should always have the blocked out master cast and the waxed up refractory cast returned for evaluation before sprueing and casting the framework. It has been my experience that the delay caused by this evaluation is well worth the trouble as there will always be a certain number of cases where the clinician is unable to adequately describe what is desired in the final product. The interaction between the clinician and the technician is equally significant for fixed prosthodontic restorations in the situations already described under additive mouth preparation.

The phases of RPD construction in the laboratory can be divided into:

- Design transfer
- Blockout and duplication
- Waxing
- Sprueing, investing and casting
- Metal finishing
- Addition of wire clasps (where indicated)
- Addition of the altered cast tray (where indicated)
The actual construction techniques and materials are usually proprietary, having been developed by the dental laboratory industry and the metal manufacturing companies. The alloys are generally chrome or cobalt based although iron and titanium alloys have been proposed and are in use. Vitallium and Ticonium were for many years the most commonly used commercial alloys in North America. These two alloys use different investments and different duplicating agars but are otherwise quite similar in their construction techniques. They show similar results in materials testing as well. The composition and characteristics of these alloys are available in any text on dental materials and should be a part of the knowledge base of the clinician involved with prosthodontics at the advanced level. Advancing technology will, no doubt, bring other alloys to market but they will most likely be constructed using similar techniques. Milling of a complete framework, either in a “printed” resin as a substitute for a wax pattern on a refractory case or in metal, while now possible using CAD-CAM techniques must as yet be considered experimental and not competitive in cost. The advent of segmented construction and laser welding of components can also be expected to influence the construction of the basic RPD framework. *Laser welding will be described in detail in Chapter10.*

**Design Transfer**

Construction in the laboratory begins with the transfer of the design from the diagnostic cast or the work authorization to the master cast. Specialists who are comfortable with their ability to make a precise drawing on the master cast need to be sure that the color code they employ is known to the technician. By placing the design on the tripoded master cast, one area of potential error is eliminated. Special care must be taken in the outline of relief pads for retentive meshwork. The extent of the internal finishing line must be clearly marked 2 to 3 mm from the gingival marginal tissue so that that area will be in metal rather than in resin. **Fig. 5-1**
Heights of contour must be carefully marked with the surveyor lead on both hard and soft tissues so that no areas requiring blockout are missed.

Perhaps the most critical area of design transfer is the accurate drawing of retentive clasp arms. The terminal third of all circumferential cast clasps must be accurately placed at the desired undercut depth, almost always 0.010” (.250 mm). Depending on the steepness of the undercut and the amount of mouth preparation, undercuts in the terminal third of the tooth surface may require blockout even though ideally the entire terminal third of the clasp should be contacting the tooth in the undercut area. Occasionally a master cast must be rejected if the available undercuts are inadequate in depth or position on the tooth. Before deciding that the master cast will not be acceptable, the path of insertion/removal must be reviewed to assure that the cast is, in fact, at the proper tilt on the surveyor.

**Blockout and Duplication**

Depending upon the proprietary techniques specific to the alloy being used for the framework, the designed master cast may be sprayed with a model gloss to seal the cast and preserve the drawn design. Obviously, care must be taken to not over spray since any accumulation of the protective coating would change the dimensions of the master cast and may result in an unusable casting. Most modern techniques have eliminated this process.

Blockout wax, either the commercially available blends or home-made, is then placed on the stone teeth to begin the blockout process. It is **essential** that no blockout wax be placed **above** the line indicating the height of contour on any areas where the casting is intended to touch the teeth, on guiding planes, rest seats and clasp arms. **Fig. 5-2**

The reason for stressing this seemingly benign step is that the contours of the stone teeth will inevitably be changed by the process in areas where accuracy is essential to the final fit of the casting. The technician removes the excess
blockout wax using a vertical blade in a surveying instrument, sometimes even one that is electrically heated to increase the possibility of creating a smooth surface on the refractory cast. Wax placed above the height of contour in areas of tooth-frame contact must also be removed. In an attempt to do so, the technician will either leave a small amount of wax, thereby making the master cast and resultant refractory slightly larger than it really is or, in attempting to remove all the excess wax, scrape some of the stone and thereby make the master cast slightly smaller in that area. In either situation, the accuracy of the master cast has been compromised. It is far better to be very careful in the initial placement of the blockout wax and never have to deal with the problems that arise in its removal.

The blockout is generally done at 0°, that is to say parallel with the intended path of insertion/removal. It is possible to alter this angle by substituting a blade that has a 2° or a 6° angle. This type of divergent blockout is used primarily for certain types of precision attachment situations. In using a blockout of other than 0°, frictional resistance to dislodgment is inevitably lost forcing increased reliance on clasp retention.

Some laboratories use a technique where a ledge is created in the blockout wax at the inferior border of clasp arms. This ledge is duplicated in the refractory and serves as a shelf onto which the plastic clasp pattern is placed during the wax-up. It should be obvious that the ledge must be placed with careful regard for the underlying drawing of the clasp arm. **Fig. 5-3**

Since the placement of the plastic clasp pattern to a precise position on the refractory cast is not an easy task, the ledge should be placed slightly (about 0.5 mm) below the line that represents the inferior border of the clasp. This will insure that the clasp will reach the desired undercut position.
When the abutment teeth have been recontoured with the blockout wax to the extent prescribed, the relief pads are added to the master cast. A full thickness of baseplate wax (roughly 1 mm) is the minimum for the relief of the retentive mesh. Commercial laboratories often choose to use a thinner relief wax in the belief that by keeping the meshwork closer to the edentulous areas there will be more room for the rapid placement of the denture teeth. While this is true, the result of too thin a relief pad is that insufficient space is created for quality resin under the meshwork. It also creates an internal finishing line that does not have adequate depth to retain the resin in the critical area next to the abutment tooth. The relief pad thickness also determines the amount of space that will be available for the impression material of the altered cast impression. **The internal finish line is established by that portion of the relief pad that is adjacent to the abutment tooth. The pad in this area must be contoured to create an undercut wedge in the final casting in order to lock in the processed resin. Fig. 5-4**

![Fig. 5-4](image)

Again, 1 mm is the minimum space for impression. In addition, the recommended procedure for a reline of the distal extension base is to first remove a uniform amount of material to insure a good bond of the added resin to the old denture base. When less than a millimeter of resin exists under the meshwork, the reduction of the material often results in grinding completely through to the mesh. The thickness of the relief wax pad must be prescribed by the clinician, not determined arbitrarily by the laboratory, especially where overdenture abutments and implants are involved (to be discussed later). The relief pad must be sealed to the master cast so that it does not separate in the duplicating procedures to follow.

To complete the blockout procedures, wax or caulking materials are placed in all undercuts that are not part of the framework. Blockout of these non-
essential areas is important, nonetheless, since the entire cast must be removed from the duplicating mold without tearing the agar. Any undercuts other than the 0.010” for the clasp retention have the potential for distorting the agar.

The fully blocked out cast is placed in a saturated solution of dental stone to be hydrated before duplicating it in the refractory material.

The duplicating agar is commonly one that is provided by the manufacture of the alloy system and is chosen for compatibility with the refractory material. For example, a phosphate-bound investment does not set against a water-based colloid, so a glycerin-based duplicating agar is used for the higher heat alloys. The agar is usually kept in a electrically heated dispenser from which it is poured through a controlled valve into the duplicating flask at a prescribed temperature and to which it is returned after recovery from the set refractory at the end of the duplicating process. The duplicating material does have a expiration point based upon the number of times it has been broken down and reheated. Clinicians need only assure themselves that the laboratory does indeed record the number of cycles and replaces the agar as directed by the manufacturer at the appropriate times.

The flask used to contain the duplicating agar is designed with a metal base and a non-metallic side ring that fits into a channel on the base. The blocked out master cast is placed on the base and the hot (temperature depending on manufacturer) agar slowly poured into the flask up to the level of the top of the ring. The entire flask is placed into a circulating cold water bath where the metal of the base conducts the shrinkage of the cooling agar towards the base to result in an accurate mold. When the agar is cooled to room temperature, the flask is removed from the bath and the master cast carefully removed from the mold by placing a knife blade in the cast base at both sides and lifting the cast vertically out of the mold without stressing the agar. Having the sides of the base of the master cast trimmed to diverge slightly towards the base will make removal easier.

More recently, a silicone duplicating impression material has been advocated and anecdotal reports indicate a more routinely accurate tooth-frame relation can be established with these materials.
The liquid/powder ration for the refractory cast is **critical** for the accuracy of the casting. The density of the set refractory determines, to a great extent, the expansion of the investment mold. It has been claimed that a change of as little as 1 cc of liquid in the liquid/powder ratio can affect the clinical fit of the framework. Our research has shown that the addition of 1.4ml of water to a mix 400 gm. will decrease the expansion of a phosphate bonded investment cross arch by an average 50 microns. Because of the high casting temperatures of the stellite alloys, the thermal shrinkage with cooling is significant. Our ability to sufficiently expand the mold is limited. By decreasing the amount of liquid to powder, the expansion of the mold can be increased to offset the thermal shrinkage. Unfortunately, the thickening of the mix that results from the change in the ratio makes the mass too thick to pour into the agar mold without fear of trapping air. The technician who uses the manufacturer’s recommended ratio with exact measurements of both liquid and powder will generally produce a mold with adequate expansion. Beware the technician who is careless with the measurement of the liquid or perhaps overlooks water in the bottom of the mixing bowl. A mix that has too much liquid in the ratio results in a mold that cannot expand sufficiently to match the expected thermal shrinkage.

Most techniques for the casting of these RPD alloys call for the desiccation of the refractory cast in an oven to remove excess moisture, followed by dipping the cast in a bath of hot molten beeswax. This wax seals the pores of the refractory and makes it less susceptible to abrasion. It also eliminates the need to soak the refractory cast before adding the first layer of paint-on investment over the waxed framework. Commercial model spray can also be used for these purposes. For the spray, two light coats are required, with a 2-3 minute drying time between coats.

**Waxing**

At this point, the design is again transferred, from the master cast to the refractory cast to form the outline for the waxing of the framework. The clinician has every right to expect a casting that conforms to the design placed upon the master cast. Commercially available plastic patterns are used whenever possible to maintain standard dimensions for major connectors, clasps and finishing lines. Rests are apt to be hand-waxed to blend in with the plastic patterns. The clinician needs to have seen the patterns and evaluated their shape and thickness to be able to truly prescribe
the components of the framework. Clasp patterns, since they have such a major effect on the performance of the cast clasp and come in such a variety of tapers and width/thickness ratios, must be selected with care.

The plastic patterns are quite flexible and can easily be stretched when removing them from the cards on which they come or when adapting them to the refractory cast. They also have a memory so they must be held in place with some sort of adhesive that is compatible with the entire process or with the addition of very small amounts of molten wax. A mixture of acetone and the plastic pattern material will create a tacky liquid that can be painted onto the refractory and to which the patterns will adhere. The tacky liquid should have only enough viscosity to glue the pattern in place. Excess material, painted on the cast, will result in a change in dimension of the resultant casting.

Once the tacky liquid has been applied, the patterns are cut to shape and adapted with either finger pressure or with a soft pencil eraser (or similar instrument). Sharp instruments may create cuts or grooves in the patterns that may influence the performance of the final casting. The sections of the plastic patterns will have to be joined with wax, trying to maintain the contours of the pattern. Since the resultant casting will not come out of the casting process as smooth and precise as a cast crown, the wax is always added in slight excess to allow for finishing and polishing of the surface. Where clasp arms join the minor connectors, care must be taken to assure that there is a taper established that will not create a thin area in the active portion of the clasp or at the junction of the plastic pattern and the minor connector which will often be thinner than the pattern. Fig. 5-5

This thin area, in between two thicker areas, can only act to concentrate stress and a fractured clasp can be predicted in the future.
Since the blockout/relief pad established the internal finish line, the technician need only worry about the accurate placement of the external finish line. This line, usually a portion of a plastic pattern, should extend to the occlusal portion of the line angle of the abutment. **Fig. 5-6**

![Fig. 5-6](image)

This position will permit a small amount of denture base resin between the denture tooth and the casting in the completed prosthesis.

The tips of cast clasp patterns should extend to just beyond the terminal extension of the transferred design to allow a very small excess of metal for finishing, no more than 0.5 mm.

Distal extension meshwork will require a tissue stop to be added at the end of the relief area of the refractory, either distal or mesial, depending on the situation. The stop should be roughly 3 mm X 3 mm and should be placed on the crest of the edentulous ridge or slightly buccal to it, wherever a relatively flat area can be found. The stop indicates a complete seating of the casting in that area for fitting and finishing. It should be removed as part of the altered cast procedure for those situations where this type of impression is required.

While a plastic pattern for the meshwork is adequate for the vast majority of situations, there are occasions when the resin retention should be created freehand in wax. Loops or strips of ½ round 8 or 10 gauge wax can be placed on the relief area of the refractory and waxed into the finish line area. This approach is most effective for maxillary tuberosity areas where space for resin is at a premium. The larger retentive areas of the hand-waxed resin retention may create a stronger link to the processed resin although the shape of the commercial patterns appears to be adequate. However, the patterns do not provide adequate retention for resin in constricted spaces. Should mesh be required in the space of a single tooth, custom waxing of
the retention is desirable since the plastic patterns will not provide sufficient retention because of their small lattice arrangement. Fig. 5-7

![Diagram of vertical post added to meshwork and raised meshwork.]

"Bead retention", a term often used for metal coverage with loops, beads, nail heads or any solid retentive contours is waxed by extending the major connector over the edentulous ridge with the addition of about 0.5 mm thickness of plastic pattern or wax and then adding an external finishing line in the same place as if retentive mesh had been used. The internal finishing line results from the butt joint formed from terminating the extension of the major connector buccal to the ridge crest and before any undercut is present. Bead retention can be formed from #14 resin beads available from KC Dental or by using the multicolored sugar balls used to decorate birthday cakes. These beads should be separated by a distance 2 ½ their circumference for the optimum resin retention. The beads are reduced to their circumference after casting using a cut off disk since the retentive undercut is only below that area which saves some space for the placement of the denture tooth.

At this point, the refractory cast and the blocked out master cast are to be returned to the clinician for review. It is essential that this review take place on every case until the technician truly understands the quality level expected by the clinician. For complex cases and all precision attachment partials, it must be standard practice. The technician sees that the clinician cares about quality and is knowledgeable about laboratory techniques. Misunderstandings that inevitably occur on design and construction are most often the fault of the clinician being unable to describe in words exactly what is required. It is only common sense that the wax-up should be reviewed before sprueing and investing. It has been my experience that around 25% of the time there will be some aspect of the wax-up that will
need to be refined and that percentage makes the inconvenience well worthwhile.

**Digital Blockout and Wax Pattern Formation**

Very recently, computer driven systems to digitally scan the master cast, blockout all undesired undercuts and wax the framework have reached the market. **Fig.5-8** The 3 dimensional data is transferred and the framework pattern is printed in resin using some form of laser jet printing. This framework has its sprues attached and is invested and cast like the traditional method. All following steps are the same as the traditional method. Dental laboratories are experimenting with these systems because they feel that they can create the wax pattern faster and with greater control than with the traditional method. The success of these systems remains to be seen.

**Sprueing, Investing and Casting**

These steps in the laboratory construction of the removable partial denture are industrial in nature and generally follow the proprietary instructions of the metal manufacturer. The clinician does not have a role to play here except for being aware of the process, especially the sprueing, since the variation in sprueing techniques is great with every technician doing things just a little bit differently. As an example, the laboratory with which I have
worked these last 18 years uses a helix in the sprue leads, usually 2 or 3 leads for a mandibular casting and 4 for a maxillary. **Fig. 5-9**

The technicians feel that the helix does two things that dramatically affect the quality of the casting. The helix acts as a reservoir for the metal mass that reduces the potential of a suck back. It also slows the flow of the molten metal, however briefly, reducing the turbulence and thus reducing porosity.

**Fig. 5-9**
Sprue leads without the helix are sometimes used as an additional lead for complex casting configurations. These sprues are always slightly curved to slow the metal flow.

The clinician should always examine the resultant casting and any broken castings for evidence of porosity as a quality control check on the laboratory. It is possible but not practical, to x-ray a casting to visualize porosity using an occlusal film as was the standard practice for subperiosteal implants.

While there is little that the clinician can do, beyond showing interest, about the casting of the partial denture framework, the treatment of the casting after it has been cast is a critical procedure that dramatically affects the ultimate success of the partial denture.

**Metal Finishing**

Metal finishing is an all-encompassing term covering the steps from the actual casting of the partial denture framework to the fully finished and polished framework. It is an aspect of the process that historically has been left entirely to the discretion of the technician with the clinician accepting the finished product without question. The most important phase of construction is in the finishing and fitting of the casting and it is here where an accurate casting can easily be rendered unacceptable if the internal surfaces that contact the teeth are altered in any way. The standard means
of finishing the casting, once the sprue(s) have been removed with a cut-off disc, is to electro-polish, that is, strip the entire casting electronically in order to remove a small amount of metal from the entire surface. This process reduces the amount of fine finishing and polishing that will be required. Unfortunately, the removal of even this potentially very small amount of metal (40-50 microns at the very minimum) will reduce the frictional retention that could have been obtained with the parallel guide planes established through mouth preparation. The only way to control this electrochemical process is to not allow it to occur at all in areas that are critical to the tooth-frame relation.

All tooth contacting surfaces; guide plates, minor connectors, rests and clasps must be protected from the electrolytic deplating process by coating them with a high fusing wax or a substance like fingernail polish that will not allow contact with the acid bath. Stripping or deplating occurs when a metal is placed in an acid bath attached to an electrode and a controlled microamperage is passed through the metal via the electrodes and the bath. A commercial unit with temperature, amperage control and timer is used that has a clamp on the electrode to hold the framework. Obviously, all the ingredients of the system contribute to the rate of dissolution of the surface of the framework and so are susceptible to improperly calibrated components or careless technicians. This system works in reverse as with a die plating unit and is similar to the units used for micro-etching of bonded castings.

Once the contact surfaces have been protected, the frame can be safely placed in the bath and kept there until the normal dark color of the as-cast alloy is replaced by a clean and shiny surface. The frame is now ready for preliminary finishing and fitting to the cast. Once again, the clinician must demand that the contact surfaces are not touched in any way by the technician and that no fitting of the frame to the master cast take place in the laboratory. One way to assure this is to not return the master cast to the laboratory after reviewing the completed wax-up and the blockout. The technician is instructed to finish and polish all non contact surfaces of the framework in a standard fashion leaving the fitting to the clinician. The reason for stressing this point is that the technician, in attempting to fit the frame to the master cast, will inevitably remove more metal from the contact surfaces than is required which decreases the quality of the tooth-frame relationship. Once a casting has been placed on a cast, the cast surface will
be abraded and no longer accurate so that subsequent fitting will be done to a cast that does not represent the mouth.

If the casting is not fitted to the master cast in the laboratory, then this responsibility will rest with the clinician. The state-of-the-art casting will be first fitted to the teeth by the clinician and only when an acceptable relationship has been obtained will the casting be placed on the master cast. Should the cast be scraped in the process it will be of no significance since it will not affect the tooth-frame relationship. If it is not possible to fully seat the casting in the mouth, then the master cast must be remade since there is no way to accurately determine if the cause of the misfit is an inaccurate impression or a laboratory error.

The laboratory must be instructed to place the highest possible finish on the casting gingival to the contact area of the guide plate. Fig. 5-10

This will require careful stoning and rubber wheeling so as not to abrade the contact areas. This quality finish is required since plaque retention in this area has the greatest potential for tissue damage. In fact, this is the only area of the partial denture for which there is a physiological reason for polishing. All other surfaces could just as well be left in the as-cast state except that technician, clinician and patient expect the appliance to be highly polished, as a customary finish for anything that goes into the mouth.

The clinician has two options for seating the casting on the master cast when the framework requires the additional steps of adding wire clasps or altered cast trays. The casting can be returned to the clinician for the fitting of the frame and the fitted casting sent back to the laboratory on the master cast or the technician can be instructed to place the finished casting on the master cast in the lab, always at the expense of the stone teeth. The intraoral fitting of the framework can be done with the wires and the tray in place although it is generally easier to work on just the frame alone.
Addition of Wire Clasps

While it is technically possible to cast to wires, this procedure is primarily used for gold base castings and high gold content wires. When stellate alloys are used for the framework, the wire is best soldered to the finished framework some distance from the point of flexure. Casting a stellate alloy to a wire clasp or soldering the clasp directly to the minor connector will result in a more brittle clasp and increase the likelihood of subsequent clasp failure.

Wires for retentive clasp arms are most often round in cross section. It is possible, however, to use a ½ round clasp wire. There is no clinical evidence that this form has any advantage over the simpler shape. In fact, the ½ round wire is much more difficult to adapt to the tooth since any bend across the flat surface is a technical challenge. The desired position relative to the height of contour has been indicated on the master cast and marked with a single line. The technician should be able to contour the wire exactly to this line. For the wire “I” bar, the clinician must indicate just how much of the foot of the clasp should contact the tooth. Usually a gentle bend 2-3 mm from the tip of the clasp will give sufficient linear contact to ensure a positive contact of clasp on tooth. The tips of either form of wire clasp should be rounded before soldering them to the framework since access to the tip may be limited once the clasp is in place.

The wire clasp is adapted to the master cast with the framework in place. Occasionally the guide plate is notched at the point where a circumferential clasp will exit the resin so as to position the clasp exactly as designed. The tang of the clasp is directed down the guide plate and onto the lingual surface of the casting. It will terminate in a positive contact area, either a retentive mesh square that has been filled in during the wax-up or to a retentive bead that has been flattened with a disc after casting. **Fig. 5-11**

In either instance, the wire must make a positive contact with the casting if resistance...
brazing is to be used to solder the clasp. Our studies have shown that an 800 fine solder will produce the best joints when used in conjunction with a non-precious or a PGP (platinum, gold and palladium) wire. Softer wires such as the Jelenko Standard Clasp Wire are better soldered with a torch and conventional 650 solder.

Resistance brazing, which utilizes a step down transformer and a carbon tip to heat the solder while a copper tip completes the circuit through the casting is a quick means of soldering stellite alloys and is used extensively for repairing partial denture frameworks. **Fig. 5-12**

Like all soldering operations, brazing is an art rather than a science and considerable experience is required to create a dependable joint. Fortunately, the wire will also be retained by the resin but, to do this, the portion of the wire embedded in the denture base must have some bends for physical retention.

**Clinic-Laboratory Relations**

While not as important as the maintenance of the hard and soft tissues of the oral cavity in the long term, much of the potential for success rests with the quality of the laboratory phases of construction. Finding the state of the art dental laboratory and building a working relationship with the technicians will always be a major factor the treatment of patients needing the removable partial denture. The more complex the partial the greater the need for technicians to be fully involved the process.

The clinician has a responsibility to their dental laboratory; to keep those special technicians current with what appears in the various Prosthetic Journals and what is learned at conventions and study clubs. I have found that the technicians are more than happy to reciprocate with what they learn from their Journals and what comes to them from the dental industry. While
it would be great if both sides of the “team” routinely read the same materials but it is unrealistic to assume that this actually occurs. In world of the partial denture, both fixed and removable, quality comes from teamwork!
Chapter VI

Establishing the Tooth-Frame Relationship

Since the laboratory technician has not touched the tooth contact areas of the framework during the recovery and finishing of the framework, the responsibility for fitting the frame devolves entirely on the clinician. While this may be interpreted by some as unnecessary and time-consuming, I see no other way to obtain the highest quality fit of the casting and to retain the frictional fit of the guide plates on the prepared guiding planes.

There are three phases of this fitting procedure. Since the as-cast surface of a stellate casting is quite rough due to the porosity and grain size of the refractory, the first step is to examine the casting under magnification and to carefully remove all the blebs on the tooth contact surfaces, primarily the guide plates. Because the stellate alloys are so much harder than gold alloys, the adjustment of the contact spots is not easily or quickly accomplished. Special burs are available for these alloys (the Brassler Co., makes an E-series bur for the straight handpiece intended to run a 10,000-15,000 RPM. These burs come in a variety of sizes and in both regular and fine cut. There are also fully sintered diamond stones that are intended for use with chrome alloys.) The goal at this point is to remove the positive imperfections without changing the contact surface of the guide plate. Once the blebs have been removed the contact surfaces are sandblasted to leave a uniform mat surface to make the identification of intraoral contact points easier.

The second step is to obtain a static fit in the mouth where the casting fully seats on the prepared teeth. Using magnifying loops and a sharp explorer, this fit is verified visually. The seating process begins with the use of a disclosing material to identify areas of premature contact. Historically, disclosing waxes or a mixture of gold rouge in chloroform was used to identify these areas. Both have been discontinued; the waxes because they were a mess to apply and to clean up and the chloroform-rouge mixture because of the concerns related to the volatility of the chemical and its toxic nature. A convenient substitute has been found in Fit Checker, a GC product. This very low viscosity and quick setting silicone, intended for
evaluating the fit of crowns, works equally well for frameworks. It identifies contact points, in a static fit only, since it sets chemically.

For the casting that is difficult to seat, it is good to remember those areas most apt to be in hyper contact. Our studies have shown that the area most likely to have contact is the marginal ridge area where the transition from the guide plate to the rest occurs. If the tooth preparation has left a sharp line angle here, the chances are excellent that the cause of the casting not seating can be traced to this area. Unfortunately, identification with the Fit Checker in this area is not as obvious as it is on the flat surfaces of the guide plate. It is always possible that there are still some minor blebs at this critical junction that were not identified in the first step.

To obtain a functional fit as is required for a mandibular Class I or to identify areas of interference that are not identified with the static Fit Checker articulating tape (Accu-Film II) or similar milar based die marker can be used. Small pieces of the tape, 20x20 mm. are placed between the frame and the tooth and the frame is rocked around the fulcrum point of contact. Die from the tape will be deposited on both the tooth and the point(s) of premature contact. Obviously, it is the frame that is adjusted, not the tooth. This process is continued until a satisfactory fit is obtained OR it is determined that the framework will have to be remade.

Once a satisfactory static fit is obtained, usually after a number of adjustments of the guide plate surfaces, the fitting of the frame is complete for all but Class I partial dentures. For the bilateral free-end situation, functional relief is required if the clinician wants the supporting areas of the edentulous ridges to bear some of the load of mastication. Remember, if no functional stress relief is created in the casting, either through the short guide plane concept already discussed or the use of tapered blockout, the casting must be relieved to allow some rotation movement around the distal-most points of contact.

How much stress relief is desirable? There is no clear scientific answer to this problem. It may be best to tailor the amount of movement to the displacement of the areas of major support for the denture bases. When the ridge tissue is firm and healthy, little relief is needed to protect the abutment teeth from luxation. However, when the supporting tissues are weaker, the
amount of possible base movement in function is increased and the amount of stress relief must be increased. As a general rule, if two millimeters of rotational movement is possible at the distal extension of the retentive mesh without binding on the abutment teeth, stress relief will have been established. The longer the edentulous span, the greater the amount of stress relief that must be created in the casting.

In order to rotate the framework, the tissue stop must be removed from the distal extension of the meshwork. If it is not removed it will, quite possibly, dig into the soft tissue beneath it and restrict rotational movement. Again, Accu-Film II or similar material is cut and placed in the casting in the area of the guide plate(s). The casting is seated and rotated by placing a vertical load on the distal-most part of the meshwork or the altered cast tray (if one is attached at this point) to identify rotational interference. The casting is adjusted with the same instrumentation as used previously, always with care not to remove any more metal than is absolutely necessary, until the desired movement is obtained. The mylar has just enough elasticity to adapt itself around the tooth. It, and the tooth, must be completely dry in order to lay down a crisp mark at the point of contact.

The combination of parallel or “milled” guide planes, accurate final impression and attention to detail in the laboratory should create a casting that can be fully seated without eliminating the frictional resistance to removal of the framework. Even the finest casting can be severely compromised by careless fitting of the frame. The clinician must get in the habit of treating the partial denture casting with the same care as would be given to a crown margin.

What to do if the framework does not completely seat on the abutment teeth? In some instances it may be possible to retrofit the casting to the abutment tooth by bonding on resin to contact the frame. The most obvious example of retrofitting is when the casting fits everywhere except for one or two rests that fail to contact their rest seats. When these rest seats are in enamel it is both convenient and acceptable to etch the existing rest seat, prime the enamel with any suitable bonding agent and then place composite resin on the rest area and seat the framework. In most instances, sufficient light can be transferred to the composite by varying the angle of the light source to achieve a stable mass of resin. Excess material that may have extruded over the casting is eliminated and the framework removed.
Additional light curing is done before any finishing procedures are undertaken. The quality of fit of the new rest seat will be perfect since the seat was made to fit the existing casting. Other areas of the framework are not as easy to retrofit but using chemically cured composites, guide planes can be brought into contact with the guide plate. Studies have shown a dramatic increase in frictional retention with these retrofitted contacts.

Inevitably, the clinician must face the problem of a casting that cannot be brought into an acceptable fit in the mouth. Often it will not be possible to determine what was the likely cause of the poor fit. The fit of the frame on the master cast will often show that the laboratory phase of construction has produced a frame that fits the cast in an acceptable manner. If this is true, one can only conclude that the error was not made in the laboratory. The clinician must then review the procedures for making the master impression. I have found that the inaccurate master cast can most often be traced to patient movement during the setting of the alginate gel or the separation of the alginate from the tray during removal of the impression. If one assumes that the alginate was prepackaged and mixed for the recommended length of time and that a careful double pour technique was used to create the master cast there really is no other place to look.

The removable partial denture framework is not an easy casting to make with precision. The geometry of the frame and the variations that can occur just from differences in expansion based on placement in the casting ring make the framework far more complex than is found in the casting of a crown. One could well expect to find 1 out of 8 or 10 castings unacceptable if one’s standards of acceptance are high. It only makes sense to reward the excellent technician if one is fortunate enough to find one. At the very least, they should be made to feel an essential part of the team and praised when things go well. Sending a photo of a special completed case is an excellent way of keeping laboratory interest high and reminding the technician of the high standards that the clinician requires. Technicians involved with continuing education within the dental laboratory profession should be offered access to clinical slides of the cases to which they have contributed.

In addition to fitting the frame to the teeth, the frame must also be brought into occlusal harmony with the natural teeth. The clinician must evaluate the natural tooth stops without the partial casting in the mouth and assure
that the presence of the casting has not altered this relationship. Since the occlusal and incisal rests are routinely over-contoured in the waxup, it is to be expected that the cast metal may well interfere with complete closure to centric occlusion on some occasions. The clinician should first of all evaluate the thickness of the offending rest by measuring, both at the center of the rest and at the marginal ridge area, the thickness of the metal. The rest should never be reduced beyond 1.2 mm for fear of subsequent fracture, sometimes months or years later. When this dimension is reached, further adjustment must be done on the opposing tooth. Obviously, careful mouth preparation will reduce the need for these adjustments.

Since the occlusal surface of the rest will have to be rubber wheeled and polished after adjustment, the metal should be sandblasted on those surfaces to make the identification of the die marks from the Accu-Film easier to spot. It is not easy to return the laboratory finish to the casting with standard chairside finishing stones and rubber points. The hardness of the metal requires that a high speed dental lathe be used to quickly restore the metal to its original luster. The re-polishing of these occluding surfaces is a laboratory function and should be completed before the positioning on the denture teeth begins.

The additional time and effort required to establish the ideal tooth-frame relationship must be added to the total cost of creating the very finest partial dentures. Without this level of attention to the final fit the goals of esthetic tooth replacement without visible anterior clasp ing and the substitution of frictional retention for clasp retention cannot be achieved on a routine basis. As the partial denture becomes more sophisticated with the addition of precision attachments and implants the ability to control the interface becomes even more essential to creating partial dentures of the highest quality.

When a framework cannot be fitted to an acceptable level in the mouth there are only two options open to the clinician; 1, to start over with a new master cast. It does not make sense to remake a framework without a new master cast since it is impossible to identify for certain the cause of the misfit, or 2, to treat the removable casting as one would a fixed partial denture frame, and to section the offending area of misfit from the frame and see if the segments now have an acceptable tooth-frame relation. If one is lucky, and some luck is generally required, then the segments can be individually fitted
to the abutments and related in the mouth using some type of quick setting and accurate pattern resin. Some type of soldering cast is poured against the segments and when set the components can be laser welded, soldered or brazed together and the “new” casting returned to the mouth to verify the tooth-frame relation before continuing on.

Soldering and/or brazing a dependable joint for a stellate alloy is far from an easy task and requires great skill and experience from the technician. The clinician is here totally dependent on the dental laboratory since the equipment and the skills for this procedure are not a part of clinician’s environment. Fortunately for us all, the advent of the dental laboratory laser welder has made this second option most viable and must be considered for correction of misfit as well as a number of other options that will be discussed later.

Clinical studies have shown us that one of the few mechanical factors that have a statistical as well as a clinical direct effect on long term tissue health in the removable partial denture is the requirement that a quality tooth-frame relation exists. “The better the fit of the frame the better the tissues will be long term”.
Jaw Relation Records

Jaw Relation records are normally made only after the framework has been fitted to the mouth and brought into the desired occlusal relationship with the opposing arch. Remember, if the master cast can be related to the opposing cast by simply placing the casts in occlusion with wear facets for reference, this will always be the method of choice. Only when this stable relationship is not obtainable should a actual record be made. The most positive recordings are made in a material that is truly plastic for the recording and then rapidly sets to a hard surface. Registration materials using ZnOe as a base are most often used. Bosworth’s Super Bite or Blue Mousse *MFDG* are excellent examples of this type of material. They require a base of hard wax, trimmed to be 2-3 mm out of occlusion, as a platform for the actual recording. The setting time can generally be decreased by adding a very small amount of water or alcohol to the mix. Once set, these materials can be trimmed with a sharp knife so that only the tips of the opposing cusps are visible. **Fig. 7-1**

Since the opposing cusp tips are more likely to have accurately reproduced in the opposing cast than in the full occlusal surface, the record should be easily verified when using this technique. The hard wax base should not contact the soft tissue in a Class III situation. Only on terminally edentulous areas, is it necessary to obtain some support from the soft tissue.

Since the ZnOe pastes are truly plastic for a short time after mixing, the record could theoretically be made without any posterior support. A compromise between no support and a full tissue base coverage can be made by placing an island of autopolymerizing resin under the place where the tissue stop is (or was) located, after the cast has been coated with a separating agent. **Fig. 7-2**
This will re-establish the tissue stop support of the distal extension framework as well as serve as a base for the strip of hard wax that supports the recording material.

**Fig. 7-2**

There is little evidence to support the making of a face bow record for the removable partial denture case with natural teeth in the opposing arch. Only when the opposing arch is a complete denture, could an argument be made for the use of an ear bow or other arbitrary mounting. The great majority of removable partial dentures sent to a commercial laboratory for set-up and processing will use a plane line articulator. The need for protrusive records to set condylar inclination is also of little use since the plane line articulator is not adjustable.

Jaw relation records for a removable partial denture opposed by a complete denture require a much more involved technique. These records are most often made as a part of a separate appointment where anterior teeth will be positioned as well as the basic records taken. When an altered cast impression is involved, that impression must be made before the jaw relations appointment. On occasion, a suitable record can be made in conjunction with the altered cast impression as described earlier.

The relationship to be captured for the CD/RPD situation is centric relation rather than the centric occlusion of other partial denture types. Either a processed denture base for the opposing arch, or one made with a combination of plasticized resin (Lynal or similar material) and fast-setting orthodontic resin needs to be available for the centric relation record. The record must capture centric jaw relation, which is a posterior, unstrained, patient-assumed position at a vertical dimension of occlusion that allows the establishment of an esthetically pleasing face height, adequate speaking space and some inter-occlusal space at rest, much the same as is required for complete dentures.
The first step is to establish the vertical dimension of occlusion. A quick and dependable method for finding and capturing this position of mandible to maxilla is to first establish a length of wax rim that will extend just short of the length of the relaxed upper lip. The patient is instructed to close to first contact and the face height evaluated. The patient must appear obviously over closed at this time. This does not in any way simulate the vertical position of the anterior teeth as tooth placement is independent of the jaw relation record. A cone of wax or compound is added to the wax rim in the midline of the upper jaw. This cone is directed to contact the incisal edge of one of the lower anterior teeth, usually a central incisor. Fig. 7-3

When no natural anterior teeth are present in the lower arch, then a denture tooth (incisor) is arbitrarily placed in the central incisor area.

The cone is long enough to ensure that the vertical dimension of occlusion is exceeded at first contact. The cone is warmed in the compound heater and the patient instructed to close, in centric relation, into the cone until the clinician tells the patient to stop, that is, when the face looks neither over-opened nor over-closed. The clinician then evaluates the esthetic face height and repeats the procedure as necessary. The cone is allowed to harden to preserve the tentative vertical dimension record. After the cone has hardened so that it will not distort, any excess material can be removed so that only the incisal edge of the tooth remains in the record.

The contact of the cone and the incisor tooth will normally be visible to the clinician so that the speaking space can be evaluated. The amount of space seen when sibilant sounds are spoken will usually give an indication that the necessary “speaking space” has been created. Unfortunately, speech is not a good measure until all the teeth are present in the dentures of both arches and the patient has had time to adapt to the new contours. The clinician can, however, easily evaluate the inter-occlusal space at rest by looking at the relationship of the tip of the cone and the opposing tooth, even if the lips
have to be slightly parted by hand to gain a line of sight. This check must be done out of the dental chair with the patient standing in a relaxed but vertical position since the head position in the modern dental chair will distort the resting vertical dimension as shown years ago by Sev Olson (one of my early teachers). One could expect to see anywhere from 1.5 to 6 or 7 mm of space at rest with the Class III patient having the least and the Class II the most. Finding the ideal vertical dimension at rest requires the balancing of these different factors. Since it is quite clear that there is no exact vertical dimension of occlusion, the clinician need only find an esthetic and comfortable dimension and then verify that position later with the trial set-up.

The cone, as it contacts the lower incisor, will also serve as a visual indicator of centric relation for the actual recording. To make the record as positive and as fool proof as possible for others to mount casts into the articulator, one can place a molar denture tooth on each side of the maxillary rim in the area of the 1st and 2nd molar. Fig. 7-4

The cusps of these denture teeth will imprint the recording material on the partial framework with a minimum of pressure and leave very precise indentations so that, with the cone as the third point of reference, a positive record can be easily verified visually, both in the mouth and when mounting the master casts. Instead of using a new denture tooth for this purpose, unused teeth, always available in the office, can be cut in half horizontally so that no interference will occur when placing the occlusal portion onto the maxillary rim. This method is always superior to cutting grooves in the rim and expecting the recording material to flow up into the grooves.

Placement of denture teeth

The occlusion desired for RPD situations where the opposing arch contains natural teeth restored in any manner is one of contact in centric occlusion
only. Disclusion, both in lateral movements and in protrusion, should not occur on the denture teeth, if at all possible. When denture teeth must be involved in disclusion, as when a cuspid is replaced, some form of metal coverage on the denture tooth must be considered to eliminate the rapid wear that can be expected to occur when resin wears on other materials, porcelain, natural teeth or restorative materials.

For those situations in which the opposing dentition is a complete denture, the partial denture occlusion should be similar to that of standard complete dentures, that is to say, some form of working and balancing contacts over a range of 1 to 1.5 mm from the centric position. Protrusive contacts are often not possible to obtain without drastically altering the vertical and horizontal overlaps of the anterior teeth which will most likely be unacceptable esthetically.

Before placing the first denture teeth onto the partial framework, consideration must be given to the contour of the resin flange. Since severe resorption of the residual ridge is unlikely to occur immediately adjacent to an abutment tooth, the first denture tooth will be much more likely to appear natural if it is butted to the ridge and the flange begun in the interproximal area between the first and second tooth. Fig. 7-5

![Fig. 7-5](image)

A denture tooth of sufficient occlusal-gingival length must be chosen to allow a natural transition between the abutment tooth and the denture tooth. Often this implies a tooth with a well-formed and colored root surface (as is found on the Ivoclar posterior tooth, for example). Should the abutment tooth be clasped with a visible circumferential clasp, the denture tooth will have to be carefully contoured to create space for the clasp to exit without causing an esthetically unacceptable display of base material. Should too much of the denture tooth be removed for placement, the resulting unnatural denture base can be removed with a cavity preparation in the resin and a microfilled composite placed to simulate a proximal restoration after processing and finishing the partial denture. Fig. 7-6
In the CD/RPD situation, it is not always possible to position the denture tooth in the ideal position that would be used in a CD/CD. The position of the remaining natural teeth will often require the use of diastemas or crowding of the denture teeth to create a standard denture occlusion.

The same mesial-distal considerations mentioned above can be expected to occur when the partial denture is opposed by natural teeth, with or without a partial denture. In addition, the contour of the occlusal surface of the denture tooth will often not harmonize with the occlusal surface of the natural tooth. In order to obtain good esthetics with maximum centric contact, the denture tooth may need to be placed in hyper-occlusion and then ground into a solid centric contact. When this need arises, the clinician must verify that a denture tooth of the same dimensions as the natural tooth has been selected. The manufacturer’s recommended mold, as taken from the mold guide of any anterior tooth, cannot be used, as it will always be too small to allow optimum occlusal contact. Instead, the choice of the posterior tooth mold will be made only on the basis of the mesial-distal and buccal-lingual dimensions of the opposing natural tooth. In the same manner, the choice of cusp height is based on the contours of the opposing teeth.

In most instances, a 1 mm hyper-occlusion that is adjusted into contact will be satisfactory. The occlusal surface of the adjusted tooth must be recontoured to recreate the occlusal anatomy, usually by re-establishing the grooves and fossae with an inverted cone bur. Denture teeth should be positioned and ground into suitable occlusal contact one at a time instead of setting all the teeth into hyper-occlusion at once since some teeth will require a greater or lesser degree of hyper-occlusion than others.
As the positioning of the teeth proceeds posteriorly, (or anteriorly in the case of the Class IV), the creation of small randomized diastemas will usually result in a lifelike appearance of any teeth that are visible. Likewise, if anterior teeth are included they will need to be selected on the basis of the dimension of the edentulous area and decisions made as to diastemas or crowding. Since anterior diastemas are unlikely to occur in one arch only, the most common placement will be one with some level of crowding. Remember, it is very unlikely that any patient requiring anterior tooth replacement in the mandible would have perfectly straight incisors unless they are very young or have the tooth-arch discrepancy that would indicate the need for diastemas. Obviously, the patient can be expected to remember the presence of diastemas while they may not recall the crowding.

Only when the opposing arch contains second molars that have the potential for continued eruption would second molars be placed in the mandibular partial denture, unless the opposing arch is a complete denture and the patient is severely Class III. In the maxillary arch the second molar may be partially visible and therefore should be replaced.

For the removable partial denture opposed by a complete denture, (almost always CD/RPD), some decision on the occlusal scheme of the combined prosthesis must be made. There is no evidence that one form of occlusal arrangement is superior to any other but for esthetic reasons some form of cusped tooth is usually indicated since a flat tooth may be difficult to harmonize with the remaining natural teeth. Perhaps the lingualized arrangement is the most adaptable.

Final waxing, or for that matter, waxing for try-in, should that be indicated, must be identical, except that the final waxing includes sealing the margins. Unfortunately, waxing for try-in is often done in a casual manner which does not allow the clinician, or the patient, to fully evaluate the final form and esthetics of the denture. The wax-up must always be evaluated off the cast to ensure that adequate thickness of base material will be available after finishing and polishing. Any areas of potential sore spots, as might be found adjacent to a sharp mylohyoid ridge, should be over-waxed and then recontoured in the final resin once any problems of pressure spots have been eliminated. Any flange area where tinting of the denture base material is planned must be waxed to exacting contours since the tinting will be
superficial and easily altered by recontouring. Those flange margins that
will be visible must be waxed to a very thin margin and should be slightly
curved as they pass vertically since a straight line will tend to be more
visible than a margin that flows with the contours of the tissues. As a final
step in the waxing of the denture base, all traces of wax must be removed
from the exposed denture teeth. This is normally done with a sharp carving
instrument like a Walls carver. No further use of the flame is made since a
flash of wax will inevitably result. The object of this final waxing is to
create a surface that will require no finishing whatever, only a light
polishing, since any finishing operation will remove some of the outer
surface of the tooth and the tinted denture base.

Flasking, Tinting and Packing

The laboratory procedures of flanking and packing the removable partial
denture are more complex than those of the complete denture which are,
extcept for the tinting of the denture base, not highly technique sensitive.
Since there may often be many small areas of isolated base resin, a split
packing of the flask used. The technique of split packing implies that a
sheet of cellophane, with resin on both sides, is kept between the halves of
the flask up to the final closure of the denture flasks. This procedure
ensures that the resin will not pull out of the interproximals or from around
clasp arms during trial packing. At the final closure, the cellophane is
removed and the two resin surfaces moistened with monomer to ensure a
complete bond.

Another technique, often employed, is to use a “no trial pack resin” where
the resin is placed in the mould before the usual “snap” stage occurs and the
flask pressed closed and immediately placed in the curing unit.

The tinting of the flange is one of those special areas that make the
difference between the standard partial denture and the state-of-the-art
prosthesis. As part of the tinting of the denture base, consideration must be
given to opaquing the casting in areas where the grayness of the metal may
show through thin sections of the flange. Resins associated with the 4-META
bonding agents can be used to bond on a thin layer of opaque that is
suitably colored but experimentation with coloration will be required
between clinician and technician.
Certainly, accurate tinting to truly match the patient’s gingival color is a matter of art rather than science and, unfortunately, something that cannot be done at the chair. Superficial tints are available but they are only temporary in nature. Definitive tinting requires that the tinted resins (available from Kay See Dental Mfgd. Co., Kansas City, MO for Dr. Earl Pound’s “sift in” technique) be placed in the flask and blended from the outside inward before the regular base material is added. Fig. 7-7

The clinician interested in developing this aspect for the “advanced” partial denture must create a series of shade tabs in conjunction with the dental laboratory that will process the resin. The Kay See kit contains 5 vials of colored polymer that range from a very light pink used to tint areas of firmly attached tissue over the necks of teeth to a dark, heavily pigmented color that is compatible with darker tinting patterns. The kit also contains red flocking that can be placed in the areas of unattached gingiva to simulate blood vessels. The short flocking that is commonly found in denture base materials does not present a lifelike appearance, especially when it appears in the marginal gingiva in a random pattern as can be expected with standard packing techniques. This type of flocking does, however, add color to otherwise partially translucent material. When the tints are placed in the outer surface of the base and backed up with the standard resin, the end result can be indistinguishable from natural tissue. Since a natural appearance of the visible denture base is critical to ideal esthetics, mastery of the tinting process is an essential component of an advanced level of prosthodontic care. The instructions that come with the tinting kit provide sufficient guidance for choosing the appropriate colors but do not cover the fine points of their application.

Since the denture base adjacent to the denture teeth has been carefully waxed to the desired contour, the final preparation of the finished denture base should require only the removal of the flash from the packing and the possible slight reshaping and polishing of the denture borders. Finishing
and polishing of the junction of the denture tooth and the base should be kept to a minimum for the most esthetically pleasing result.

Should the partial denture be Class I or II and opposed by a complete denture, a remount cast must be made for the finished prosthesis. Occasionally, the dentate portion of the master cast can be salvaged in deflasking but, more often than not, the cast is destroyed in the process. A second pour of the dentate portion of the final impression is perfectly adequate for the remount cast. The finished partial is placed on the dentate portion and a plaster base added to support the distal extensions. **Fig. 7-8**

![Dentate cast](image)

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If undercuts are present in the denture bases they must be blocked out before pouring the plaster base.

**Fig. 7-8**

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**Insertion**

Because of the care taken to make the final impression or the altered cast impression, there should be little adjustment of the denture base at insertion. Flanges of tooth borne segments should be short of any undercut areas. Pressure indicator paste will identify areas of possible subsequent sore spots but it is important to remember that the correlation of a visible spot in the pressure paste and a subsequent area of soreness is not 100% and some thought must be made before removing denture base material. The most common areas that can be expected to require adjustment are those below the height of contour of areas of tissue undercuts that are normally found adjacent to the terminal abutments. **Fig. 7-9**
The guiding planes will dictate the path of insertion. The resin in these usually minor undercuts must be relieved even if the undercuts do not initially hinder the full seating of the denture. The soft tissue in these areas is usually quite thin over the bone and tightly bound. In order not to traumatize these tissues the partial denture should never be fully seated at first. Rather, pressure indicating paste is painted on the resin and the partial seated until the first slight resistance is felt or until the patient feels pressure. The partial is removed and adjusted and this careful procedure repeated until the partial fully seats without any feeling of pressure or rubbing expressed by the patient. By starting the flange of the denture base distal to the first denture tooth as was described earlier, some of these problems can be eliminated.

Retentive clasp arms may have been distorted in the deflaking process and may require adjustment at insertion. Rather than trying to over-adapt the clasps, the patient is better served by leaving the partial on the loose side with the explanation that the goal initially is to have the partial only minimally retentive. Since all prosthodontic patients are to be seen on at least one post-insertion visit within the first few days, further adjustment of the clasps can be done at that time if the patient finds the initial retention inadequate. Most patients will understand that having the partial too rigidly attached to the remaining teeth is not desirable in the long run.

Occlusal adjustments are almost always required at the insertion appointment and should be looked on as fortuitous since the absence of prematurities often means infra-occlusion which can only be corrected by the addition of metal occlusals. Under no circumstances should the patient be released if the natural teeth are not back in contact with the opposing occlusion unless some type of overall onlay casting has been deliberately selected to increase occluding vertical dimension. When the patient has a partial denture in both arches, the partials should be adjusted one at a time to natural tooth contacts before attempting to place both partials in the mouth for final adjustment. Any easily visible natural tooth contact can be chosen as a witness mark to be sure that natural tooth contact occurs, both in centric occlusion and in excursive movements.

A post-insertion visit within three days of the insertion appointment is essential to complete the insertion procedure. If all aspects of construction have been accomplished with care, there is seldom need for any additional
post insertion appointments. The patient can be placed on a well-defined recall program at this point, realizing that only through regular recall and re-evaluation can the full life of the partial denture be assured.

**Metal Occlusal Surfaces**

When the removable partial denture is opposed by natural teeth or fixed restorations, consideration must be given to protecting the occlusal surfaces from the inevitable wear that occurs. There are many techniques for fabricating metal occlusals which can be made in either precious non-precious alloys. Perhaps the most dependable method is to allow the patient to wear the new partial denture for a month or so to be certain that the chosen occlusal scheme is appropriate for that situation. At that point, the patient returns and the partial is placed back on the remount cast, if one has been made for adjustment at insertion. Sprue leads of 6 gage round wax (or similar wax forms) are added to the occlusal table, one at the most posterior cusp and one at the most anterior. **Fig. 7-10**

![Fig. 7-10](image)

Then a silicone mold is made of the occlusal surfaces of the denture teeth to include the sprue leads.

Using a resin finishing bur, the occlusal surfaces of the denture teeth are reduced by a uniform 1 mm, to include the grooves. A 3 mm deep central groove is cut into the teeth (and, in some instances, extending into the denture base material). This groove should be wide enough to occupy 1/3 of the buccal-lingual width of the teeth. **Fig. 7-11**

![Fig. 7-11](image)
The occlusal surfaces of the denture teeth and groove are lubricated with a separating material, the silicone mold(s) replaced on the partial, and molten inlay wax is injected, using an eye dropper, into one of the sprue leads until wax is seen coming out the opposite sprue. When the wax has cooled, the silicone molds are removed and any voids or defects corrected with additional wax. For those partials where no remount cast was made the wax contacts can be verified in the mouth. When the desired occlusal contacts are obtained, the wax occlusal block is teased from the denture and sprued from the underside of the central groove with sufficient sprue leads to assure a complete casting. Before investing the wax patterns, a retentive groove is cut into the bulk of wax that extends into the central groove. **Fig. 7-12**

![Diagram](https://via.placeholder.com/150)

The purpose of this groove is to insure physical retention of the casting in the denture base. 4 META-type bonding agents can be applied to the casting as an additional retentive measure. The partial denture is cleansed and re-inserted and the patient dismissed. Since it will take only a day or two to invest, cast and finish the casting, the patient can use the partial in a normal fashion even if mastication is somewhat compromised.

When the castings have been finished, the patient returns and the partial is placed on the remount cast (if one exists) to complete the process. Since the tooth-colored resin that will be used to join the casting to the teeth will be viscous, additional space for the resin will need to be created by removing a small amount of tooth substance from the internal surface of the prepared cavity. The casting is tried into the preparation and if the occlusal contacts are satisfactory, tooth-colored resin of the appropriate shade is mixed and placed in the groove and on the other prepared surfaces as well as in the retentive groove on the casting and the casting is forced to place by closing the articulator to the original occluding vertical dimension. Excess tooth-colored resin is removed and then a stout rubber band is placed around the articulator to hold the casts in occlusion while the articulator is placed in the
After finishing and polishing, the metal occlusal surfaces can be expected to add considerable life to the removable partial denture. The only potential problem with this procedure is that there will be micro leakage at the metal resin interface that will, in time, leave a dark line in the resin. By using a bonding agent this line can be eliminated or greatly reduced.

Depending on the opposing occlusion, the metal occlusal surfaces need not cover the entire occlusal surface of the denture teeth. They may, in fact, take the form of large Class I restorations. When the opposing occlusion is a complete denture, the lingual cusps of its posterior teeth can be made in metal using the same technique and a lingualized occlusion created for the patient that virtually eliminates occlusal wear for the expected life of the dentures.

**Long Term Maintenance**

Long term maintenance of a partial denture constructed to the highest standards, as described in this manuscript, will be minimal and limited to the occasional readjustment of retentive clasp arms and precision attachments. Resilient attachments can be expected to need replacement on an annual basis. Relines of distal extension bases and areas of recent extraction will be required when indicated. An evaluation of the fit of the resin denture base must be a part of the annual recall appointment.

Of far greater importance in the recall and maintenance phase of treatment is the continued management of both the periodontal and restorative components. There are excellent studies that would indicate that the life expectancy of a removable partial denture can be increased up towards twenty years if the supporting structures can be maintained. Remember, the partial denture patient has already demonstrated some degree of inability to manage his/her own disease process, with the exception of traumatic and congenital needs for care. In the first year after insertion, the patient should be seen at either 3 or 6 months to evaluate the response of the tissues to the partial denture. An essential part of this recall is the evaluation of the patient’s ability to clean, not only his remaining teeth, but the partial denture as well. The use of a solution of vegetable dye to stain the partial will generally indicate those areas where plaque remains. Often the clinician will find that the patient has lost the denture brush that is normally
given to the patient at the insertion appointment and is trying to clean the partial with a standard toothbrush that may not have bristles of sufficient length to get into all areas of the partial. A short brush of the kind that is used to apply pressure indicating paste has proven to be ideal for plaque removal from the spaces formed by guide plates, rests and clasp arms. The standard of clinical care has not been met until patients have proven their ability to keep the partial free from accumulations of plaque.
CHAPTER VIII

REPAIRS, ADDITIONS, RELINES
and
LASER WELDING

Many of the necessary repairs and additions to a removable partial denture will, by necessity, be made in the dental laboratory. It is incumbent on the clinician, however, to be knowledgeable in the area of framework repairs and to fully understand the clinical requirements necessary to prepare the prosthesis for the laboratory repair.

Pickup Impressions

The clinician will be responsible for relating the partial to the mouth and for capturing this relationship in the pickup impression, regardless of the type of repair or addition. To be certain that the partial denture is fully seated during the impression; the clinician will often be required to hold the partial in position while the impression is being made. This requirement necessitates a sectional impression. Fortunately, repairs are almost always confined to one specific area of the denture so that a pickup impression that covers only the quadrant in question will allow the partial to be held firmly in position. In some instances, an assistant will be required to seat the tray while the clinician maintains the components in position. When a pickup impression, almost always made in irreversible hydrocolloid, is fully set, every attempt should be made to remove both the impression and the partial in one piece. Should the alginate separate from the partial, the clinician must be certain that the prosthesis has been fully reseated in the impression. This will sometimes require that small amounts of impression material that may have been bent under the partial during reinsertion be cut from the impression before the pouring of the repair cast.

When pouring the repair cast, it must be remembered that only that portion of the arch that relates to the actual repair need be reproduced on the cast. As long as there is sufficient cast structure to assure that the technician can remove and replace the segment(s) accurately, there is no advantage to having a larger cast. In fact, it is often easier to work with a partial cast,
since seating the repair on and off the cast is facilitated and the possibility of cast fracture reduced.

Resin Repairs

The need to repair only a resin portion of the properly constructed removable partial denture is usually related to an accident in which the partial has been dropped by the patient and some part of the denture base fractured. When the broken part is available, it can usually be repositioned exactly based upon the fracture line. It is then a simple matter to submit the denture and the fractured resin to the laboratory for repair. Occasionally, the patient will attempt to repair the fracture using the dreaded Super Glue. Once this material has been placed on the resin, accurately repositioning the two segments is usually impossible. In this instance, the Super Glue is removed with an acrylic bur and the remainder of the denture base prepared for a reline impression.

Approximately 1 mm of denture resin is removed from the entire tissue surface of the fractured denture base and the missing or broken area reformed, using gray or green stick modeling compound. Once the borders of the defect have been corrected, 1 mm of compound is removed from the tissue side of the addition and a wash reline impression made in the affected denture base. The wash impression can be made in any free-flowing impression material. The completed reline impression is submitted to the laboratory, a cast poured against the impression, and the reline and repair completed at the same time, either in a flask or a reline jig. By combining the repair with a reline, an accurate tissue surface is obtained regardless of the fracture site.

Another common repair situation is the fracture of an isolated denture tooth, almost always caused by inadequate framework design and construction. Since the cause of the fracture is in the framework, no successful, long term repair can be made without either remaking the specific retentive component or using one of the modern resin-to-metal bonding agents (4-META). Since the cost of remaking and soldering or welding on a proper retentive element approaches the cost of a new casting, the bonding agents offer an inexpensive and apparently dependable method of single tooth repair. The proper use of these bonding agents is technique-sensitive and the manufacturers’ instructions must be followed to the letter.
Metal Repairs

The most common metal repairs are associated with fractured clasp arms. For the most part, these fractured clasps can be replaced with a wrought clasp as a repair. Embrasure clasps and clasps emerging from some single tooth edentulous spaces are the exceptions to the rule and may not be reparable. Whenever possible, a fractured cast circumferential clasp, the most commonly used clasp, should be replaced with an infra-bulge wire clasp, since the replacement clasp will be contained entirely in the resin of the denture base and not involve the occlusal surfaces. Fig. 8-1

![Fig. 8-1](image)

When infra-bulge clasps are added as the repair clasp, the technician must be reminded that the approach arm of the clasp must not contact the gingiva if the partial can be expected to rotate into the soft tissue, as it would if it were a Class I partial. Instead, the clasp should be positioned so that it is slightly away from the soft tissue (0.2-0.3 mm). Fig. 8-2

![Fig. 8-2](image)

Before making the pickup impression, the cause of the clasp fracture, if known, should be evaluated. It may be that the clasp was poorly designed or constructed, that without some additional mouth preparation the situation cannot be improved, and that the repaired clasp will itself fracture in the future. Most commonly, this is seen in circumferential clasps where
insufficient space for the clasp was created during mouth preparation and the clasp arm or shoulder adjusted to allow full occlusal contact of the opposing teeth. The adjustment created a thin spot which became a point of stress concentration and resulted in the fracture. The thickness of the metal at the fracture site can be measured and if its thickness is less than 1.25 mm, additional mouth preparation must be accomplished before the impression. For similar reasons, other tooth contours are modified to the ideal form, line angles rounded and excessive undercuts reduced as an essential component of the repair procedure.

After all indicated mouth preparation has been done, the pickup impression is made. Again, the need to maintain the partial in its ideal relation to its supporting structures is essential since the fractured clasp may eliminate the possibility that the partial will stay in place for a full arch impression.

Rather than send the pickup impression directly to the technician, the clinician must pour the cast and remove the denture after the stone has set so that the contours of the stone abutment tooth can be surveyed and the gauge and position of the replacement wire clasp determined and marked on the cast. The same standards of clasp construction discussed in earlier chapters apply to the repair clasp.

When the clasp in question does not have an adjacent acrylic flange of suitable proportions to allow the placement of an infrabulge clasp, the repair will require a circumferential clasp. This repair will involve the opening of the occlusal surface of the denture tooth adjacent to the repair so that the wire circumferential clasp can be brought trans-occlusally to be embedded in the lingual resin of the denture base. Fig. 8-3

As a result of the preparation of the trans-occlusal groove, the occlusal surface of the denture tooth will need repair as well. To insure that the repaired partial denture will have proper occlusal contact in this area, the opposing
denture or cast of the opposing teeth should be sent to the lab with the repair cast so that the technician can restore the occlusal surface(s) involved.

The fractured embrasure clasp may be repaired by sectioning the lingual minor connector a few millimeters below the occlusal surface before making the pickup impression so that the minor connector weld is not placed in an area of occlusal load. **Fig. 8-4**

The laboratory can then block out the cast, duplicate, wax and cast a replacement embrasure clasp. This clasp, when finished and polished, can be welded to the framework to complete the repair. Unfortunately, the cost of this type of repair is high and totally dependent on the weld for longevity. In most of these situations, it is advisable to remake the partial denture.

The same procedure of sectioning the minor connector first is used for another common repair situation, that of the fractured occlusal rest. This type of fracture can almost always be blamed on inadequate mouth preparation that leaves a marginal ridge reduction of less than the 1.25 mm mentioned before. The technician can wax the replacement rest directly on the lubricated repair cast. The rest is sprued with a small round wax sprue lead and a small amount of appropriate casting investment painted on the wax. **Fig. 8-5**

Once the investment has set, the entire assembly can be teased from the repair cast and added to some other partial denture framework casting for final investment and casting. The finished rest addition is polished and
joined to the partial using 800 fine solder with a resistance brazing device as a heat source or the more dependable laser weld (laser welding to be discussed in detail at the end of this chapter). This type of soldering is an art form and requires considerable skill and experience. Laser welding requires an expensive piece of equipment and an experienced technician but the actual welding procedure is more technical than artistic. Laser welders presently cost in the neighborhood of $35,000 and are most likely not available in labs that do not do RPD or Implant frameworks. High quality laboratories with a reputation for removable partial denture frameworks can be expected to have such skills and equipment available to the clinician.

The addition of an a denture tooth to the partial to replace a natural tooth lost to decay or periodontal disease is also a common repair situation, often one that could be considered a real emergency if the tooth happens to be an anterior. The tooth can be replaced as an addition after the natural tooth has been extracted and initial healing has taken place or, and this is often the preferred way, as an immediate replacement followed by the extraction. In either case, the existing framework must be capable of supporting the addition. As we have discussed earlier, one indication for a lingual plate is when the potential for tooth loss exists. When a lingual plate is present, the best results are obtained by drilling two small holes in the plate and soldering or welding a small loop of wire, usually one of Ni, Cr, and Co, into the holes so that the loop is internal to the replacement denture tooth.  

**Fig. 8-6**
This form of retention will be as strong as one that is part of a new partial framework. When no lingual plate exists and there is insufficient adjoining resin to retain the denture tooth, a cast addition is indicated. Fig. 8-7

As in the replacement of the broken embrasure clasp, the cost of a quality repair may approach that of a new casting. Again, and on a temporary basis, the 4 META bonding agents can be used to add a tooth to the metal framework.

Fractures of major connectors can be repaired by using 800 fine solder and the resistance brazing device or with laser welding. Obviously, the mandibular bar will be the easiest major connector to weld since it offers easy access over a limited distance. Maxillary major connector repairs are seldom worth the effort. The need for a major connector repair results more often from distortion rather than from outright fracture of the metal although there are occasionally inclusions of refractory material that collect near the sprue attachment and cause a spontaneous fracture. The patient who drops their partial and then steps on it can expect that it may not fit all that well from then on. In an emergency situation, the major connector can be separated with a thin disk at the point of the perceived bend and, if both segments fit the mouth in an acceptable manner, it is worth making the pickup impression and sending the case off to the laboratory for welding. Beyond this, major connector repair is not practical.

Restorations under existing removable partial dentures

It is not uncommon for abutment teeth to require some form of restoration or re-restoration during the life of the partial denture. The two or three surface alloy restoration that fractures at the isthmus is difficult to place
under an existing partial and maintain positive contact with the rest. In these instances, the tooth usually requires re-preparation of the box form to widen, or deepen, or some combination of the two, to insure that an adequate bulk of amalgam is present. These restorations may also be made in composite if the clinician is comfortable with a posterior composite. Since the composite filling can be layered into the cavity, the final contact with the rest or other components of the partial can be made after the removal of the rubber dam and matrix. Light activation of the composite is usually possible in a two-stage process where the material is first activated with the partial in place. This will usually set the material sufficiently to allow removal of the partial denture without distorting the restoration. Additional light curing with the partial out of the mouth completes the restoration.

For those situations where a complete composite restoration is not indicated, a combination of alloy and composite can be used to support an occlusal rest. After the additional mouth preparation, the alloy is packed in the usual manner and then a dovetailed box in the area of the rest is formed. Fig. 8-8

Chemically curing composite is placed in the box and the partial fully seated in the mouth until completely cured. This combination of restorative materials will allow the creation of a positive rest seat contact. Some form of microfilled resin is indicated in these repair situations rather than any of the heavily filled materials.

Crowns under existing removable partial dentures

In many situations, the restoration of the tooth with amalgam or composite will not be adequate to support the partial or to properly restore the tooth. Some type of veneered crown, veneered or all metal, will be needed. Constructing a crown under an existing partial denture is not an easy task.
and, if it is not done to perfection, the partial will not seat passively on the tooth after cementation of the crown.

It is essential that sufficient tooth structure be left to allow for both retention and resistance forms since the potential loading of the abutment tooth can be expected to be greater than for an uninvolved tooth. If inadequate tooth structure remains, then consideration should be given to either surgical crown lengthening or orthodontic extrusion. Only as a last resort should endodontic treatment with post and core be considered, since the failure rate for this approach with partial denture abutments is high.

In almost all these repair situations, the tooth will be prepared for a full crown. The clinician must verify that sufficient tooth structure has been removed to allow a minimum of 0.5 mm of metal on the axial walls and up to 2.0 mm on the occlusal surface if an occlusal rest is involved.

As in other repair situations, the impression must be made with the partial denture in its proper relationship to the supporting abutment teeth. This requires a sectional impression with the clinician holding the partial in position while the assistant seats the sectional tray. The actual impression is made by removing the retraction cord and injecting the low viscosity impression material of choice completely around the margin of the preparation. A small amount of impression material can be injected onto the remainder of the prepared tooth. An excess of material might restrict the full seating of the partial.

The partial denture is seated in the mouth and additional material syringed onto the prepared tooth and into the space between the tooth and the partial. Once the space is filled with the low viscosity material, the sectional tray, with higher viscosity impression material, can be seated. This tray must extend on either side of the repair area so that there will be sufficient impression material to lock the partial into the impression. The impression and the partial must be removed at one time since the chance of being able to accurately reposition the partial into the impression is unlikely. The master cast is then poured, either by the clinician, if the partial is to be returned to the patient or by the technician if the partial is to be kept in the laboratory for the construction of the crown. When pouring the master cast, it is critical that the stone be poured directly against all parts of the partial denture with the exception of clasp arms, precision attachments and
undercuts in the resin areas. This will allow a positive seating of the casting during the construction of the repair crown.

If the patient can do without the partial denture for the time that it takes to complete the repair, then the technician need only marginate the die and wax the crown to fit the framework. This is usually done by first waxing a thin coping to the margins and then seating the casting on the cast and flowing molten wax in the space between the coping and the casting, using a glass eye dropper that has been warmed in the flame to prevent the wax from cooling too quickly.

The most difficult part of the repair is the waxing of the area where the clasp, should there be one present, will lie. Not only will the wax need to flow against the internal of the clasp arm, but a retentive contour will have to be built into the wax-up. The undercut formed from this contour will have to relate to the path of insertion and provide the required 0.010” dimension for the terminal third of the clasp arm. If the crown is to have a porcelain veneer, the task becomes even more difficult since the porcelain must be overbuilt originally. As a result, the frame cannot be removed from the crown without fracturing off the dry porcelain.

The solution to these problems is to sacrifice the retentive clasp arm and make the facial contour to ideal dimensions. After the porcelain veneering is complete, with appropriate undercut in place, a repair clasp is added to the partial using the techniques previously described. The resulting repair crown will have an ideal form and will often be an improvement, both functionally and esthetically, over the original abutment tooth.

Should the patient require the use of the partial denture during the repair period, the clinician will need to pour and recover the final impression and construct a temporary restoration in the shape of the original tooth form. A vacuum form made from a diagnostic cast before mouth preparation can be used to make the temporary. Another technique uses a putty matrix that is made of the tooth before preparation. Missing tooth structure can be restored with soft wax before the matrix is adapted to the tooth. After preparation, the matrix is filled with tooth-colored resin and seated on the preparation. Unfortunately, some adjustment of the temporary is almost always required to seat the partial denture. Areas of premature contact are best identified using the mylar based articulating ribbon placed inside the
partial contours when the frame is seated onto the temporary crown. Points of heavy contact show up easily and are adjusted.

The patient is allowed to wear the partial denture but is asked to return once the die has been trimmed and a wax coping dipped onto the die. The patient waits while the wax pattern is developed, using the molten wax as previously described. Since the facial surface will be shaped to ideal contours, the patient will not be needed again until the crown is completed and the repair clasp added. At this time, the crown is cemented and the partial seated. Occasionally, despite one’s best efforts, some adjustment of either the casting or the clasp is required. Again, mylar tape is the method of choice for identifying points of premature contact. Since the clasp will be made of wire, and as often as possible in the I-bar form, the adjustment of the clasp is not difficult.

**Relines and Rebases**

Periodic relining of the distal extension areas of the removable partial denture is an essential component of the maintenance phase of therapy. Relines of recent extraction areas are also required. The clinician is faced with deciding between a laboratory reline and one done at the chair. Unlike complete dentures, where a laboratory reline is preferable in all but very temporary situations, the partial denture reline is best done in the mouth. The reason for this difference lies in the fact that the partial denture casting has a different relationship to the abutment teeth when it is being relined in a flask than when it was originally processed.

When the partial denture is processed in the denture flask, it remains on the master cast so that the tooth-frame relation cannot change even if the technician should not get the flask completely closed when packing the resin. The result of any error here would be a prematurity in the occlusion which is easy to correct. In a laboratory reline, however, the partial denture does not stay on the cast but ends up in the other half of the flask. Now, when the technician does not get the flask completely closed, the tooth-frame relationship is destroyed and the completed reline will not fully seat onto the abutment teeth.

In order to avoid any chance of this disaster occurring, a resin that cures either completely or partially in the mouth is used. This allows the clinician
to fully seat and maintain the casting on the abutment teeth while the resin polymerizes. The partially light-cured resin, Astron or a similar material is an excellent choice for the RPD reline since it is quite color-stable over time and since it only partially cures in the mouth, the clinician need not fear locking in place around abutment teeth.

Regardless of which reline approach is chosen, the preparation of the partial denture base for the reline impression is nearly identical. In order for the reline material (either resin or impression material) to flow freely when the partial is seated on the teeth, the clinician must be certain that adequate space exists between the base and the supporting ridge. Just because the partial denture rocks or the patient complains of movement it cannot be assumed that a uniform space exists under the base.

To register the tissue-base relation, a thin layer of specially prepared alginate is placed in the base and the denture seated completely. This alginate is a mixture of one scoop of regular set alginate with two units of hot water. The resultant mix will be the consistency of soup, so it will not displace tissue but will set quickly because of the hot water. When the partial denture is removed from the mouth, the tissue-base relation is easily seen and any areas of contact marked before the alginate is removed. The alginate can be torn to evaluate its thickness. Often there will be 1 to 2 mm space over the ridge, especially in the mandible, but no space will exist in the lingual flange area. The clinician will need to relieve the contact areas so that \textit{1 mm of space, at the very least}, is present overall. In some instances, this will mean that the underside of the raised meshwork is completely exposed. This space is critical for the free flow of the impression material or resin.

A decision must also be made as to the adequacy of the border extensions. The light-cured resin cannot be expected to create a proper border roll if the existing border is underextended more than 3 mm. If the existing borders are greatly under-extended, a rebase of the partial denture casting should be considered, which would entail a pickup impression as described earlier. If the existing borders are properly extended, then a finishing line should be cut into the resin border to provide for a butt joint of the new resin with the old. This will reduce the possibility of later peeling away of the repair resin that is often seen when a very thin flash of resin exists at the border. The
goal of the partial denture reline should be to add a uniform layer of new resin overall. Fig. 8-9

The same finishing line should be created for an impression to be used in a laboratory reline if that option is chosen. It will give a positive line for cutting away any excess impression material before pouring the repair cast.

The light-cured reline material will set to a firm but resilient mass in the mouth without the generation of heat but, as with all resin materials, with a strange taste. When inserting the partial into the mouth with the reline resin in place, a small amount of the resin should be placed in the clinician’s mouth so that the initial set of the material can be evaluated. When the mass attains the consistency of bubble gum, it is safe to remove the partial denture since the addition is beyond the stage of possible distortion. After trimming any gross excess away with scissors, (never with a knife), an oxygen barrier is painted on the reline surface and the final cure made with a light unit. A simple light source like that used to make trays is perfectly acceptable to complete the cure.

To complete the reline procedure, the clinician must be prepared to adjust the occlusion, especially if the opposing arch is a complete denture. Since the loss of ridge support occurs over an extended period of time, migration of the opposing dentition or prostheses is to be expected. This would require a clinical remount procedure if a complete denture is involved, since intra-oral adjustments on unstable bases will never give the quality of occlusal contacts that can be developed on the articulator.

While the base support must be evaluated as part of the annual recall examination, the actual need for a reline on a mature ridge should not occur more often than once every 4 to 6 years. When a solid tissue-base relationship exists, concern over the stress relief built into the design of the partial becomes purely academic since rotation of the partial during function
can be expected to be within the tolerance of the periodontal membrane, thus eliminating or greatly reducing any damage to the abutment teeth.

As part of the recall evaluation, the wear of the occlusal surfaces of the denture teeth must be evaluated and the addition of metal occlusals considered. As discussed earlier, it may be appropriate to evaluate the wear potential of the resin teeth over a period of time and only convert to metal when a total lack of contact is found. Conversion to metal is best done immediately after the reline of the denture base(s).

Given what we now know about the need for continual maintenance of even our best efforts, the repairs, additions and relines of all types of removable partial dentures become a critical component of the state-of-the-art partial denture. Even though we have made every effort to design and construct the strongest possible partials, we know that we will be required to perform these services, with the help of our technicians, on a routine basis, along with equal efforts in combating caries and periodontal disease.

Laser Welding

The advent of what appears to be a dependable and accurate laser welder, specific to the dental laboratory, has presented us with a most valuable tool. Laser welds make the repair of and additions to a RPD framework much easier and they offer us the option of making our partial dentures in segments, as we have historically done with fixed partial dentures. The segments can be related in the mouth, joined with any one of a number of resin systems and sent back to the laboratory to weld. Our published research show a shrinkage in the range of only 50 microns (0.050 mm) from the position of the segments in the mouth to the final fit of the frame.

The strength and accuracy of the laser weld on a variety of dental alloy systems is based upon the fit-up of the segments (fit-up is a term from industry describing the relationship of the pieces to be joined). The laser weld requires an actual contact between these segments or, when a gap exists, the filling of the gap with a filler metal before welding. The laser weld also requires an overlap of the segments to be joined rather than the small space needed for soldering or resistance welding. The ideal extent of this overlap has not, as yet, been tested but it is clear from discussions with our technicians that the overlap joint is clearly stronger than a butt joint.
The width and depth of the weld joint and the degree of overlap of the spot welds all affect the final strength of the repair. Because our frameworks are not flat pieces of metal, as usually occurs in industrial welding, we are only able to use overlapping spot welds rather than the continuous weld used in other situations. It should be obvious that the laser weld used for correcting a misfit of the casting will require the filler metal or a new cast component since the disk cut, combined with the error in fit, will leave a gap between the components to be welded.

The dental laser weld also requires that the total weld joint area be exposed so that the joint can be “tacked at the corners” to eliminate the warpage that will occur if continuous spot welding is used without stabilizing the joint. This often requires a laser welding cast that will hold the components of the weld in a fixed position and provide access for the laser beam while the “corner tacks” are made. Once these stabilizing welds are made the frame can be removed from the welding cast and the weld completed. This cast is made of plaster or stone, preferably with 0° expansion, following the resin pickup from the mouth. The design of the cast is tricky since its form is specific to the joint to be made. There has not been enough research at this writing to come up with standards for the welding cast.

The finishing and polishing of the laser weld joint also poses some possible problems for the technician since any reduction of the weld surface to recontour the joint and smooth any irregularities will decrease the depth of the weld. Since the overlap of the spot welds is ideally 75% there should be no openings in the joint but the spot welds will be visible. The weld joint is unlikely to be visible to the patient but it certainly should be explained.

Laser welding technology can be expected to advance in the years to come as it truly is a better way to provide, repair and maintain our prostheses.
CHAPTER IX

Special Prostheses

Splinting With Removable Partial Dentures

The use of the removable partial denture to support multiple teeth with mobility has long been questioned. Certainly, fixed prostheses offer a more dependable means of joining loose teeth into a single unit. There will be situations, however, when the removable partial will be called upon to offer maximum support to the remaining teeth, either for financial reasons or because of the number of missing teeth in the arch. The best treatment for these situations is obviously some combination of fixed and removable prostheses where ideal contours, that is to say, guide planes and rest preparations, can be created on all remaining teeth. Careful, well-planned mouth preparation of multiple teeth, coupled with ideal casting control, can offer excellent support to weakened dentitions and has been shown to actually reduce mobility over time.

To achieve these results, special mouth preparation is required. Perhaps the most common modification of conventional preparation is the use of the “strut” or continuous occlusal rest preparation. Instead of a series of multiple regular occlusal rests, this continuous rest runs from tooth to tooth as a channel in the center of the occlusal surface of the remaining teeth and is joined to a proximal guide plate at either end of the block of contacted teeth. The channel needs to have a width of 3 mm and a depth of 1.25 mm in order to have adequate strength. Fig. 9-1

![Fig. 9-1]

The buccal and lingual sides of the preparation must be slightly tapered, with rounded internal angles to facilitate a complete seating of the partial. These surfaces must draw with the prepared guiding plane surfaces and therefore must be re-evaluated during the surveying of the check cast before final impressions. Fig. 9-2
When an extension of this rest is placed on the last tooth in the arch, normally a second molar, this amount of metal will create a rigid rest despite the cantilever from a more anterior tooth.

Since the rest will be in occlusion with the opposing arch along its total length, some modification of the waxing technique is required to minimize the amount of occlusal adjustment on this very hard alloy. The laboratory can either mount the refractory cast and wax directly to the opposing occlusion or the rest can be waxed on a mounted master cast and transferred to the refractory during the final waxing of the partial. The advantage of the latter technique is that it allows the clinician to create the desired occlusion on the master cast rather than try to describe it to the technician. When waxing the occlusal strut to be transferred, a hard wax should be used to reduce distortion during removal from the lubricated cast and its placement on the refractory. After finishing, the surface of this special rest should be sandblasted so that any eccentric interference’s to a smooth disclusion can be easily identified during the first few days of wear. After the adjustment period, the final polish can be easily restored with rubber points and a rag wheel with appropriate polishing compounds.

When this special rest is properly constructed, it will stabilize loose teeth both in centric occlusion and in eccentric movements since, when the partial is fully seated with ideal tooth-frame contact, the teeth cannot move independently from the partial. While this rest may not be “esthetic,” it normally appears as a series of occlusal amalgams to the eye of the patient. Anterior teeth involved with this type of splinting will require positive rests, either cingulum or incisal, to maintain the tooth-frame relationship during occlusal loading. Simply plating the lingual surfaces will not serve to “splint” mobile teeth. This type of framework is far more complex than the standard RPD forms and misfits can be expected. Sectioning and laser welding provides a relatively simple solution to the misfit. This type of casting can also be made in segments, i.e., the strut rests and the occlusal portion of the anterior and posterior guide plates that connect the rest to the
basic frame can be made as a second casting. The basic frame is cast, finished and fitted and if acceptable, returned to the master cast to be “re-duplicated” in refractory material so that the strut component is waxed and cast to the prepared contour of the basic frame with an overlap for the laser weld. With this approach there will be no need for a filler material for the weld since there will be a positive fit-up when the segments are joined in the mouth with the resin pick-up.

Hinged major connectors

The hinged major connector, commonly referred to as a “Swinglock” (actually a patented name and technique), is another special prosthesis that offers excellent splinting capabilities as well as a means of retention when normal tooth contours are not available for any reason. A barrel-shaped hinge with retaining dimples is attached to the major connector with a minor connector that will, in most instances, exit from an edentulous area. **Fig. 9-3**

![Fig. 9-3](image)

On the opposite side of the arch, a retaining latch of some sort extends in a similar fashion via a minor connector. **Fig. 9-4**

![Fig. 9-4](image)

Connecting these two terminals, a bar with projections to the gingival enamel of the enclosed teeth, swings from the hinge and snaps into the
latch. When the prosthesis is in the closed and latched position, all the enclosed teeth are locked together. **Fig. 9-5**

![Fig. 9-5](image)

The bar portion can take many forms, one of the popular options being a plate that runs from the vestibule to just incisal to the dento-enamel junction. The outer surface of the plate has a gingival finishing line and micro bead retention for a thin resin veneer **Fig. 9-6**

![Fig. 9-6](image)

When the plate is opaqued with the proper shade and suitably colored with resin stains, this gingival apron blends in as natural gingiva

The laboratory has two options for constructing the hinge/latch combination. The most common technique uses the patented components, hinge and latch, which are added to the wax-up of the partial and retained in the casting by means of retentive contours in the metal. A more sophisticated and potentially more precise approach involves two castings. The first casting contains the basic structures of the partial denture and the hinge and latch. After this section has been cast and finished, it is returned
to the master cast and re-duplicated; the casting remains in the duplicating agar and the refractory material is poured against it. On this second refractory, the bar component is waxed to the hinge and latch. It is sprued and cast to the first casting. **Fig. 9-7**

A very precise hinge and latch results since the freedom of movement is created by the thickness of the oxide layer that forms on the first casting when it is placed in the furnace to burn out the second (bar segment) refractory. Using this technique, it is possible to make smaller and more precise joints than one can achieve with commercial components.

The Swinglock concept was originally presented as a technique requiring no mouth preparation of any kind. Subsequent clinical studies have demonstrated that rest preparations are needed to assure that the entire assembly does not slip gingivally on the teeth. Since the hinged gate effectively holds all the teeth it touches in contact with the main casting, mesial migration of these teeth will not occur. A single, positive rest form of any type on each side of the casting will keep it from settling. The hinged prosthesis has the same requirements for the management of any distal extension base (especially on the mandible). Since these castings are far more complex than the standard partial denture framework, the clinician can expect to be charged a fee 75%-100% higher than for a routine partial denture casting.

The hinged appliance has two major indications. The most common use is in compromised mandibular situations where only a few anterior teeth remain. When one or both of the mandibular cuspids is missing it is often next to impossible to obtain adequate retention by clasping a lateral incisor. In these situations, the remaining teeth are often compromised periodontally which makes splinting them into one multi-rooted abutment advisable. It is critical, however, to provide a positive rest seat on the terminal abutment on either side to eliminate the possibility of settling. The other, and less often
indicated use, is for maxillary situations where the remaining teeth are all on the same side of the arch, often in a more or less straight line. This situation is often found in maxillo-facial patients where a maxillary tumor has caused the loss of half of the maxilla. The splinting effect of joining all the remaining teeth is often the only means of supporting and maintaining the prosthesis. Obviously, the placement of implants if possible, will dramatically alter the success of treating these conditions.

Special problems exist for the hinged appliances that are not found in the routine partial denture situation. There must be enough of a buccal vestibule remaining for the labial bar. When this space is minimal, the bar may have to be changed to a veneered plate in order to have sufficient strength. The labial bar is sometimes very objectionable to the patient because of the bulk in the lip. The only alternatives to the use of the hinged appliance for these compromised situations are either splinted, full coverage restorations of all remaining teeth with attachments, the use of implants or some combination of the two. Some patients, when elderly or compromised by arthritic changes in their hands, will have trouble opening and closing the lock mechanism and will require both training and patience to be able to utilize this design. In some extreme situations it may be necessary to remove the gate and replace it with some form of light wire clasping, even though this may be unesthetic and provide only limited retention.

Rotational Partial Dentures

The rotational path of insertion partial denture is a special prosthesis normally used in maxillary Class IV situations where anterior visible clasping is objectionable. This special design utilizes rigid projections into mesial proximal undercuts on the prime abutments (those adjacent to the anterior edentulous space) to retain the anterior part of the partial. Fig. 9-8

Since these projections are not clasps in that they do not flex, they must be placed into the undercuts by inserting the partial first in the anterior and
then rotating the posterior of the casting to place, with the rigid projections acting as the rotational point(s), hence the name “rotational partial denture”.  

**Fig. 9-9**

Since the posterior part of the casting must be rotated to place, any projections that might interfere with the rotation must be eliminated from the design. This usually implies that there be no modification spaces in the posterior segments and that the major connector be open from the rest in the anterior to the posterior minor connector for the posterior clasp.  

**Fig. 9-10**

If the modification spaces were present, then the additional potential guiding plane surfaces, properly utilized, would make the rotational design unnecessary since anterior clasping would not be required.

The prime abutment teeth must have well-defined, positive rest preparations. Any movement of these teeth over time will result in the possible loss of the partial’s retention as well as in its inability to completely seat onto the abutment teeth. This design provides anterior retention since when the partial is fully seated the anterior segment cannot rotate down and out of the mouth due to the rigid projections in the anterior undercuts. The posterior part of the casting is held in place by embrasure clasps on either the first or second molar, bilaterally. The positive rests on the prime abutments provide a solid stop against tissue-ward movement. The result is a retentive partial that replaces anterior teeth without the show of clasps in the front of the mouth.
The projection into the proximal undercut can take the form of a clasp-like arm, if the tooth involved is an anterior or a part of the minor connector if the prime abutment be a bicuspid. **Fig. 9-11**

Very special care must be taken in the laboratory to assure that this projection is in no way altered, either in the blockout (of which there should be none under the projection), or in the electrolytic stripping and finishing of the metal. This projection must contact the tooth in order for the retention of the anterior segment to be acceptable, therefore, the casting must be fitted first to the mouth and then placed on the cast without regard to possibly scraping the cast. The clinician can expect to find interferences to the rotation of the casting. These must be identified and adjusted intraorally using some form of disclosing material. Care must be taken when adjusting the rigid projections since, as opposed to a clasp, they will be too short and rigid to bring into tooth contact by bending with a plier.

Since the anterior segment must be rotated into place, the anterior flange can only extend to the height of contour of the edentulous ridge and must be tapered to a very thin margin to avoid creating a ledge for the accumulation of food. Tinting of the resin of the flange is especially important as it complements the effect of the hidden “clasp”. **Fig. 9-12**

**FIG. 9-12**
In those cases where there has been anterior ridge destruction, there may be no anterior undercut and in these situations the flange is fully extended to provide lip support. In these situations, the resin retention of choice may well be a raised retentive mesh since any large soft tissue defect can be expected to eventually need a reline. In mature ridges without loss of contour, the metal base with suitable retentive devices for the denture teeth is preferred. Depending on where the metal of the casting ends on the facial gingiva, the casting may require opaque and tinting of the denture base. Since the resin in the labial flange will most always be on the thin side, some experimentation with the tinting will be required. There will not be the normal depth of denture base resin to back up the tints and, as a result, the colors will not appear as one would expect from the tinting of a standard denture base.

The patient will often require some extra time and instruction in the placement and removal of the rotational path partial. While some loss of retention over time can be expected, the amount of actual wear from the friction of rotation is really minimal so that the partial should be serviceable for a normal period of wear.

### Onlay Partial Dentures

There will be occasions when there is a need to bring an abutment into occlusion with the opposing arch. Obviously, this could be done with a crown but should the natural tooth not need a crown for restorative reasons then one should consider making an onlay that is a component of the RPD. There are two ways of managing this situation; the time honored one is to wax the onlay on the articulated and lubricated master cast and then transfer the wax pattern onto the refractory and join the wax to the waxed frame rather than try to mount the refractory since the refractory material is weak before it is heated and easy to fracture when separating the refractory from the mounting plaster. Fig. 9-13 The second technique involves making the onlay as a separate casting, perhaps of a different alloy (gold in some form) and using the techniques of laser welding described in this manuscript, weld the onlay to the completed framework. The onlay should contact whatever guiding plane can safely be prepared. This guide plate will be extended to form a tang that fits into a recess in the edentulous retentive metal and it here that the laser weld will be made. A retentive unit, usually a bead or two, when placed on the external of the plate will provide additional resin
retention above the weld. A gold onlay will much easier to adjust and polish when compared to a stellate alloy.

There is an additional advantaged to this second method in that picking up the onlay casting from the mouth and joining it to the framework with the laser weld eliminates the effect of the distortion that always occurs from the casting process and results in the best possible fit of the onlay on the abutment tooth.

![Image of onlay](image)

**Fig. 9-13** The onlay in this picture has been waxed on the master cast and transferred to the refractory where it is waxed to the framework.

The need for the onlay is most often found when there is an isolated molar (2\textsuperscript{nd} or 3\textsuperscript{rd}) on the mandible with a complete denture in the opposing arch. The isolated molar has likely tilted mesially and lingually to the point that its mesial is below the desired food table and the tooth unable to provide occlusal stability for the complete denture.
CHAPTER X

Precision Attachments

Philosophy of Treatment

The precision attachment denture has long been considered the highest form of partial denture therapy. It combines fixed and removable prosthodontics in such a way as to create the most esthetic partial possible. It also has the reputation of lasting far longer than the conventional partial. What possible biological reason could exist to support this reputation? It has long been my belief that the reason this prosthesis is, in general, so successful is that the clinician and the laboratory simply must take greater pains in every aspect of construction just to get the precision attachment partial into the mouth. Since the cost of this particular therapy is apt to be far greater than for a conventional partial denture, there is a greater likelihood of long term follow-up care and high quality maintenance. If the more conventional partial denture, one that is clasp-retained, is constructed as described in this text, then there is no inherent reason that the attachment-retained partial should be superior. The precision attachment partial should differ only in the means of its retention when compared to the clasp-retained partial denture and the only reason for utilizing this mechanical device is to replace the visible clasp arm. All other functions of the partial can be performed by conventional means if they are understood and the partial constructed to the highest standards.

Until just the last few years, the use of a precision attachment required the construction of one or more crowns as part of the treatment. With the advent of resin-bonded components, a whole new era has opened for the attachment-retained partial. The demand for what might be called “fashion magazine” esthetics, so apparent in our modern society, has made many of our patients unwilling to accept visible anterior clasp and so we see an increasing need to be able to offer this type of prosthesis. The combination of these two seemingly unrelated statements will create a demand for a more sophisticated partial denture, one in which good tooth structure will not have to be sacrificed to allow maximum esthetics. In many situations the esthetic compromise brought on by the visible clasp arm can be eliminated with the use of the lingual retentive arm as described earlier in
This manuscript but when there is a restorative need to crown abutment teeth then the attachment option must be considered.

Since the construction of the precision attachment partial denture is technically demanding, the need for the clinician to fully understand the implications for the dental laboratory is critical for success. It is to that end that the subject is presented in some detail in this chapter. The sheer number of attachments on the market makes a truly comprehensive evaluation next to impossible. *A solid understanding of the use of seven basic categories of attachments will provide the clinician with tools to evaluate other attachment systems as they come on the market and to choose those that offer the greatest potential for long term success.*

Clinical Procedures Common to Precision Attachment Partial Dentures

Common to the use of any attachment system are a number of clinical procedures that must be mastered before a real level of confidence can be achieved.

Diagnostic Procedures

Since space will almost always be a major consideration and a problem for precision attachment selection and use, *a diagnostic wax-up and set-up is essential for every case*. Regardless of what is found in the opposing arch, this diagnostic positioning of teeth on bases that will allow verification in the mouth, must be done so that tooth position can be evaluated, both by the clinician and the patient. The final position of all teeth and the denture base must be known to ensure that the space requirements of the attachment system under consideration can be met. When insufficient space is available, either the system selected or the oral environment must change, through surgeries, orthodontics or tooth modification or, in very special situations, an increase in the occluding vertical dimension. The clinician will need an up-to-date comprehensive catalogue of attachment systems that indicates all dimensions of each unit. In choosing an attachment system, the laboratory must be a willing collaborator, since it must have experience with the chosen system, or be willing to experiment along with the clinician. Attachments International, the Preat Corporation, APM-Sterngold and
Cendres & Metaux all have current catalogues, most of which contain technical guidance as well as precise descriptions of a wide variety of attachment systems. These catalogues should be available, in a current edition, from the dental laboratory.

The Pick-up Impression

As an essential part of the clinical procedures required for constructing a precision attachment partial denture, the clinician must develop a technique for making a final impression for the removable partial denture framework that includes picking up the completed fixed components from the mouth in such a way that the position of the units remains accurately related to the remainder of the mouth. Having the actual crowns on the master cast allows precise positioning of the attachment components, a task that may not be possible when working on a stone replica of the crown, due to the probable fracturing of thin projections of stone. It also allows the master cast to be used as a milling cast to provide a stable platform for milling metal surfaces of the fixed components. This procedure will require a custom impression tray and an impression made with a relatively rigid material, usually a silicone or a polyether. The fixed units will have to be either completely retentive on the tooth because of the inherent fit of the casting or, if there is a potential for movement during the master impression, they will have to be temporarily cemented to keep them from moving. The cementing medium for this procedure must be one that will allow the unit to be removed from the mouth with the final impression since replacing a unit in a elastic material runs the risk of creating an inaccurate relationship. A very small bead of Fit-Checker, placed just internal to the margin, will usually maintain the casting-tooth relationship. An equally small bead of Temp-Bond with Vaseline can also be used. When the impression is removed from the mouth and is found to be acceptable, resin dies that have been made previously, are placed into each fixed unit and the impression boxed and poured.

These dies are made with an autopolymerizing resin, like Duralay, with a retentive wire projection to lock them into the dental stone of the master cast. Fig. 10-1
The completed crown is lubricated and the resin added up to the margin. A wire that has been serrated is inserted into the resin mass and the resin is allowed to set. The portion of the wire that protrudes from the crown is bent into some retentive form to retain it in the stone. The crown must seat completely on the resin die with the margin protected and be easily removed from the cast as needed. This is particularly true if the crown has a porcelain butt margin. The master cast must always be poured in improved die stone to gain maximum resistance to fracture and abrasion.

Pick-up of Attachment Components

The clinician, with the aid of the chair side assistant, must develop a technique for joining attachment components to the framework directly in the mouth as well as on the cast. With the advent of light-activated resins, such as Palavit GLC from Kulzer, the clinician can maintain the appropriate position of the various components while the assistant places the resin and activates it with the light. If any load is to be placed on the attachment during removal from the mouth, a used dental bur can be added to the composite mass to strengthen it. Each attachment system will require slightly different pick-up techniques, requiring some level of experience to routinely join them to the casting without introducing error. In many instances, it may be appropriate to join the attachment to the framework out on the bench, since, generally speaking, it is easier to make a quality resin bond on the bench and then take it back to the mouth to verify the accuracy of the relationship. These steps of verification are essential to success with precision attachments. Some attachments, such as clips for bar-clip attachments, will be picked up using a laboratory auto-curing resin having the same coloration as the denture base.

Other attachment systems will require that some portion of the unit, either the matrix or patrix, be joined to the removable partial denture casting in the mouth. The same approach as was used for certain types of repair impressions will be needed. In other words, the clinician must relate the components while an auxiliary places the resin and cures the mass. As with the repair, either an autopolymerizing resin like Duralay or a light-cured resin like Pavit can be used. The light-cured resin is more expensive but quicker to use. Attachment systems can be soldered or laser welded to the framework or joined in resin alone, the choice depending primarily on the
amount of available space and the possible need for retrievability. When space is at a premium, the soldering/welding option is definitely the technique of choice.

In addition to these specific techniques, altered cast impressions and precise jaw relation recording systems must be available for the construction of the precision attachment partial denture. The altered cast impression will be made after the attachment system has been joined to the framework since the object of the altered cast is to record the support of the soft tissue in relation to the abutment teeth through the fit of the casting. Adding the attachments after the altered cast impression could very well alter this tissue-tooth relationship if any movement of components occurs.

Crown Preparation For Intra-coronal Attachments

When intra-coronal attachments are to be used as a part of an abutment crown, the preparation design for the abutment tooth will have to be modified from that of a standard full veneer crown preparation. In order to create a crown that has normal emergence profiles and dimensions, some form of box preparation that will relate to the dimensions of the chosen attachment must be made. If the chosen attachment will not fit within the normal contours of the abutment in question a slight over-contouring of the crown is acceptable if the gingival one third of the contour is maintained as normal. A review of pulpal anatomy is essential to preclude over-preparation of the abutment tooth. This may require the preparation on the bench of extracted teeth with dimensions similar to those of the actual abutment tooth. The presence of secondary dentin and the determination of its depth become critical issues. When considering the preparation depth, the minimum thickness of the alloy, usually around .5 mm, must be added to the dimensions of the attachment matrix. If this reduction places the tooth at risk for over-preparation, the choice of attachment system must be re-evaluated. The choice of an extracoronal attachment instead of an intra-coronal is an obvious solution to the problem. Intra-coronal attachments are better utilized when placed into pontics where there will be no possibility of affecting abutment strength. After years of experience with intra-coronal attachment and reviewing the number of abutment fractures I have seen, due most likely, to the over reduction of tooth structure, I can no longer
recommend them over the new generation of extra-coronal attachments and now reserve their use to pontics only!

The stone tooth representing the abutment on the diagnostic cast must be prepared to accept the matrix plus the minimum space necessary for the gold of the crown. The matrix can be tried in place on the prepared stone tooth using the holding device that fits into the dental surveyor and, once adequate space has been created, an auto polymerized resin template can be quickly constructed that will transfer the preparation form to the mouth. The prepared stone tooth and the occlusal surfaces of adjacent teeth are painted with an alginate-based separation agent and an autopolymerizing resin placed into the cavity and onto the occlusal surfaces of the adjacent teeth. Fig. 10-2

When set, the template can be trimmed of excess resin and taken to the mouth to verify the dimensions of the matrix cavity by placing it onto the adjacent teeth and modifying the preparation until it accepts the form. The use of this simple preparation guide reduces but does not eliminate the risk of over-preparation of the tooth at the same time that it guarantees that there has been enough reduction to allow the matrix to be placed within the normal contours of the abutment tooth.

Conversion of an Existing Cast Partial Denture to a Provisional Resin Partial

One of the most difficult tasks the clinician will face in the construction of a precision attachment partial denture is to maintain the patient with their existing partial throughout what may be a long treatment time. When orthodontics and perhaps even orthognathic surgery are involved in addition to implants, treatment time can extend to years. Trying to make quality provisional fixed restorations that will support an existing removable partial denture for that length of time may well be impossible. It is in the best interests of the clinician as well as the patient to convert an existing metal
frame partial denture to a quality resin appliance made in conjunction with
any required fixed provisional restorations. While there are many possible
ways of creating these provisionals, it is important to bear in mind the cost
to the patient. The following technique creates a quality long term
provisional at minimum cost to the patient.

The first step is to prepare the existing partial denture for a special type of
pick-up impression. Any component of the partial that contacts the
remaining teeth is cut away with a large cut-off disk, leaving at least 2-3
mm space between the partial and the teeth. Fig. 10-3

This will allow the impression material full access to the teeth. A high viscosity
polyether or silicone impression material is mixed and placed in the partial and the
partial carried to place and maintained in a position of maximum occlusion with the
opposing arch, without regard to the abutment teeth, until set. Before removing
the partial denture, a second impression, alginate this time, in a stock dentate tray,
preferably sectional, is made over the partial and the remainder of the
denture-bearing area. Special care is taken to ensure that alginate is wiped
onto all remaining teeth and into the space created between the partial and the
teeth when the framework was sectioned.

The two impressions are hopefully removed together and poured in yellow
stone. When the alginate portion of the impression is removed from the
cast, the elastomeric impression inside the old partial is left in place until
the cast has been mounted in the articulator with the opposing cast. Once
the mounting is complete, the partial denture is carefully removed from the
cast, leaving the impression material in the partial. At this time, any
diagnostic waxing for the fixed provisional component is done according to
standard techniques. Rest preparations and guide planes are prepared and
undercuts ideal for infrabulge “I” bar clasps are created. Once the waxing is
complete, that cast is duplicated and the partial denture replaced on the
duplicate cast.
Flanges are cut away from the partial to create space for the retentive wire bar clasps. These clasps are adapted using Ni-Cr-Co wires and waxed into place on the cast. Additional wax is added to complete the desired form of the provisional partial denture. Since the resin provisional will need to be thicker than the old framework, at least one thickness of baseplate wax must be added to all areas of bare framework. The outline of the provisional will necessarily cover a greater portion of the mouth than did the old metal-based partial. **Fig. 10-4**

For the mandibular provisional, special care must be taken to wax the lingual plate area of the major connector to provide for adequate strength in the resin. Since the pick-up impression was made in maximum occlusal contact, there is no need to rearticulate this processing cast.

The completed waxed partial is placed in the first half of the processing flask in a normal manner. The second half of the flanking is the key to making this technique possible. The exposed denture with its added wax contours is covered with an elastomeric silicone mold release material (Dent-kote from Dentsply or a material of similar weight). Immediately after placing this material, usually with the finger to assure that no voids are created, the second half of the flanking is completed using the normal mix of dental stone. This immediate pouring of the stone onto the as-yet not set silicone is essential to keep them from separating during the boilout and opening of the flask.

When the flanking stone is set, the flask is boiled out in the normal manner. When the flask is opened, the old partial is easily removed from the mold. After completing the boil-out, the cast is painted with separator. A small amount of autopolymerizing resin is added to the tang of the bar clasps to stabilize them during packing. The reason for selecting the infrabulge clasps for this provisional denture should now be apparent. Had a normal circumferential clasp been used, it would have had to cross the occlusal surface of the partial which might have made removing the old partial from the flask difficult.
If the denture teeth from the old partial are porcelain, they can be removed from the denture bases by warming the base resin with a Hanau torch and prying them from the softened mass of resin. They are cleaned and placed back in their cavities in the silicone mold release material. Since porcelain teeth are seldom used for partial dentures, the technician has the option of cutting the resin teeth and their associated resin from the old partial in block form and placing them back in the mold or pouring tooth-colored resin into the tooth negatives in the elastomeric material. The flask would then be placed in a pressure pot for the cure of the new denture teeth. The segment of teeth will have to be removed from the mold and the excess resin removed before placing them back into the mold for final processing. In either case, the provisional partial is packed in a high impact heat-cured resin and processed and finished in the normal manner, using the block form.

The original master cast, with its waxed provisional restoration, is now used to create an eggshell fixed provisional for relining in the mouth. Additional wax is added to the marginal one third of the teeth to be provisionalized to assure adequate resin at the margin and a putty mold of the wax-up is made. Tooth-colored resin of the appropriate shade is painted into the putty, usually with both incisal and body resin, and the mold placed in the pressure pot. Since the fixed provisional restoration will be required to support the removable provisional the stresses placed on the temporary cement seal will be greatly increased, especially if the provisional partial is a Class I and can rotate in function. Any washout of cement and resultant caries will create a disaster that can be at least partially be overcome by reinforcing the provisional with orthodontic band material. The band material is loosely adapted to the preparation and spot welded in the interproximal areas as well as in the edentulous pontic areas. When completely adapted the band is placed in the mouth and the fixed provisional shell relined in normal fashion resulting in a metal reinforced provisional fixed unit that has a greatly increased resistance to flexure and cement seal fracture. **Fig. 10-5**
It is also required that the fit of the provisional RPD be adjusted to reduce what is often excessive frictional retention due to this technique by the use of Fit Checker.

Since the fixed provisionals and the removable provisional partial denture were made from the same master cast, they will, with a minimum of adjustment, fit together. In fact, it is in this state that the relining of the fixed provisionals onto the prepared teeth will occur. To reline the fixed provisionals without regard to the removable partial will almost assure that their relationship will change and that unnecessary adjustments to the resin partial will be required to seat the removable provisional restoration. Rather than completely fill the fixed provisional restorations with resin to reline them, only a small amount of resin should be placed in the eggshell and then the entire provisional assemble, fixed and removable is seated and directed to place using the occlusion with the opposing dentition and the contact of the partial against the supporting soft tissue as the guides for proper placement. The small addition of resin will imprint the occlusal/incisal portion of the prepared teeth and positively relate the provisional. The removable provisional can now be removed from the fixed units and the relining of the fixed provisionals completed without the interference of the removable partial

The result of all this will be a combined fixed and removable provisional restoration that can be adjusted and added to as needed while other forms of mouth preparation are made. The only chair time expended will be that needed to make the double impression pick-up impression so the cost to the patient and clinician will be low. The only down side of this provisional combination will be the added bulk of the all-resin removable portion when
compared to the old metal partial denture. Patients generally tolerate this bulk since they know that it will only be temporary.

Immediate Temporary Resin Partial Dentures

Many of the patients whose ultimate treatment will be some form of a precision attachment partial denture with associated fixed prosthesis enter our practices with failing restorations, some fixed and some removable. They are in immediate need of a temporary restoration to carry them through the initial phases of treatment. Often a failing fixed partial denture will present with the loss of retention of one abutment, leaving the bridge supported by only one abutment, and the patient is well aware that the bridge is loose. The first step in treating this type of patient must always be to obtain the very best possible initial impression of the affected arch. Any attempt to remove the defective fixed partial denture without a usable initial cast of the arch will require a more traditional technique with additional appointments and increased cost if the defective restoration is completely undermined with decay and it is not possible to maintain it in place for a later impression. The patient is without the bridge and a conventional temporary partial denture, especially if a large number of teeth are involved, some days away from completion.

A very quick solution to the problem that will provide an almost instant replacement can be made using a combination of autopolymerizing tooth-colored resin, ortho resin and non-precious I bar wire clasps. When the original alginate impression is removed from the cast, those teeth that will need replacing are poured immediately in the appropriate tooth colored resin and the alginate is placed in the pressure pot. The block of teeth is removed and trimmed and the stone teeth are removed from the cast. Wire clasps, again preferably in the I bar form, are adapted and sticky waxed to place. The new resin tooth segment is substituted for the stone teeth and the ridge trimmed as for any immediate denture situation. Any obvious undercuts on the lingual surfaces of the teeth to be contacted with the denture base are blocked out with baseplate wax to roughly 90°. After coating the cast with a separating medium, the bulk of the partial is formed in the fine grained ortho resin, either pink or clear, and the entire project is placed in the pressure pot.
The resulting partial denture can be expected to closely approximate the defective restoration in tooth position and arrangement. If the patient requires the extraction of non-restorable teeth, the teeth are removed and the temporary partial is seated and adjusted as needed. A piece of clear thin plastic, normally used in trial packing of dentures, is then placed over the sockets and Lynal is added to the partial and the partial inserted. The Lynal will act as a soft bandage for the initial healing. The purpose of the plastic sheet is to preclude the Lynal being forced up into the socket. Once the Lynal is into its initial set, the partial can be removed from the mouth and the plastic easily peeled out of the Lynal.

Most immediate temporary partial dentures need only one clasp arm per side. As “I” bars, these clasps are much easier to adapt initially and are readily adjusted to the abutment teeth if necessary. Any areas of this quickly-made temporary prosthesis that do not fit satisfactorily can be easily readapted with any autopolymerizing resin intended for in-the-mouth use.

**Modifications of the Design of the Framework**

At times there may not be sufficient contact areas between the framework and the remaining teeth to assure positive orientation during the pick-up operations described earlier. This will be true most often when attachments that will also bear some of the vertical support of the partial denture are used. In these cases, additional struts are added to the major connector and extend to the occlusal or incisal surface of at least two widely separated teeth. **Fig. 10-6**

The strut is waxed directly on the refractory cast and has the dimensions of a normal minor connector. The struts provide a very positive position of the framework in the mouth while attachments are joined to the casting and while altered cast impressions are being made. After these two operations are completed and the fit of the attachments

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*Fig. 10-6*
verified, the struts are cut from the major connector and the surface returned to a normal contour and finish.

Many partial denture frameworks will need a strut added to the retentive mesh area in order to have something to which the patrix can be either soldered or attached with resin. The exact shape of this strut will be dependent on the attachment system used but since it is a critical element its design must be reviewed with the laboratory. **Fig. 10-7**

![Vertical supporting strut](attachment_matrix.png)

**Fig. 10-7**

**PRECISION ATTACHMENT SYSTEMS**

**Over Coping**

The most basic precision attachment system is that of the precision coping. A thin walled coping cemented in place on the abutment tooth permits an over coping or crown attached to the removable partial denture to fit over it and provide, based on a frictional fit, some degree of retention for the partial denture as well as excellent lateral stability and solid occlusal stop support. These copings are usually milled to the planned path of insertion/removal or with a slight taper, around 2 to 5 degrees, depending on the height of the coping. They have been used for many years for extensive splinted fixed restorations, commonly referred to as perio-prostheses, with great success since the entire superstructure can be removed by the patient for total access for cleaning. Moreover, should a coping abutment be lost for any reason, with time, the tooth can be removed and the over-coping filled with resin to become a pontic. In many cases these large restorations can still be used
even with the loss of some of the original abutments. Great success in using this approach for overdentures has also been well documented.

**A critical element in the restoration of badly broken down teeth for copings is the need to obtain a ferrule effect on solid tooth structure of at least 2 mm.** When endodontically treated teeth are used, this ferrule will dramatically reduce the possibility of root fracture. In many instances, it will be necessary to perform crown lengthening procedures to gain sufficient tooth structure supra gingivally since the coping margin should be placed at the gingival crest.

Any posterior tooth or root portion can be considered for a coping restoration. Often, one root of an otherwise periodontally involved molar tooth will have sufficient bone remaining to justify its retention in the mouth. When this root can be maintained, an effective tooth-borne partial denture can be constructed in a situation that would otherwise result in a distal extension base.

Vital abutments, when used with copings, must have sufficient occlusal reduction to allow both the coping and the over crown to have sufficient thickness to withstand occlusal wear. **Fig. 10-8**

![Fig. 10-8](image)

At least 1.5 mm must be available, with the coping needing .5 and the crown taking up the remaining space. For this reason, the occlusal surface of the crown should be in metal since porcelain would require at least 2.5 mm reduction. The need for a facial veneer in the over crown is a more common requirement. Slightly less than the 2.5 mm space can be used and it will still hold shade and contour. Non-vital abutments are obviously more adaptable to the use of a ceramic over crown.

The construction of a milled coping starts with a diagnostic wax-up and set-up that will include the opposing arch, be it a complete denture or a partially edentulous restoration. The design of the partial denture is determined and
drawn on the diagnostic cast with indications for subtractive mouth preparation. The stone teeth that represent the abutments are prepared for either additive or subtractive mouth preparation to a chosen path of insertion/removal and the vital abutments that will be used for copings are prepared to the appropriate dimensions and angulations. This diagnostic cast becomes the blueprint for the actual mouth preparation. Endodontic treated abutment teeth usually do not require the same level of diagnostic preparation since there is much more freedom in creating the desired milled contours. After the cast is used as a guide for mouth preparation, it can be used as a prescription for additive mouth preparation to the dental technician. The stone coping teeth are prepared, waxed and milled on a surveyor using a blade that will attach to the vertical arm of the surveyor. The diagnostic cast will then represent all the desired contours in such a way as to ensure that the technician will be able to reproduce them exactly in the final restorations.

The actual preparation of the coping abutments occurs only after all the subtractive mouth preparation has been completed. In this way, the prepared guide planes can serve as vertical indicators of the final path of insertion/removal during the preparation of the abutments that will receive copings.

The master impression must involve all the teeth in the arch as well as all edentulous landmarks that will be required for the construction of the final partial denture framework, even though the casting will never be made from this cast. Once the dies have been trimmed and the casts mounted in the articulator, the copings can be rough waxed by first dipping the prepared dies in molten wax to establish a thickness of at least 1 mm and then milled to the desired taper using the dental surveyor or with wax burs in the industrial milling machine that must be available in the dental laboratory chosen to support the treatment. Copings can also be formed from thin vacuformed plastic sheets that are cut short of the margins to allow for full margination using wax. The use of the resin coping results in a more uniform coping thickness.

When the milling is complete, the waxed copings are marginated to allow for a coping margin of at least 1 mm. The placement of this margin will determine the margin of the over crown or over coping. Because of the angulation of an isolated tooth relative to the path of insertion/removal that
the partial denture must take, it may not be possible to mill all sides of the
coping to that path for the full length of the coping. In these situations, the
margin of the over crown or over coping will rise or fall according to the
milled surface. Fig. 10-9

The more surfaces that can be paralleled, however, the more the
frictional retention of the partial can be increased. Fig. 10-9

The coping is then sprued and cast in a type IV gold to reduce long term
wear, finished and returned to the master cast. The coping should never be
thinner than 0.5 mm in any portion. The copings can now be milled on the
milling device to bring them into ideal contour. Great care must be taken in
thin areas, obviously, but this should not be a problem in the hands of an
experienced technician. The metal is best left in a sand blasted surface since
there is no advantage to a high polish, except at the margin with the tooth.

The decision between an over coping that will have no occlusal anatomy
and a over crown with normal occlusal contours is based on the position of
the tooth in the arch and the available inter-arch space. In general, a second
or third molar on the mandibular arch indicates the over coping as the
design of choice if occlusal contacts with the opposing dentition are not
essential. When they are an over crown is indicated. Both the coping and the
over crown are returned to the mouth for the final impression for the partial
denture casting. This impression must pick up the over casting as it would
any additive restoration since they must all appear on the master cast.

The coping attachment, whether an over coping or over crown, will be
soldered or laser welded to the framework in most situations. It is possible
to attach retentive loops or beads to the over coping and retain that unit in
the resin base but the need for this approach is limited to situations where
there is a great deal of interocclusal space present and where the extension of the over crown into occlusion would result in an excessively thick crown. Fig. 10-10

While these over crowns can certainly be veneered if they fall into the area where the patient’s esthetic demands would be compromised by a full gold crown, these coping-crown situations are most often found in the posterior part of the mouth where a display of metal is acceptable. Fig. 10-10

The coping will, in every instance, act as a vertical stop for the partial denture. In most cases it can also provide frictional retention. It is most effective when used in combination with other attachment systems which provide greater resistance to dislodgment or with conventional clasping in other areas of the mouth.

Bar-Clip Attachments

The bar-clip attachment has its origins in turn-of-the-century dentistry when the Gilmore clip system was made available to the profession. It was commonly used with copings or crowns over vital teeth and later on with endodontic treated teeth where a post coping system attached a solid bar of about 8 ga. to the teeth. The attachment mechanism was a plate gold, U-shaped clip, of various lengths, retained in the resin of the prosthesis or soldered to some internal framework. The Dolder Bar system offered an egg-shaped bar that permitted a certain amount of rotation of the prosthesis while still retaining the denture. This system was used extensively in both arches and was equally adaptable to the removable partial denture as well as the complete denture.

Advances in organic chemistry have resulted in the creation of resilient clips made of thermoplastic materials that are very inexpensive and can be rapidly replaced by the clinician. They have the disadvantage of wearing
more quickly than the gold plate clips. These plastic clips are offered with a thin metal retainer housing, with retentive contours on the inner surface to retain the clip. They are, in turn, held in the resin of the denture with retentive contours on their outer surface.

Bar-clip systems are widely used with implant-supported over dentures of many different designs and are available from a variety of manufacturers.

When used as an attachment for a removable partial denture the bars, either in the form of a castable plastic pattern or as a wrought precious metal bar that is intended to be soldered, are attached to elements of the fixed prosthodontic component. It is again essential that diagnostic wax ups and set ups are created to relate the position of the denture teeth to the position of the bar and to assure that adequate space exists, not only for the bar, the clip and the clip retainer, but for the teeth and associated resin that will usually be placed directly over the bar-clip assembly. When space is limited, the use of a protective metal covering over any thin resin areas is indicated. This will often take the form of a cast metal occlusal surface for a posterior tooth since the expected wear of a resin denture tooth in function can result in breakage over the clip assembly.

Once the diagnostic wax up is complete and the teeth to be replaced on the partial have been tried in the mouth and verified esthetically, a putty matrix of the teeth is made with a positive seat on the cast to allow both the clinician and the technician to find the ideal position for the bar relative to the denture teeth. Fig. 10-11

As part of this decision, the vertical position of the bar relative to the soft tissue will have to be selected. If the bar is placed on the tissue of the ridge, or even slightly above it, experience has shown that the tissue will, in time,
hypertrophy and will not only come into contact with the underside of the bar but extend up along the sides of the bar into any space not occupied with the clip. Perhaps the best position of the bar in relation to the tissue is just high enough off the tissue to allow the tip of a mini proxy brush to pass under the bar. The patient must assume responsibility for daily stimulation of the tissue as well as keeping the under-surface free from plaque. The contours of the bar where it connects to the crowns or copings must also be carefully evaluated as the clearance required for the marginal gingival tissue is even more critical than for the bar as a whole. **Fig. 10-12**

The level of the bar in these areas will, almost without exception, need to be raised. In practical terms, this means that the bar must be cut short of the connector area, maintaining sufficient length for the clip, and then waxed into contact with the crown, usually in a curved segment. **Fig. 10-13**

As this connector is closer to the incisal/occlusal plane, space may become a problem, even if there was adequate clearance over the straight length of the bar.

Usually the plastic bar pattern is cast to one side of the fixed component and soldered to the other side after relating the segments in the mouth or from the master cast. The pre-formed bar is soldered in similar fashion, usually with post solder after any ceramic component has been completed. The
solder joints must always be larger in circumference than the bar itself. In the finishing and polishing of the bar, care must be taken not to touch the section of the bar that will receive the clip since any change in dimension will reduce the retentive effect of the clip. Other areas of the bar, solder joints and tissue surface for example, will receive the same degree of finish as the fixed units. When the fixed components including the bar have been completely assembled and finished, they are picked up in the final impression for the removable framework as described earlier so that they are available to the laboratory technician during the subsequent construction phases.

It is not essential to use the clip with the bar. In fact, in instances where space is at a real premium, the bar makes an ideal anterior rest for the partial. Conventional clasping or other attachment systems elsewhere in the mouth will then provide the necessary retention. This approach also serves as a less expensive alternative to fixed pontics in many situations, most commonly when mandibular incisors are missing and the option is either to include them with the fixed component as pontics or to replace them with the partial denture. As a result of adding the bar in the anterior region, the two sides are more effectively splinted and an ideal rest created. A disadvantage to this use of the bar is that the patient is forced to wear the partial denture at all times for esthetic reasons.

Whether the clip will be used or not, the bar is to be blocked out along with the other components of the remaining dental arch. The superior surface of the bar is left free of blockout wax so that the partial denture casting will contact the bar along that surface up to the solder joint area where a slight amount of relief is appropriate. **Fig. 10-14**
This blockout of the bar presupposes that the bar and associated fixed components have been picked up from the mouth in their finished state and are a part of the master cast submitted to the laboratory for construction of the framework. If a clip is to be used, it, along with its housing, must be in place on the bar at the time of blockout so that a refractory replica the exact size of the housing will be created. **Fig. 10-15**

![Fig. 10-5](image)

The clip must be placed in such a way as to ensure that its midline is parallel to the path of insertion, as indicated by the prepared guide planes on the abutment teeth, permitting both wings of the clip to be flexed the same amount when the clip is activated during insertion and removal.

The clip will be reproduced in the refractory cast to create an opening in the casting exactly where the clip is to be positioned. The outer surface of the casting adjacent to the opening will require retentive beads or loops to retain the attaching resin.

The tooth replacement retention in the area of any bar-clip attachment or the bar alone is to be metal with beads or other mechanical projections. This will always be superior to having that area only in resin since the limited space will require the strength of the full metal coverage. The metal coverage must extend to the crest of the remaining ridge just anterior to the bar with the remainder of the denture base in resin of the appropriate color. When that resin is apt to be thin it will be necessary to have the laboratory opaque the facial aspect of the metal so that it will not be seen through the partially translucent denture base.

When the casting is returned from the laboratory, all components are seated in the mouth if some natural teeth are present or on the master cast if all contacts are on fixed units and its fit corrected as required. If the casting contacts only the fixed components present on the master cast, then the clip, or the clip housing, depending on the system in use, should be attached to the frame on the master cast with a small amount of autopolymerizing resin,
either pink or tooth-colored, depending on the area of attachment. When the casting contacts teeth not associated with the fixed restorations present on the master cast as well as the fixed components, then the clip should be attached in the mouth, with all components completely seated. Only after the clip is attached to the framework is the altered cast impression made (where indicated) and jaw relation records are taken. The object is to have the framework and associated abutments in their final relationship before any support of the soft tissue is obtained. This will ensure that no misalignment occurs during processing of the denture bases.

Before the flasking of the denture bases, the fixed components are removed from the master cast so they will not be subjected to the high pressures of trial packing. The metal housing in the area of the clip is filled with a silicone mold release material or a putty to protect the clip and housing and the fully waxed denture is seated on the master cast and the borders are sealed. The first half of the flasking will cover the resin cores that once supported the fixed components in addition to any exposed areas of the framework in the standard fashion. The silicone will make the clean-up of the clip area very easy since no stone will be present.

The clips, either metal or plastic, will eventually wear and will need replacement. In general, the plastic clips will wear much faster than the metal clips but, since they are now in a metal housing, they can be replaced in seconds at very low cost. Their life expectancy can be improved in two very important ways. If the remaining teeth/fixed units are milled to 90° to the path of insertion/removal, the wings of the clip will flex equally and minimally as the clip is activated. Secondly, if the patient can be made to take some responsibility for the method of insertion of the precision attachment partial, that is, to never bite the partial to place but use only finger pressure, the load on the clip will be controlled. These two suggestions are applicable to all partial dentures but are especially pertinent to the precision attachment with a resilient component.

In replacing the plastic clip, any dental hand instrument that can fit inside the metal housing can be used to slide the old clip out of the housing. The new clip is placed on the insertion tool that is specific to that clip and snapped into place. Replacement of the metal clip will require that the old clip be ground out of the partial by making an access hole over the clip,
usually just lingual to the replacement teeth. The hole must be large enough to allow access to the entire clip and its retentive extensions. These retentive extensions are covered with a thin coat of autopolymerizing resin of the appropriate color and the clip is placed on the bar, *making sure that it is aligned with the path of insertion* and the partial is seated over the clip. By completely covering the retentive elements of the clip with resin outside the mouth, the clinician will ensure that no voids are created when the clip is actually connected to the partial in the mouth. Only enough additional resin need be added by picking up polymer with a wetted brush and placing it through the access hole to create a solid joint. *Fig. 10-16*

Once this layer of resin has completely cured in the mouth, the partial is carefully removed and the remainder of the required resin added to fill the hole to excess, after which the partial is placed in the pressure pot for the entire curing time. By filling to excess and then finishing away the excess, the density of the added resin will be maximized.

The bar-clip combination offers a relatively inexpensive attachment system that has been used successfully for a few generations. It is adaptable to many situations and easy to maintain. Its only real disadvantage is that it does require a good deal of space, both vertically and horizontally, and so cannot be used universally.

**Intra-coronal Precision Attachments**

The intracoronal attachment that is classified as precision comes from the manufacturer as two components: a matrix and a patrix. These are often accompanied by a paralleling guide that fits into the dental surveyor as well as devices to activate the attachment after fabrication. The matrix is waxed into the crown or bonded into a preparation in the tooth. The patrix is attached to the framework in some fashion, usually by soldering. In many instances, the patrix will have some retentive component that can be activated and readjusted as wear occurs.
These attachments, being machined to close tolerances (0.001” on the average), cannot be expected to allow for controlled freedom in rotation of a denture base and, as a result, are used in all tooth or tooth/implant-supported partial dentures. There are a number of intracoronal attachments that have an integral hinged component intended to offer stress relief to a distal extension base. The use of this hinged attachment does not, in my opinion, fulfill the need to distribute the maximum load to the selected abutments. Instead, it places an uncontrolled amount of force on the tissue least likely to withstand the load, the edentulous ridge tissues. Since we know that resorption of the edentulous ridge is an ongoing, generally irreversible process, the use of any hinged device places an additional maintenance requirement on the clinician. The distal extension base must be kept in ideal contact with the underlying tissues through relines to minimize soft tissue impingement and stripping of tissue. I see no need for this type of attachment in the modern partial denture.

The standard intracoronal attachments that contain no moving parts do, however, offer excellent retention and esthetics for the tooth-borne partial. Since these attachment systems become a part of the crown or pontic, they must be contained within the normal contours of these restorations. The average dimension of the intracoronal attachment is just over 1.5 mm and, allowing for a minimum of 0.5 mm of metal in the crown internal to the matrix, it can be easily seen that a minimum of 2 mm of reduction in the area of the attachment is essential to keep the final unit within normal contours. It may be that bonding the matrix into a prepared cavity in the tooth would require less axial reduction than for a casting but this treatment modality is in its infancy without longitudinal studies to support its use.

There is general agreement that, in addition to the axial space requirements, the tooth must have sufficient clinical crown length to accept a matrix with a vertical height of a minimum of 3.5 mm. The length of most matrices as received from the manufacturer is 6 mm but it is not common to find a crown length capable of accepting the total length. Obviously, the greater the vertical length of the attachment complex the greater the potential retention and stability that can be expected. There are a number of split attachments that have some form of latch (Sterngold GL, for example) which can be effective in shorter vertical lengths since the actual retentive mechanism is a split casting with a ridge at its most gingival portion (a minimum of 2.62 mm is required). **Fig. 10-17**
Because of the split casting, the ridge can compress on itself and snap into a recess in the matrix.

Fig. 10-17

These space requirements must be taken into careful consideration during the diagnostic waxing and positioning of the denture teeth. In the younger patient, where large pulp chambers and a lack of secondary dentin are found, it may not be possible to use an intracoronal attachment (extracoronal attachments will be necessary for these patients). The width of the matrix in a buccal-lingual direction will be in the range of 3 mm, a dimension that can be accommodated in most abutment teeth. For example, the width of the matrix for the Sterngold GL is either 2.43 mm for the Standard Head or 1.77 mm for the Micro Head.

Before mouth preparation on the actual abutment teeth, all guiding plane preparations on the remaining teeth that will not be treated with crowns or other castings must be made and verified. It is far more practical to make the attachments and any guiding planes on their crowns to match the path of insertion/removal as it exists on the other prepared teeth than to make the attachment containing crowns first and then try to parallel guiding planes to match the path. Since these attachments are very precise, it is nearly impossible to match their path after they are in place. The same system of diagnostic mouth preparation as suggested for the conventional partial denture must be employed with a careful verification of the check cast before beginning the actual preparation of the teeth to be crowned.

It should be obvious that any master cast for the construction of the crowns must include all other teeth involved with the partial denture. The clinician must determine the desired path of insertion/removal and transfer this spatial relationship to the technician through the use of 3 widely separated tripod marks, placed with the vertical arm of the surveyor in a locked position.
Laboratory construction of intracoronal precision attachment crown and pontic units is not difficult although some experience is necessary to use the surveyor and special tools to position the matrices perfectly parallel to the indicated path of insertion. Some discussion with the clinician is needed as to the extent of the porcelain coverage on the abutment crowns since the matrix will require a small amount (0.4 mm minimum) of metal around it that is free of porcelain. Fig. 10-18

![Fig. 10-18](image)

These abutments will often also require milled guide planes and appropriate contours to accept rests, all of which will influence the cutback of the metal for veneering.

The intra-coronal attachment will not normally be indicated on the mesial surface of anterior teeth since the alteration of contour will, most likely, prove to be unacceptable (the cuspids being the only possible exception). Generally speaking, anterior edentulous spaces are better filled with fixed pontics than with components of the removable partial.

When the crowns have been completed and have been found to be acceptable for esthetics and occlusion, the final impression for the removable framework is made using a firm setting elastomeric impression material, either silicone or polyether in a custom tray with ample retention (holes and adhesive) to ensure that the impression material does not separate from the tray during removal of the impression from the mouth. It must be remembered that these materials are not intended to impress large undercuts, as may be found on unprepared natural teeth. Since the goal of the final impression is to relate the fixed components to the remainder of the arch and to allow the pick-up of these components without distorting the final impression, it is often necessary to blockout large undercuts, furcations, the under surfaces of pontics and any other area where the resistance to removal is apt to be so high as to threaten the integrity of the final impression. Any
number of materials can be used for the blockout of these unusable areas; wax, temporary cement, cotton pellets and alginate are examples that should be considered.

Ideally, the crowns and other fixed components should come out in the impression since repositioning them in the impression does not guarantee accuracy. As discussed earlier, resin dies should be available to insert in the crowns prior to pouring the master cast. The modern impression materials used in these situations can be comfortably transported to the dental laboratory without fear of distortion and the construction of the master cast left to the technician. A diagnostic cast must accompany the final impression to inform the technician of the prescribed design of the framework. It is much easier to convey specific requirements via a diagnostic cast with a neat and careful drawing of the outline of the framework than to try to describe the desired outcome over the phone or on the work authorization form.

The same requirements of design and construction as described for the conventional partial denture must be adhered to for the precision attachment framework. When the frame and master cast are returned to the clinician, the fit of the frame in the mouth and to the crowns must be verified before the patrices are picked up in resin, either in the mouth or on the master cast. The decision as to where best to join the attachments to the framework is dependent on many factors and there is no one correct way. It must be remembered, however, that in every instance the frame/attachment relationship must be identical from the mouth to the master cast before the construction can continue. Most intra coronal attachments will be joined to the framework by soldering or laser welding since space is apt to be a critical factor.

The fit of the framework must be re-verified after the soldering operation in every instance. Only when the tooth/frame relation meets the highest standards, can other procedures be undertaken, i.e., altered cast impressions and jaw relation records. The completion of the case, once these steps are done, is relatively standard as far as positioning of the denture teeth and waxing, processing and finishing of the base are concerned. An area of special consideration is the protection of the patrix connection when the amount of resin over or around this area is minimal (less than 2 mm of tooth
structure or base resin). In these instances, metal occlusal surfaces are to be constructed, usually in type IV gold and added to the denture teeth to ensure that subsequent wear will not break through to the patrix.

At insertion of the intracoronal attachment partial denture, any undercuts to the path of insertion/removal where resin has extended will have to be carefully identified and recontoured to fully seat the partial. Since the path of insertion will be so precise, the finished partial must never be forced to place on initial seating until all possible undercuts in resin have been identified and adjusted. The soft tissues of the mouth occlusal to areas of slight undercut may compress and allow the full seating of the partial but will not allow the partial to be removed without pain or discomfort to the patient, sometimes with great difficulty. If pressure indicating paste is placed on all resin areas and the partial inserted with very light pressure until resistance is felt, either by the clinician or by the patient, areas of potential difficulty can be identified without fear of tissue irritation.

There remains only the activation of the attachment, in those attachment systems where this possibility exists. In general, the patient should be informed of the intention to use only the lightest activation that will satisfy the patients needs for retention, since the lower the level of activation, the better the chance to reduce distortion and the need for repeated adjustments. Activation is accomplished with the use of specific tools provided by the manufacturer which distort the patrix by increasing the opening of the split areas of the metal. Fig. 10-19

The tools are carefully calibrated to assure that over activation does not occur, a frightening situation where the partial denture cannot be removed from the mouth without excessive force. For this reason it is not wise to allow the patient to reactivate their attachments by themselves. Assuming that every aspect of construction of the intracoronal precision attachment partial has been done to the highest standards, the attachments should only need periodic reactivation, undertaken as a part of normal recall activities. Systematic recall for these patients is perhaps as critical as high standards of construction for the long-term success of the patient’s entire treatment.
Certainly, these two components of treatment are far more important than variations in design of the partial denture.

A wide assortment of intra-coronal attachments is available to the clinician, all based on the same general principles described here. Dental technicians will have their favorites, depending upon their experience, however, it must be remembered this experience is based upon fabrication issues and not on clinical evaluation and so while one attachment system may be easier to construct, it does not follow that the system will work as well as some other type over the expected lifespan of 20 ± years. The sheer number of attachments precludes that any one clinician or technician will have had sufficient experience working with all attachments to define the selection in any scientific manner. (See listing of attachment manuals and manufacturers).

**Extracoronal Attachments**

There are a variety of extracoronal attachments available to the clinician. Some of these are rigid, that is, they do not allow any rotation of the partial in function. Others are hinged, offering a stress-breaking action to the distal extension base. More recently, a number of resilient extra coronal attachments have come on the market that permit a limited amount of movement of the denture base for the Class I partial situation. Both the rigid and the resilient have a distinct place in the tooth and tissue-borne partial denture. The need for hinged attachments is less obvious and the rationale for their use can be questioned if one recognizes the need to utilize the remaining possible abutment teeth for maximum support and retention and to reduce the load on the soft tissues as much as possible. The conventional distal extension removable partial denture creates stress relief through rest placement, light clasping, altered cast impressions and careful maintenance; with periodic relines to keep the base movement to the very minimum. If the conventional partial denture, constructed to these principles, is potentially as successful as longitudinal studies would have us believe, then there seems little advantage to placing greater load on the extension base through the use of hinged attachments. It has been my experience that the hinged attachment has great potential to become destructive to the soft tissue unless it is very carefully maintained and replaced as soon as it begins to show lateral movement in addition to its
planned vertical rotation. For that reason I do not consider its use justifiable.

The great advantage of the extracoronal attachment is that it neither alters the normal contour of the abutment crown, being entirely outside of these contours, or, and more importantly, requires only minimal tooth reduction. An additional advantage of the rigid attachment is that the entire length of the attachment, from the gingival tissue to the occlusal plane, can be used for frictional retention, making it invaluable in situations in which the abutment teeth are short.

A simple rigid extracoronal attachment is one commonly referred to as the pin and tube attachment. Fig. 10-20

For most of these, the pin (patrix) is added to the fixed unit and the matrix (tube) to the partial denture. The attachments can be easily made by hand. They are also available from attachment manufacturers (Preci-Vertex from Preat Corporation, Interlock and Tubelock from APM Sterngold, for example). Some intracoronal pin and tube attachments can be used as extracoronal attachments by reversing the patrix and matrix so that, instead of having the matrix in the crown, it becomes part of the partial denture (Cylindrical slide CM attachment from American Precision Metals. Recently, resilient retentive sleeves have been added to the matrices of pin-tube attachments. The most commonly used of this special form is the Vertical Hader Bar. A similar current form is the Preci-Vertex from Preat Corp, which, according to the manufacturers claims, can be used either as a rigid attachment or, reducing by 0.3 to 0.5 mm the coronal portion of the
patrix, as a resilient attachment. All these simple attachments can be constructed using the same principles with little expected variation. They differ from the older systems in that the matrix is lined with a resilient material that can be easily and inexpensively replaced as needed for retention. The matrices come with a precisely machined metal cover which has retentive contours on its outer surface to which resin can adhere. The metal matrix covers are intended to stay in the partial for its normal life allowing the resilient inner matrices to be replaced.

A slightly different attachment system that is well known and has been used for over 30 years is the CEKA attachment (CEKA NV, Antwerp, Belgium). This attachment differs from the others in that the patrix is a split metal post that is adjustable and snaps into a metal matrix attached to the proximal surface of the abutment crown. This system has many modifications for use in a variety of situations. The patrix post is threaded so that it can be screwed into the holding device and easily replaced if damaged or worn. A spacer ring is used to allow the possibility of stress relief, creating a vertical space of 0.3 mm when the spacer has been removed after construction. This space allows a small amount of rotation of the partial denture which will place some of the load on the tissues of the denture base. A recent CEKA innovation is called the CEKA REVAX attachment. This system places the matrix in contact with the gingival tissues in a way that allows easy access for hygiene, both under the matrix and between the matrix and the axial surface of the abutment crown so that the gingival tissues are never compromised. Fig. 10-21

![Fig. 10-21](image)

A very old system that has been in use since the turn of the century is the Roach attachment. The patrix of this attachment is a partially split, adjustable round ball that extends out from the axial surface of the abutment crown. The ball comes as a finished casting that can be soldered to the axial
surface of a crown or cast to. The matrix of this system is a tube, in much the same form as discussed earlier. In its earliest form, the tube was made from plate gold and was attached to the partial denture by means of a metal tang that had been soldered to the tube. The modern edition has a tube with one form to be used if the attachment is to be soldered to the framework, another if the matrix is to be attached with resin. **Fig. 10-22**

Since the matrix is a round ball, the contact with the matrix is only at the circumference which allows for more rotation than any of the other systems. The increased stress relief available with this system indicates its use for compromised dentitions where a conscious decision has been made to transfer load from the abutments to the supporting tissues of the denture bases. The exact amount of rotation allowed with the Roach attachment is a factor of the space between the tube and the axial wall since the tube can only allow rotation to the point where it comes in contact with the crown. In all the systems that allow rotation, the amount of movement that is desired is slight since the use of the altered cast impression and the relines that are made when indicated keep the amount of space between the base and the tissues to the minimum. If the precision attachment partial denture is ignored for long periods of time, no attachment system will permit control of the rotational forces.

**The modern equivalent of the Roach Ball is the Bredent Attachment and it is that attachment that I currently find the most practical, inexpensive and easiest to use of all the extra-coronals.** The Bredent consists of a castable pattern of a ball extending from a flat plate, as does the Roach, and uses a resilient matrix. **Fig. 10-23**
This portion is added to the abutment crown adjacent to the edentulous area using a dental surveyor and is parallel to all milled surfaces. The matrix for this attachment is a thermoplastic “snap” that is contained in a housing that is either preformed in resin and therefore castable, or in metal for use when the matrix is to be attached to the framework with resin. Fig. 10-24

The matrix, in green as attached to the cast ball in the above illustration, has an indentation on both sides which serves as the retention of the matrix in the housing. A custom housing (see below) can be created in ceramo-metal and veneered with porcelain or cast in a non-precious metal and veneered with composite and laser welded to the framework. This approach is essential for situations where vertical space is minimal. Fig. 10-25

The Bredent comes in two sizes, a 1.7mm and a 2.2mm ball along with appropriate snaps and housings. The 1.7 mm matrix seems to provide more than enough retention for any RPD on the mandible when combined with appropriate milled surfaces. The “snaps “are easy to replace and have been lasting for from 3 months to over a year depending, I believe, on the amount of milled surfaces available to restrict the path of insertion and removal.
This attachment, like the Roach, does allow some rotational movement before binding up.

After all fixed units have been waxed to full contour and milled in wax for maximum guiding plane surfaces, the patricies, of whatever system that has been chosen, are added to the axial surfaces of the abutment crowns using the special alignment tools provided by the manufacturer. The patricies are generally patterns, made in some form of hard resin that is amenable to burnout and casting in standard ceramo-metal alloys. The alignment tool is placed in the dental surveyor at the same tilt of master cast as was used for the wax milling of the guiding plane surfaces. **It is critical to note that the path of insertion/removal to be used takes into account the height of contour of the edentulous soft tissues as well as the remaining teeth.**

The plastic pattern is to be placed somewhat to the lingual of the center of the proximal surface. **Fig. 10-26**

![Fig. 10-26](image)

This step ensures that the bulk of the matrix will not interfere with the esthetics of the buccal cusp of the replacement denture tooth. The average patient can tolerate a slight excess of contour to the lingual since esthetics are not involved.

The patrix (in the pin systems) is to extend from a contact with the edentulous ridge just lingual to the crest of the ridge to the occlusal plane. This length can be maintained in those systems that utilize an open tube. If the system requires a capped housing, then the patrix will have to be shortened to accommodate the housing. The decision on which type of system to employ often hinges on the amount of vertical space available. The patrix pin must extend far enough out from the abutment tooth that floss or cotton yarn can be passed under the pin and up to the marginal gingiva. Most plastic patterns come with a self-limiting platform that, when waxed into the normal contour of the abutment tooth, automatically controls the extension into the edentulous area. **Fig. 10-27**
When the teeth bearing the extracoronal attachments are to be veneered with porcelain, resin or composite, the extension of the cutback for the veneer is critical. The veneering material must not be allowed to contact the matrix portion of the attachment. In most cases, this requirement will cause the margin of metal to extend further to the facial and lingual surfaces than it would in a veneered crown not involved with the attachment. This extension beyond the normal cutback is generally in the area of 1.0 mm to 1.5 mm and does not usually create an esthetic problem since the attachment is most often found on the distal proximal surface of the abutment tooth.

Fortunately for both clinician and technician, the manufacturers of attachments provide excellent instructional material, generally at no cost. Since systems are constantly being redesigned, the inclusion of great technical detail in any text is apt to be a waste of time.

After casting, the technician is careful to leave the patricies untouched since any finishing and polishing will decrease the retention of the system. The fixed units are finished and veneered and are then included on the master cast for the partial denture framework as described earlier. This step is essential for the extracoronal attachment since the patricies are so small that they would not stand up if impressed and poured in stone. By having the actual casting on the master cast, the technician creating the partial denture can wax out the contours and prepare the refractory cast so that the attachment of the matrices is precise and accurate.

When all the remaining teeth in the arch are part of the fixed component, the matrices can be best picked up on the master cast and verified in the mouth. When some of the abutments are natural teeth not associated with the fixed units, then the task of picking up the attachments becomes slightly more
complex since the stone replicas of these abutments may be damaged. In this situation, it is best to place all the fixed components in the mouth, fit the frame and then attach the matrices with autopolymerizing or light-activated resins. The complete assembly must then, of course, be returned to the master cast for verification. Tolerances for the relationship of components in the precision attachment partial denture are much finer than for the conventional partial so the use of magnification whenever possible is essential.

Most of the extracoronal attachment systems are self-aligning when it comes to joining the matrices to the patricies. The components need only be fully seated on each other and the resin applied. Some systems, the Roach, for example, have aligning tools for the matrices that are to be used with the dental surveyor. These systems must be attached on the bench.

For each of these systems, the decision whether to solder the matrices to the framework or to attach them with resin must be made on an individual basis with the space requirement the biggest factor. Both means work well and, with care, will not cause problems.

The set-up and wax-up of the partial denture containing extracoronal attachments is generally not complicated except for placing the denture tooth that sits over the attachment assembly. Often, this first tooth will need to be hollowed out to a mere shell. In order not to have the denture base resin show through the tooth, it will be necessary to pack a small amount of tooth-colored resin, preferably heat-curing, under the tooth before the remainder of the denture base is packed. When space is at a premium, metal occlusals or custom housings are the only ways to prevent rapid wear and associated destruction of the attachment assembly. The cost of adding a small onlay or ¾ crown form to the partial is minimal compared to the cost of repairing the attachment partial denture down the road.

For any or all of these systems, when they are used on a Class I or II arch, primarily on the mandible, the need for an altered cast made after the attachments have been joined to the framework is essential. A separate appointment will often be required to obtain this impression and the following jaw relation records since the addition of resin to the matrices/patricies requires access to the retentive meshwork in the same areas as would be used to join the altered cast trays. For these situations it is
recommended that the attachment component be soldered/welded rather than attached with resin since the resin of the altered cast tray may attach to the attachment, making removal of the tray a real problem!! With the attachments fully seated, the altered cast impression can be made with confidence since the support of both the hard and soft tissues has been optimized.

**Resilient Attachment**

A final classification of extracoronal attachments remains to be discussed. We have already spoken in passing of the use of resilient materials to line the matrices of some of the tube type attachments as well as of the Bredent. These could be classified as resilient attachments but the term is more apt to be restricted to a relatively recent development, best illustrated by the ERA, O-SO™, Locator and the Bredent attachment systems. These systems were developed to allow for stress relief and for simple and rapid replacement of the resilient components. Both systems wear out quickly but are so easily replaced that some patients can do the job themselves.

The ERA system is similar to the CEKA attachment already described, the difference being that the patrix in the ERA is a plastic material that snaps into a matrix ring attached to the crown. **Fig. 10-29**

![Fig. 10-29](image)

The ring comes as a castable plastic pattern. 4 different levels of retention are available with four slightly different plastic patrices. A metal housing with internal retentive grooves for the plastic inserts and external ridges for resin retention, is included with the attachment system. The patrices are color-coded, with the white unit being the most flexible and progressing through orange to blue to gray as the most rigid. Recent studies have indicated that after a very short time, there is no clinical difference between
the three colored units. Most situations will need only the white patrix as
the amount of retention it gives, when combined with other frictional
retentive components of the partial denture, is more than adequate. A
trephine bur is provided that allows rapid removal of the worn patrix. An
insertion tool is provided that carries the new patrix into the partial and
forces it to place in the housing. The entire operation takes less than a
minute. A processing patrix is also a part of the system. It allows some
space for movement of the patrix in the housing to create stress relief as it is
slightly longer than the colored units that are installed after
processing. The ERA has been popular due to its ease of replacement and the slight amount
of flexibility it allows.

The O-SO™ attachment is actually classified as a stud attachment, with a
patrix which looks somewhat like a doorknob and with a rubber O ring
matrix. The O ring comes, in its most recent form, with a metal housing not
unlike that used with other systems. **Fig. 10-30**

The system also uses a
processing ring which is replaced
by a soft rubber ring before being
placed in the patient’s mouth.
Since the ring is quite soft, it is
quickly worn but very easily
replaced since the old ring can be
picked out with an explorer or
small tweezers and the new ring pushed into place with any small blunt
ended instrument. The patrix comes as a castable plastic pattern which can
be attached as an extracoronal attachment or, in a slightly different form, as
an overdenture stud. It is the most flexible of all the attachment systems and
is therefore of greatest use in situations where the level of tooth support is
minimal. This system has a special advantage over all the other current
systems, especially when used as a “stop attachment” placed in the
edentulous areas of a Class I, II or IV partial. Here, the top of the ball of the
patrix serves as a metal stop that is independent of the retentive component
which is far superior to a system where the resilient component bears the
load as a stop.
For the most part, the metal housings for the matrices of the ERA, the O-SO™ and other resilient attachment systems will be attached to the framework of the removable partial denture with resin, not soldered. These matrices can be related either in the mouth or on the cast. In either case, a thin coat of resin must be carefully applied to the external surface of the housing and allowed to set in the pressure pot before the bulk of resin is added. This step is made necessary by the very fine retentive grooves and ridges on the external of the housing. The quality of the joint between the housing and the partial is dependent on the highest quality resin-metal interface. If a laboratory grade repair resin (such as Perm by Caulk) is to be used, the fibers must be removed by sifting them out of the mix. The fibers tend to clump when adding the resin using a brush. Once the resin has fully cured, additional, fibered resin is added to complete the attachment and the unit placed back into the pressure pot. Later the bulk of the resin can be thinned appropriately to fit within the confines of the partial without damaging the interface. Autopolymerizing tooth-colored resin can also be used to reduce the risk of a show-through of the pink resin for those situations in which space is limited and esthetic demands are great. All internal traces of resin must be removed, preferably under magnification, after the processing unit is removed from the housing and before the retentive matrix is snapped into place.

The resilient attachment systems work best when their path of insertion/removal is restricted by the guiding planes prepared on the abutments and the well-fitting guide plates of the modern framework. When a restricted path of insertion exists, the patients cannot jam the attachment to place from a variety of directions. They are limited to the path dictated by the planes. They must be advised that if they wish to minimize the wear and replacement of the resilient elements, they must place the attachment partial with their fingers only, never biting it to place. When the resilient component is forced to function only along its intended axis, the wear is greatly reduced, both for the ERA, the O-SO™ or the Bredent as well as for any other modern attachment that uses a resilient insert. The manufacturers often show these attachments as being the only connection between the partial and the abutment teeth, implying that they function as an adequate rest system in addition to providing retention. It is my opinion that this approach breaks the basics of modern partial denture design and construction and should be ignored.
It has been implied that all extracoronal attachments are cast as a part of abutment crowns. This is not strictly true, as recent events have demonstrated the high level of success of resin bonded extracoronal attachments.

While it may not appear that an etched and bonded restoration would have sufficient retention to the tooth to resist the additional stress of an attachment, when micro-groove preparation on the abutments are combined with careful patient selection, the bonded attachment is a successful and conservative means of obtaining the esthetics of an attachment system. A review of the work of Scharer and Marinello will acquaint the reader with the parameters of this therapy. In these cases especially, the partial denture should not load only the attachments. Additional abutments with positive rest preparations, both in natural tooth structure, crowns or bonded surfaces will reduce the load on the bonded attachment and should increase its length of service. All the extracoronal attachments discussed in this chapter are amenable to bonded restoration and have been used successfully over the last 8 to 10 years.

There are a variety of stud attachments that can be used for retention of the removable partial denture even though they are generally intended to be used in the overdenture. The stud attachments placed either in the endodontically prepared tooth or into an implant create potential problems for the precision attachment partial since their angulation is limited by the long axis of either base. They are to be placed first and the remainder of the guiding plane/attachment surfaces aligned with their long axis. If their alignment causes the other components to be aligned beyond a rational limit, the use of the root or implant for retention should be eliminated and used for occlusal stops only.

The Custom Extra-coronal Welded Housing

Perhaps the most difficult of the problems associated with all attachment systems are caused by the lack of vertical space into which must be placed the matrix, its housing, resin retention and a denture tooth. Unless there has been some loss of adjacent bone it is unlikely that sufficient space will be found adjacent to the terminal abutment in Class I situations, especially if that abutment happens to be a bicuspid. The resilient extra-coronal
attachment lends itself to the creation of a custom housing that will contain the resilient matrix, taking the place of the separate housing. Constructing the custom housing is, at first, a confusing challenge, due, as always, to the lack of space. It is really essential that a diagnostic waxup and setup be done to perfection for this concept. The diagnostic cast must be as accurate as any final impression, especially the gingival tissue levels adjacent to the proximal surfaces of the potential abutments because the measurement from both the occlusal and gingival extensions of the patrix will be critical in choosing the attachment system. The measurement from the top of the patrix to the opposing tooth will determine the type of custom housing, whether it will be all metal, metal and porcelain/composite or, if crestal bone must be removed to lower the placement of the patrix. Fig. 10-31

The putty matrix, made from the diagnostic set-up indicates the amount of vertical height available for the housing. The housings are likely to be so thin vertically that they cannot be waxed, sprued and removed from the master cast without distortion. This forces us to create a separate and special refractory so they can be cast as individual units, completed with their respective veneers and then picked up and laser welded to the frame. Fortunately, the laser weld can be brought very close to the veneer without harming it (within .5-1.0 mm).

The sequence for constructing the custom housing is as follows:
Select the extra-coronal attachment system after diagnostic procedures
Complete mouth preparation, both subtractive and additive
Make master cast for RPD frame picking up all fixed components
Instruct lab on special provisions for the weld joint contours and retention for the resin pickup
Return waxup for final contouring by clinician
Cast frame with the usual instructions on finishing the outer side only
Fit to mouth
Blockout patrix and seat fixed components
Using a wire mesh sectional tray make silicone impression of the area to become the custom housing with the framework held in ideal contact with tissue
Pour sectional impression in chosen refractory compatible with the alloy to be used for the housing
Either mount refractories to the opposing cast or prepare thin resin transfer coping so that the custom housing can be waxed on the master cast in occlusion when required or, if no occlusal contact will occur on metal wax housing directly on refractory Fig. 10-32

![Fig. 10-32](image)

Sprue and cast custom housings and veneer with porcelain if that was the plan
Assemble in mouth and pickup housing with resin
Submit for laser welding
Complete the RPD
As you can now realize, this is not a simple procedure but once completed for a patient it will be much easier to see and evaluate. Don’t let this lengthy list discourage you!

The Milled Abutment as a Precision Attachment

Finally, and perhaps, most importantly, has been the realization that the milled surfaces of abutment teeth, and especially abutment crowns are, in themselves, precision attachments as long as they are truly parallel and that the framework that contacts them has been constructed and fitted to perfection so that a tolerance similar to that of a quality intra-coronal attachment exists. The fit of this type of RPD can be so precise that, especially on mandibular Class III’s, no other means of retention is required. In any situation where this kind of precision fit has been created conventional clasping can be reduced to one clasp per side and if that clasp assembly is in the posterior of the mouth or if the clasp is on the lingual
surface then no visible clasp need ever again be seen. This relatively simple system also allows, in fact begs, for the utilization of the dento-lingual bar as the major connector of choice.  **Fig. 10-33**

![Fig. 10-33](image)

This major connector covers the least amount of tissue and reduces its presence in the mouth to a minimum that is greatly appreciated by any patient who has ever had to wear a “conventional RPD”. The techniques required to create this type of a RPD have been presented throughout this manuscript but can only really be appreciated by constructing one under supervision.

A mastery of these few attachment systems will cover the needs of most prosthodontists as well as to provide a basis for the understanding of those systems to come. While the actual attachments can be expected to change and improve with time the techniques for their use are standard and must be a part of the technical background of clinician and technician alike. The precision attachment, in combination with the other aspects of advanced partial denture construction, offers us the possibility of making prostheses that can be undetectable by the patient esthetically as well as retentive, strong and problem free and that will not compromise the oral health of our patients.
CHAPTER XI

Implants and Removable Partial Dentures

The ideal use of one or more implants for the removable partial is to eliminate the posterior extension base by providing a direct stop, especially on the mandible or the extensive anterior base in a Class IV situation in either arch, where chronic problems associated with the loading of the edentulous ridge have plagued the profession. A second and more complex indication, for their use is as a replacement for critical abutment teeth. A good example might be a situation where a mandibular cuspid serving as a prime abutment is lost, leaving a lateral incisor as a terminal abutment. In the past, one might have considered a hinged major connector in this situation as described earlier. A single implant placed near the cuspid position can provide both vertical support and, through the use of any of a number of attachment systems, retention as well. There are a number of advantages to placing a crown on this implant if its position in the arch is reasonable for an esthetic crown contour, primarily the consideration that may allow the patient reasonable esthetics without the partial in place.

Finally, implants can play a major role in mouths with extensive tooth and tissue loss by providing both a vertical stop for the partial as well as some form of retention through a variety of possible attachments. In these situations implants should be connected by a casting that is milled to the path of insertion and contains the attachments of choice. The milled casting can provide frictional retention to the casting while its superior surface serves as the vertical stop. Fig. 11-1

Fig. 11-1
Here the platform, supported by two implants, has a flat bearing surface to serve as the rest plus a Bredent attachment to the distal and a semi-precision attachment slot milled into the lingual surface of the platform. The lingual surface of the platform has also been milled parallel to the lingual milling of the crowns on the opposite side of the mouth.

A major decision must be made early on in treatment with a RPD utilizing implant support. Will the implant have a retentive element or be used only as a stop? Fig.11-2

I have come to believe that the best use of the implant(s) is as a stop due to the difficulty of alignment of the implant with the desired path of insertion and removal. When only one implant is to be placed, the long axis of that implant can determine the path and the remaining abutments aligned to it through either subtractive or additive mouth preparation. When more than one implant is to be used the problem of implant alignment can be avoided if a bar-clip retentive element is used rather than any of the individual resilient attachments (Locators, Bredents, ERA’s, etc.) since the placement of the bar between the implants determines the path rather than the inclinations of the implants. The Bar-Clip supported by two implants also creates a solid stop for the RPD so that the vertical load is directed to the implants without going through any retentive element. Fig. 11-3
Only the bar (in the above illustration a Hader Bar) needs to be parallel with the crowned abutments. The implants can have any alignment.

The future would appear bright for the use of selected implants, providing critical support for partial denture patients and still keeping the total cost of treatment at a reasonable level through the use of the removable partial denture as the prime restoration. The well-planned use of an isolated implant in these situations does not preclude a later, more complex treatment plan utilizing additional implants and fixed restorations.

**Implants for the Class I and II Partial Denture Situations**

The obvious situation in which a single implant can make a major contribution to the success of a removable partial denture is in the distal extension partial denture. Patients have often been dissatisfied with our best efforts, either with conventional or precision attachment partials because of chronic soreness under the distal extension base. This is especially true in those situations where the opposing arch contains a full complement of natural teeth or fixed partial dentures. When a complete denture is involved, the potential load on the tissues is generally reduced with fewer patient complaints. Implants placed distal to the foramen, ideally in the area of the second molar, would effectively change the Class I or II situation to that of the Class III. (Fig. 11-2 above) The implant need not provide retention, since adequate retention is most always available from other abutments.

Unfortunately, because of long term ridge resorption, finding sufficient bone in the distal extension base area becomes a major impediment to this therapy. Numerous studies have shown that implant loss is proportional to
the length of the implants used, with special concern for the 7 mm implant, which is presently the shortest dental fixture available. These studies have evaluated the implants for lateral support and retention as well as for vertical support. If the fixtures are used for vertical support only, the success of the shorter implants may well show better results. There are shorter fixtures which may be used in these situations. They are intended for extra-oral maxillofacial use and are in the 3-4 mm range. They have not yet been evaluated for this purpose but, again, when properly integrated and if not stressed laterally, they offer real potential. To cap the implant with a rounded abutment that would provide point contact on its most superior surface and no element of lateral contacts at all would allow vertical loading with minimal lateral stress. The partial denture connection to the abutment will need to be designed to provide the point contact and to maintain this contact throughout the life of the partial. A sliding point contact between the abutment and the partial would also allow the expansion and contraction of the mandible during opening and closing with minimum lateral forces being transmitted to the implant. **Fig. 11-4** This type of abutment requires a hex to place the unit since the standard implant screw leaves an access hole exactly where we don’t want it!!

It is quite possible that future advances in implant bio-mechanics will provide the profession with alternative forms of implants that will be sub-periosteal rather than endosteal. If the load on the implant can be made exclusively vertical then something of this type could be used on severely resorbed mandibles, eliminating or greatly reducing the need for grafting bone.

While the ideal position for Class I and II implant placement may be in the second molar area, any position distal to the terminal abutment where sufficient bone remains is acceptable. There is no reason for the denture base, when supported by an implant, to extend to the traditional borders. In fact, once posterior support is available, the design of the denture base should be altered to make its contours as much like those of a fixed restoration as possible. **Fig. 11-5**
This will mean that there will be no advantage to extending into the floor of the mouth, or onto the external oblique ridge.

It may well be possible to cantilever one occlusal unit posterior to the area of implant abutment support so that an implant placed in the second bicuspid position would support at least a first molar. **Fig. 11-6**

As was pointed out at the beginning of this chapter, as long as the implant abutment is not expected to carry an attachment component, the angulation of the implant relative to the remaining abutments is not important. For those situations where some retentive attachment is required, the angulation is critical. Either the fixture can be placed in the long axis of the remaining abutments (parallel to the path of insertion/removal) so that any attachment will draw with the remainder of the mouth or the abutment, with its attachment component, must be completed first and the remainder of the mouth prepared to accept that path. **Fig. 11-7**
Resilient attachments, the type that would most often be used in this situation (ERA, O-SO™, Bredent or similar), do allow for a small divergence from the path without damage to the resilient component. Recent additions to the available attachment systems, in particular the Sphero Flex from the Rhein 83 Corp. of Bologna, Italy, offer swivel ball attachments that screw directly into the implant fixture allowing 8° freedom of rotation. The retentive element is an O ring much like that of the O-SO™ system. **Fig. 11-8**

![Fig. 11-8](image)

**Fig. 11-8**

An OSO attachment will be the retentive component for the RPD seen in **Fig. 11-7** because the anterior abutments are too short to accept an attachment, either intra or extra-coronal.

There is another option for the isolated single implant, in any position in the mouth. By constructing a casting that has both a stop and a milled guide planes as well as an attachment, implant angulation is immaterial since this casting is made to be parallel with other components of the supporting structure for the RPD. **Figs. 11-9&10**

![Fig. 11-9](image) ![Fig. 11-10](image)
Space, in those situations for which an attachment component is intended, may often be at a premium, especially if the implant is placed quite posteriorly. A measurement taken from the occlusal surface of the opposing tooth must show that space exists for the abutment, the attachment components, sufficient resin to pick up the attachment and for the denture tooth destined to complete prosthesis. Where space is minimal, the occlusal surfaces of the denture tooth over the implant are protected with metal occlusals as in any attachment situation. Where space is severely limited a custom housing that has the potential for veneering for esthetic requirements will be required. (see Fig.s 10-31 and 10-32)

If the implant is distal to the first molar, it is not essential that a denture tooth be placed if space is lacking. Occlusion through the first molar, when the base is well-supported posteriorly, will provide adequate mastication.

The implant-partial interface can be constructed in a number of ways. The possibility of using a modified healing abutment as the stop for the distal extension is certainly to be considered. A potential problem arises from the fact that the healing abutment may not be torqued down to the same load as a transmucosal abutment would be. This means that screw loosening of the healing abutment can be expected and, indeed, that has been our experience. As long as the patient is aware of this possibility and inspects the healing abutment periodically, no damage is apt to occur should the abutment loosen. The modification of abutments that can receive greater torque should solve this problem for most situations although at some increase in cost. A custom casting to the abutment or to the fixture levels can be made to contain either an attachment component or the rounded occlusal stop. These can be made using the hexed UCLA type castable abutment or by modifying any of the ball abutments normally used for overdentures. Contour modifications of these attachments would be done on the working cast so that the angulation of the sides of the rounded occlusal stops would be in general alignment with the guiding planes planned for other abutments. This step will reduce the need for excessive blockout on the partial.

The clinician must choose between making a custom metal casting to ride on the ball (rounded occlusal stop) or to allow that contact to be in the resin
of the denture base. For the former, fixture analogues will have to be present on the master cast for the partial denture casting. They may be needed on the working cast for any fixed components as well. On the master cast, the patrix, that is the ball, is blocked out so that only the center of the ball surface will be contacted and this unit is duplicated in refractory. **Fig. 11-13**

An over casting is waxed with retentive beads or loops to lock the casting into the denture base if the over casting is to be retained with resin alone. A tang extension, running to the retentive meshwork will also be required so that the casting can be picked up from the mouth after the framework is fitted. In situations where space is limited, the tang extensions can be soldered or welded to the retentive meshwork of the partial denture casting. If the contact is only in the resin of the denture base then that contact is perhaps best achieved by a sectional reline using Astron after the insertion and adjustment of the finished RPD.

The anterior retentive components of implant-supported distal extension partial dentures need not offer any stress relief as they should with the conventional Class I situation. Either intra or extra coronal attachments or conventional clasping can be used effectively since these partials are now effectively all “tooth”-supported.

The other major area of interest is that in which the implant becomes a prime retentive abutment, as it would if a cuspid were to be replaced by an implant. In these situations, we are going to be faced with decisions on the best way to integrate the implant into the support, stability and retention of the partial denture. We will also need to consider the esthetic replacement of the missing tooth that would be found over the implant in question.

Perhaps the easiest approach will always be to place an attachment on the implant, either connecting directly to the fixture or threaded onto the transmucosal abutment. Given sufficient space, any stud type attachment
could be used along with the ERA and O-SOTM type systems. The attachment need only fit within the shape of the replacement tooth and allow metal retentive extensions from the framework that will provide dependable retention for the denture tooth and associated denture base resin. When space is severely limited, as one might find in a severe Class II Div II case then it may be necessary to place a single tooth on the implant and use that unit as a conventional or attachment abutment.

When using the implant crown as a conventional abutment tooth, the partial framework must be in intimate contact with all remaining abutment teeth, natural or crowned, so that the teeth will be effectively splinted to the implant. The fact that the implant crown will not change its position in the arch while the remaining natural teeth retain that possibility should not complicate the design if the partial fits to our standards and is worn by the patient on a daily basis. Should the partial not be worn for any lengthy period, this disparity in the possible migration of the abutments could result in a framework that no longer fully seats.

For these single implant abutment crowns, the use of an extra coronal attachment to retain the partial denture seems indicated. Intracoronal attachments will most likely not be possible since the internal contour of the crown is taken up by the implant components. The selection of the attachment to be added to the implant crown is driven by both the design of the implant and the needs of the partial denture. Since the implant crown, properly integrated, will not move, there will be some need to consider stress relief if the partial in question is a Class I. The potential lever arm is an issue here as it would be for any cantilever from a terminal implant. Unfortunately, there is no body of specific knowledge to which to refer at this time to help us with our decisions on stress relief. We will have to draw on our experience with other implant prostheses as well as conventional knowledge of the removable partial denture. It would appear that for Class I situations in the mandible at least, if there is no possibility of posterior implant support, then the more resilient the attachment, the less the possible damage to the implant. This would suggest a ball attachment with an O ring retentive element placed extra-coronally as the best possible option. Obviously, conventional clasping with resilient wire forms will also offer stress relief depending on the amount of relief built into the casting.
The decision of whether to use an overdenture approach as opposed to the placement of an implant crown is determined in part by the position of the implant. If the implant has been placed within the confines of the root of the missing tooth, or very nearly in that position, then an implant crown offers an esthetic advantage over a stud type attachment and a denture tooth by allowing a visible tooth when the RPD is not being worn. If the implant has been placed outside of these limits then the construction of an esthetic crown contour is unlikely. Again, retention in either of these scenarios is not at issue. Finally, the effect of the overdenture approach on the smile must be considered. If the tooth in question is clearly visible, say up to the mesial of the second bicuspid, then placing a crown on the implant will allow the patient to appear normal when the teeth are exposed. Lacking this crown the patient will often be forced to wear the partial denture most of the time to keep up their appearance.

Implants for Class III situations

When implants are used in Class III situations, we would expect to see them used only in extensive edentulous areas where an additional abutment is critical to success. Most likely they would be used as overdenture abutments, usually with some type of attachment system for retention of the partial, when they are placed in the posterior of the mouth. When two or more implants can be splinted together with a bar, a clip-retained partial offers a dependable option. The bar-clip assembly can be used with any other attachment system, conventional clasping on other teeth and with precision milled crowns to provide both lateral stability and retention. Since the parallelism of multiple implants cannot be assured, the bar-clip system allows any undercuts in the gold cylinders to be blocked out in the housing and not be contacted by the partial casting. **Fig. 11-14**
The superior surface of the bar can always be used as a vertical stop for the partial so that the implant attachments need take no wear at all from the housing. If there is sufficient anterior-posterior space then the lingual surface of the bar should be milled to be parallel with the rest of the guiding planes in the arch so that stability and frictional retention are enhanced.

The lack of vertical space for the implant attachment system will always be a potential source of problems. For that reason alone, a diagnostic waxing and setup is essential. This procedure must contain an evaluation of the implant attachment mechanism, best accomplished by placing the implant components on the diagnostic cast after a putty matrix has been made from the diagnostic setup so that the actual remaining space can be clearly identified. This step will also allow the clinician to decide if metal occlusal surfaces on the denture teeth will be required to protect the attachment system or whether a custom housing must be created since either of these solutions will be a factor in the final cost of treatment.

**Implants for Class IV Situations**

Large edentulous Class IV areas really benefit from the addition of an implant stop to support loading of the anterior area. Retention is seldom an issue since the milling of proximal and lingual surfaces of posterior teeth combined with conventional clasping on the most posterior abutments will provide retention. Because of the potential lack of vertical space in the incisor areas retentive devices on implants often cannot be fitted into the RPD so the stop is the obvious option. The implant should be placed in the cuspid area rather than under the incisors. If both cuspids are present then this is does not qualify as a Class IV case.

In almost all cases the implant(s) will be placed at the beginning of treatment and the remaining abutments adjusted to maximize the implant position and angulation. There are situations where it is advisable to construct the definitive RPD first and then retrofit the implant(s) under the prosthesis. The indication for this approach is when conditions preclude the construction of quality provisional prostheses or when continued wear of an existing and ill-fitting prosthesis might compromise the surgical aspect of implant placement and integration. There are special design and construction implications for this approach in that the framework must
allow enough space below the meshwork to insert the implant under the completed partial. This decision is made by the clinician/surgeon before treatment begins and the laboratory is instructed as to the relief, both vertical and horizontal, necessary to raise the mesh off the tissue enough for the implant. Obviously, this approach is only feasible when there has been extensive resorption of the edentulous area. **Fig. 11-15**

This casting is the one for the case shown in Fig. 11-3 and illustrates the amount of space generally sufficient for the retrofitting of anterior implants and a bar.

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**Fig. 11-15**

**Retentive Components for RPD Implants**

There will be occasions when implants will be required to support retentive devices when conventional retention is not available. Because of the great variety of possible attachments the selection of the most suitable is bound to be controversial. The issues to be considered are almost always space and angulation, not retentive force. All the attachments that I have seen provide adequate retention for a well made RPD. When the RPD is a component of a maxillo-facial appliance then other demands can be expected in regards to retention. As mentioned earlier, the ball/O ring type of attachment offers stress relief and provides some allowance for non-alignment but at the price of quickly wearing out. Fortunately the cost of the O ring and the time and skill required to replace it is minimal. 3-6 months is a reasonable expectation before the retention is lost. The Locator attachment is currently very popular and claims some allowance for non-alignment of the implant fixture. It is inadequate as a stop, however, so is best employed when stops are provided by other components of the partial denture.
The advantages of the laser welding of frameworks and/or attachment of components are clearly as important, if not more so, with the implant unit used with the RPD as with the previously described more conventional uses. The cost of the laser welding as a part of total treatment is not clear at this time since the options can vary greatly and the dental laboratory industry has yet to establish a clear time and materials criteria for this potentially superior means of construction.

While the use of implants in conjunction with removable partial dentures is in its infancy, the chances are excellent that new systems and new uses for those systems will enter our practices in the future. As long as they are used in conjunction with thorough mouth preparation of soft and hard tissues, employ precisely fitting castings and are cared for with regular recall and appropriate maintenance, we can be confident that they will improve the quality of removable prosthodontic therapy. To expect them to be a solution for all our problems without this level of careful adherence to basic principles is foolhardy.
CHAPTER XII

Co-Cr Frameworks for Implant Overdentures

There is another form of a “partial denture” framework that does not result in the conventional Removable Partial Denture. Since this casting is made using many of the techniques described in this book it is appropriate that it be discussed in depth as the final chapter of Das Book.

Co-Cr, Ni-Cr, Titanium and all the other alloys that may be used to cast a RPD framework (The alloy used in the Graduate Program at the UW is Jelenko JD, (CO-63%, CR-28.4%) and all the castings discussed in this book are made using that metal) can also be used to create metal bases for complete dentures and overdentures, supported by either natural teeth or implants. Obviously their great advantage over the all resin base is one of strength and thereby a reduction in thickness. They also have a casting shrinkage well below that of the resin. When used in combination with milled components, most often bars connecting implants, great stability and some frictional retention can be expected in the final prosthesis.

The greatest advantage of the metal base is however, that the retentive attachments, whatever they may be, can be joined to the base as soon as the fit of the base has been verified. This allows the base to have its final retention and stability while final jaw relation records are made as well as while the denture teeth to be placed in the mouth are attached and for the activities associated with the try-in process completed.

There are two situations where a metal base is clearly indicated when overdentures are contemplated. The first, most always a result of poor planning, occurs when an all resin base fractures in function, or occasionally from an accident. This is most always an emergency situation since it is unlikely that a fractured denture base, usually in two or more parts, can be worn successfully. The other instance is when the use of a metal base is clearly indicated in the treatment planning phase for obvious reasons. They will be discussed separately here.
Metal bases for routine complete dentures

Going back to the era of swaged gold plate, metal bases for complete dentures have been a special, but universal component of prosthodontics. Many alloys have been used in their construction; those mentioned above as well as aluminum and are well documented in our literature. The form of the bases has changed with time with metal coverage past the ridge crest and without raised meshwork now considered routine. Fig. 12-1

The base includes the posterior palatal seal and it extends just to the point where buccal undercuts begin. Some feel that the posterior seal should be in resin so it can be relined if the final seal is inadequate. Others would say that if you can’t capture that area accurately you shouldn’t be doing this level or prosthodontic care. For those concerned about being unable to reline this type of denture it is obvious that the denture base must be mature before considering this option. While the denture cannot be relined it certainly be rebased using the same techniques discussed in this chapter.

Inserting a cast base in a resin prosthesis as a Rebase

When a resin based complete denture of any type has fractured an analysis of the thickness of that base is the first step in treatment. If the cause of the fracture is clearly accidental then a routine repair of the resin base is the normal solution to the problem. But when it is equally clear that the thickness of the resin was inadequate and that thickness cannot be augmented due to the available space then a metal base must be constructed and inserted into the resin base. Fig. 12-2
Here, the cause of a fracture over the right implant was a stress fracture from lack of strength of the resin and a classic indication for the insertion of a metal base, using the rebase technique.

The first step in this process is to orient the segments of the fractured denture so that an accurate base can be poured against the denture. Often the patient has attempted to repair the fracture themselves using the dreaded Super-Glue with disastrous results. Any material that might have been inserted between the segments must be completely removed with no concern if some of the adjacent denture base material is also lost. The segments are now inserted and the patient asked to close into maximum intercuspation with the opposing dentition, natural or prosthetic. Fast setting impression plaster is loaded into a syringe and injected along the buccal surfaces of the segments to cover at least ½ inch on each side of the fracture. **Fig. 12-3**

The plaster provides a rigid core so that the denture can be removed from the mouth without distortion. Should the segments become separated they can be accurately reassembled before pouring a repair cast against the internal surface.

When the repair cast is set the segments are removed and the joint area prepared for an autopolymerizing resin repair. With that complete a wash impression, as for a reline, is made in the denture following normal practice.

That impression is poured and once recovered three widely separated “V” cuts made in the base to allow the base to be separated from the mounting plaster and accurately replaced later in the process.

The base is now lubricated with separating media and the cast attached to the lower component of the remount jig.  The mounting is completed by
using a plaster index connected to the other half of the jig. Once this plaster is fully set the cast is separated from its mounting and the metal base designed. **Fig. 12-4**

The coverage is outlined and the amount of relief wax for the retentive mesh, usually one thickness of baseplate wax, is placed or outlined for the lab. The area of the implants is clearly marked so that the holes in the casting will be exact for the pickup of the attachments. Note that the internal finishing line distal to the implants is about 3 mm.s as it would be for a conventional RPD. The anterior segment will usually be a full metal coverage with bead retention which must be placed around the holes for the later resin pickup. **Fig. 12-5**

Before joining the implant attachment units to the casting, their retentive elements must be coated with a thin layer of autopolymerizing resin and placed in a pressured pot until fully cured. These units, patrrix or matrix depending on the system, are now snapped to place and locked to the retentive balls on the casting with additional resin while the casting is held in place by the clinician. **Fig. 12-6**
Now, after placing a small amount of Fit-Checker or similar low viscosity silicone into the attachments the frame is placed back on the cast and the cast returned to the reline jig. The silicone will keep any resin out of the attachments while the resin for the rebase is packed into the flask. Space at the intaglio of the denture is created by grinding the base so there is no contact between the metal and the old base and the denture is waxed to the borders of the cast and the contour of the flanges restored. The cast is again remover from the jig and flanked as for any reline/rebase, boiled out and packed.

The only problem that can arise is a possible movement of the casting during packing of the resin. By leaving a small amount of exposed metal on the lingual border of the casting the frame will be retained by the investment of the first half of the flanking. Fig. 12-7

Constructing a Metal Base for an Implant Supported Complete Denture

The best results for this type of prosthesis will come from implants joined by a “bar” that has been milled where possible to create guiding surfaces. Ideally, 6 widely spaced implants are generally recommended for this overdenture. When the overdenture casting contacts these surfaces through
careful attention to detail (as described fully in earlier chapters of this book) great stability along with the possibility of some frictional retention can be expected. Actual retention will be provided by any of a number of attachment systems built into the bar. Usually one attachment per side will be more than adequate but the tendency is always to place more attachments than are really needed.

Another very obvious advantage of the bar is that the path of insertion of the prosthesis is determined by the milled surfaces, not by the alignment of the implants. As we all know, the chances of a number of parallel implants, especially in the maxilla, is most unlikely.

This “bar” can be in many shapes depending on the position of the implants and the space available for the denture. The actual form must allow access for hygiene under the bar and around the implant fixtures and adequate space above for the cast base, the denture teeth and sufficient resin to join these components. Great ingenuity is often required to comply with these restrictions. Fig. 12-8

![Fig. 12-8](image12-8)

This picture illustrates a “bar” that is being milled around the fixtures while the bar form, a Hader Bar, is left untouched for the clip that will provide the retention. The milling is performed on the lingual side of the bar only. Early attempts with this design milled both sides but it was found that the milled surfaces were so close together that the fitting of the framework was very difficult and that using guiding surfaces on the lingual alone was perfectly adequate to stabilize the completed prosthesis. The labial surface is tapered in the waxing to around 5° which also creates more space for the necks of the denture teeth. Fig. 12-9
This illustration shows the previous bar blocked out for duplication with Hader clips in place to create spaces in the resultant casting for their attachment to the casting, which always takes place in the mouth after the cast base has been fitted to its underlying bar assembly. The fitting of the casting can take place on the master cast since the only contact with the underlying tissue is through the contact areas adjacent to the clips. The process for fitting the framework is the same as for the removable partial denture but because of the multiple contact areas it is most often a frustrating and time consuming task.

Fig. 12-10 is of the finished cast base in the mouth ready for the clips to be joined with autopolymerized resin to the retentive beads adjacent to them. The clips have been prepared for the pickup with the application of a thin amount of resin, now fully cured, as for any other attachment pickup. Notice the slight space between the clips and the casting. This is critical since the pickup resin must completely seal off the interface between clip and casting to keep the denture base material to enter the area under the force of packing the resin. When the clips are successfully attached and the result clinically
acceptable wax rims are placed and jaw relation records made and the placement of the denture teeth and contours completed.

Metal Base for Implant Overdenture- 2nd Edition

Because of the difficulties experienced in the fitting of the casting to the bar a new approach in design and fabrication has been made. The bar has only isolated areas of parallelism, this time on both sides of the bar, which will be contacted by laser welded gold clips. They will not be retentive attachments but precise guide planes. These parallel surfaces will provide the highest level of stability and restriction of the path of removal. Figures 12-11 to 15

These two pictures show the bar structure with two Locator attachments in place. There will be three areas milled out to serve as the guide surfaces.

The three milled areas are waxed in to provide a raised area on the refractory cast so that the casting will have an opening in which the custom clips will be laser welded.
After the casting is fitted to the bar resin patterns of the clips, with added retentive contours in wax are formed. The small beads will provide retention for the pickup of the clip castings using fast setting resin.

The three clips have been cast in Type IV gold picked up in the mouth and laser welded to the casting and it is ready for the addition of the wax rim and the completion of the prosthesis. The only contacts between the bar and casting will be the areas adjacent to the clips which will serve as stops and the clips themselves. All other areas where the casting might contact the bar have been lightly blocked out before duplication (these areas can be seen in Fig. 12-13).

This design has proven to be most effective in that laboratory time has been reduced without loss of stability or frictional retention. The principles shown here should be adaptable to any of the implant overdenture situations that can be expected in the future.
This completes the editing of the “second, and unprinted” version, of my text book, Advanced Partial Dentures. It is current with my thoughts and ideas as of the 31 Oct 2012, an appropriate date to have completed this revision. I can only hope that it will serve my graduate students as aid in their learning and as a jolt to their memory when they have forgotten most of what I told them. May I live long enough to edit a “third” edition!

Col B