THE DESIGN OF ROOT CAPS

FOR OVERLAY DENTURES

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A thesis submitted in partial fulfilment of the requirements for the degree of Master of Dental Surgery

University of Sydney, 1988
I would like to express my sincere thanks for the help and dogged support provided by Professor Iven Klineberg, Dr. Norton Duckmanton and Associate Professor Barrie Gillings, without whose help this thesis could not have eventuated. My special thanks to my dearest Carolyn for her patience and encouragement. Lastly to Judy Faulkner who has "moved mountains" in typing this report.
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SECTION 1

THE CONCEPT OF THE OVERLAY DENTURE
CHAPTER 1

THE GENERAL PRINCIPLES OF OVERLAY DENTURES

The concept behind overlay denture construction stems from the situation which commonly occurs when patients have lost most of their teeth and have only a few remaining teeth in the arch. Often these teeth include the mandibular canines, which may only be left remaining due to the fact that canines usually have added root length and bony support. However, the teeth that remain may be periodontally and cariously involved, as the patient, in most cases, has already passed through a long history of teeth loss for various reasons. Certainly, if any kind of restoration is to be made, a complete and drastic change in the patient's attitude and motivation must be achieved before this form of treatment can even be embarked upon. Oral hygiene and motivation to keep their remaining teeth must be a prime requisite.

The alternatives in prosthetic reconstruction, when there are few remaining teeth, are very limited. In all likelihood, the remaining teeth may also be overerupted and it may prove very difficult to establish a functional occlusal plane. A partial denture constructed with "steps" to accommodate the tooth setup will quickly deteriorate due to tipping forces on the opposing denture bases and the axial rotational forces on the remaining teeth, no matter how well maintained, could easily exceed their tolerable limits. The ensuing mobility of the teeth eventually leads to discomfort and insecurity for the patient.

On this basis, it may be more advisable to improve the root to crown ratio of these teeth, at the same time enabling the creation of a correct occlusal plane, whilst maintaining the bony contour around these
teeth as denture base support and even providing the denture base with some mechanical means of retention against displacement.

To this end restoration of the root face, after root canal therapy has been completed and the tooth height has been reduced, is an important facet in the construction of overlay dentures. Decisions have to be made as to the type and length of post that is required, the form of the cap, types of attachment, cementing medium and rotational locking that may be required to ensure a well functioning, reliable, retentive and health promoting prosthesis.
CHAPTER 2

THE CONCEPT OF THE RESTORED ROOT

The retention of teeth roots for overdentures is a practice which is becoming increasingly accepted as a method of providing patients with an alternative to the loss of all their teeth. However, according to Erlinger (1977), there must be a reason for the preservation of teeth which may previously have been scheduled for extraction. Overdentures may be considered in cases where extreme resorption and ridge loss are obvious, the alternative possibly meaning eventual discomfort and functional impairment.

2.1 Bone Retention: Studies by Atwood (1962), Tallgren (1972), and Kelsey (1971) have described the resorption which occurs in the mandibular ridge which greatly exceeds that which occurs in the maxillary ridge. Tallgren (1972) has shown in her studies that pronounced reduction of the pre-extraction morphologic face height occurred particularly in the first year after complete denture insertion. Decrease in facial height was, on average, only half that noted with complete dentures when the subjects were provided with complete upper and partial lower free end saddle dentures. The decrease in facial height was mainly due to pronounced reduction of the mandibular ridge and consequent forward positioning of the mandible. Tallgren (1972) suggests that this may be due to the lower ridge responding more to functional forces than the upper ridge due to its smaller area and the less advantageous shape of the lower basal seat area.

Force produced on the ridge must be dependent on an interaction
of various factors: anatomic, functional and prosthetic. Bone resorption has been shown by Tallgren (1972) to be due in some part to muscular force, of the type measured by Ahlgren (1966) in electromyographic studies. Kelsey (1971) believes that bone resorption is primarily due to local factors, including intrinsic biomechanical forces, genetic influence and interaction between the bone and its covering membranes. The effects of vitamins, minerals, hormones and other systemic factors play a secondary part. Kelsey (1971) believes that the elimination of bone resorption is not possible, but prevention of excessive bone resorption in local areas is. Methods of achieving this are by:

a) Assuring the optimum state of health of the denture supporting soft tissues before making impressions.
b) Avoiding occlusal locking.
c) Carefully balancing and adjusting the occlusion.
d) Recalling the patients regularly and correcting occlusal disharmonies.
e) Encouraging the patients to remove their dentures on retiring.

Certainly, studies by Carlsson et al. (1967), Atwood (1963) and Nakamoto (1968) suggest that resorption of the residual ridges is an inevitable and irreversible physiological process after extraction. Carlsson et al. (1967) found with serial biopsy of the maxillary alveolar ridges following extractions, that nearly all the original labial plate of bone has been resorbed and partially replaced by new bone in about 40 days, the new plate not being continuous or as lamellar as the original one. By three months he found that only four had a continuous (but uneven), labial plate and the rest had no continuous bony plate.
Atwood (1963), by use of microradiographs, showed that the post extraction changes were different in all patients, suggesting that a number of factors were at work, but that in all 21 patients, external resorption of the residual mandibular ridge occurred after extraction. Nakamoto (1968), in 72 mandibular and maxillary specimens, found periosteal resorption with no evidence of repair in all cases. Atwood (1962) discussed the anatomic, metabolic, functional and prosthetic factors involved with bone loss. Anatomic factors suggest that if a patient has a large ridge before extractions, then their potential for ridge loss is greatest. Size, shape and density of the ridges, the thickness and character of the mucosal covering, the ridge relationships and the number and depth of sockets are all important. Metabolic factors are so complex that there is no real way of predicting how much bone loss will occur except by clinical judgement and the patients' past experiences. Functional factors may include the frequency, intensity, duration, and direction of forces applied to bone, which are then translated into cellular activity resulting in either bone formation or bone resorption, depending on the patient's own resistance to these forces. Thomson (1971) discusses the loading effect of habitual, non-functional occlusion and other habits on complete denture intolerance. The mean denture bearing area in his samples were 12.25sq cms for the mandibular cases and 22.96sq cms for the maxillary cases. Watt et al. (1958) found that the area of periodontal support of a natural dentition is in the order of 45sq cms in each jaw. Retention of roots of teeth could therefore aid loading factors by both increasing the total area of the ridge and by retaining some periodontal support for the prosthesis.

Crum and Rooney (1978) found in a five year study, using cephalometric radiographs and study casts, that an average of 0.6mm of alveolar bone was lost in the anterior part of the mandible when mandibular
canine roots were retained for overlay denture construction. The average bone loss for conventional dentures is, according to these authors, around 5mm, or as much as eight times that of patients with overlay dentures. Also bone between and immediately posterior to the canines, was found to be better preserved. This situation occurred even though the teeth may have been involved with periodontitis and hypermobility before treatment.

2.2 Proprioception: Another important factor involved with loss of teeth is the loss of proprioceptive sensations that convey knowledge of the position and state of parts of the body. Root cap design should be made to encourage this function. Proprioceptive pressoreceptors, described by Ramfjord and Ash (1983), are concerned with sense of position and movements of the body and its parts.

The periodontal ligament is highly innervated with these receptors which respond to mechanical stimulation. The presence of proprioceptors has been confirmed by various electrophysical and histological studies outlined by Ramfjord and Ash (1983), and these are considered to be the large group I and II fibres, which travel up the brain stem by the mesencephalic nucleus of the fifth nerve (NV). Pfaffman (1939) demonstrated in experiments on nerves from cats' teeth, that pressure on teeth particularly, could be recorded by means of an oscillograph and this continued regardless of the fact that the pulp was removed. This pressure was also interpreted as local pressure on the enamel even though the tooth was decoronated. Light pressure on even a small remaining tooth root also evoked a response.

Jerge (1965) states that if the periodontal ligament is lost, not only is the support of the tooth lost, but the sensations arising from it are also lost. Jerge (1963) and Pfaffman (1939) found that the
periodontal receptors are particular in that they are directionally sensitive (that is, they respond particularly to pressure on teeth in one particular direction), but can also be stimulated if pressure is applied more heavily in other directions. The tissues surrounding teeth also have receptors supplying the same nerve bundle. Thus, according to Jerge (1965), the teeth have a whole array of receptors around them which can receive information about pressure stimulation from any direction. Also, the cell bodies of these neurones, according to Corbin and Harrison (1940), are located both in the mesencephalic trigeminal nucleus and in the gasserian ganglion, thus linking these sensations to the motor reflexes and to the higher centres of perception. Signals from these periodontal receptors thus may influence movements of the mandible by their influence on the trigeminal nucleus, as described by Ahlgren (1967), Sessle and Schmitt (1972) and Lund and Lamarre (1973). A root cap designed therefore, not to overload the periodontal innervation, but to encourage normal stimulation may help chewing performance.

Siirilä and Laine (1963) compared the tactile sensory perception of various teeth, and found that perception of material between the teeth was not appreciably greater from the anteriors to the molars and that anaesthesia had surprisingly little effect on the tactile sensation of teeth. Axial stress threshold, however, increases by 50-70% and lateral stress threshold doubles with the use of anaesthesia according to Adler (1947). Manly et al. (1952) found that in comparison between the sensitivity of patients with natural dentitions and full prostheses, the denture wearer is at a distinct disadvantage. Even though detection of very small particles can be detected by both cases, due to the vibration between the teeth, very small forces cannot be determined in complete denture wearers due to the distribution of the force through
the denture base. Larger forces used in mastication can more easily be
determined by complete denture wearers. However, tactile thresholds of
over 125 grams occurred for complete denture patients compared to an
average of 1 gram in the anterior teeth and 10 grams on posterior teeth
in natural dentitions.

Kawamura and Watanabe (1960) showed that, in general, patients
wearing tissue borne dentures could not discriminate vertical opening as
well as could those with "reduced teeth" and overlay dentures. Physio-
logically, the proprioceptors of the muscles and joints are capable of
making the necessary evaluations, but the instability of lower dentures
makes this ability poorer in edentulous patients. Perhaps stability in
the lower denture may be largely an operator variable. Visual input and
any other extraneous sensory input apparently modifies the patient's
ability greatly.

The more anteriorly situated the structure in the mouth the more
sensitive it becomes. Studies by Manly et al. (1952), Kawamura (1960)
and Grossman (1964), correlate the facts that lips, tongue tip, mucosa
and anterior teeth are all more sensitive. This may be related to the
patient's own physiological makeup as the anterior part of the mouth is
more related to appearance and more involved as a sensory warning area.
Sensory innervation around the teeth has an inhibitory effect on the
masticatory muscles by sending messages to prevent overloading of the
teeth according to Jerge (1965), Kawamura (1964 and 1967) and Edel and
Wills (1973).

Obviously roots associated with overlay dentures, if sound
periodontally, are of great value even without the innervation from the
pulp. Studies on perception of occlusal forces have been done in
relation to overdentures, but as pointed out by Crum (1975) this must be
related to the root cap and attachment design being used in conjunction
with the prosthesis.
2.3 **Other Factors:** Sensory and functional advantages are also combined with the psychological benefits entailed by the patient believing they are "keeping their teeth". Schabel (1972) discusses the psychology of the ageing process and the oral changes which occur for the geriatric patient with complete dentures. These include:

a) Degenerative mucosa
b) Loss of muscular tone resulting in facial collapse and angular chelitis
c) Alveolar resorption often to the extreme
d) Decreased vertical dimension
e) Enlargement of the tongue
f) Overall breakdown of the masticatory mechanism.

Schabel (1972) believes that these patients believe life has been a series of losses. By slowing down the process of tooth loss the aged patient may adapt better to the ageing process (Ingle and Traintor, 1985). Endodontic therapy may however be contraindicated in an aged patient. A young person would also benefit from the psychology of retaining teeth, previously thought to be unsaveable.

2.4 **The Advantages and Disadvantages:** Overall, Dodge (1973), Lord and Teel (1974) and Kotwal (1977) sum up the advantages of the overlay denture.

a) The enhanced stability due to resistance to lateral movement by the added height of bone.
b) Positive retention due to the height of the alveolar ridge and when a special attachment is used in conjunction with retained roots. This procedure is particularly valuable when retention could be a problem, as in cleft palate prostheses.
c) Proprioception from the periodontium is maintained providing
awareness of jaw position and protection against over-closure.

d) Vertical dimension can be maintained as long as any maxillary and
mandibular teeth are maintained.

e) Centric relation is more easily recorded if upper and lower teeth
roots are maintained. Even when crowns prevent centric relation being
achieved, this can later be achieved with overlay dentures.

f) Lip and face support can be achieved by placing the artificial
teeth in positive orientation to the natural dental arch. Alveolar
resorption, causing loss of support is less of a problem.

g) Gnathologic occlusion and cuspid protection of the occlusion may
be feasible due to the support and retention allowed by retained roots.

h) Psychological benefits to the patient who believes that he still
has some teeth.

i) Ability to masticate food is improved.

j) Post extraction comfort is more often obtained due to the support
from the remaining teeth or roots.

k) Positive support and comfort is possibly more achievable as
structures designed to resist occlusal forces are retained.

l) Ease of making measurements with the recording bases.

m) Lost advantage compared to fixed partial denture.

n) Minimal number of adjustment appointments.

o) Ease of cleaning abutments.

p) When overlaying a complete dentition a patient can easily revert
back to their original status.

q) Stabilizing existing structures can be achieved as little change
in bony morphology occurs around the retained teeth.

The Disadvantages:

a) Usually endodontic therapy is required.

b) Frequently the teeth need periodontal therapy and surgery.
c) Oral hygiene maintenance is very important.

d) Frequent recalls are necessary.

e) Patient motivation needs to be ideal.

f) The risk of recurrent caries necessitates the use of home care fluoride applications and meticulous oral hygiene.

g) The length of time needed for the preparatory phases for overlay denture construction, the added number of laboratory procedures and clinical procedures necessary.

h) The cost of materials and retention elements can often be very high.

2.5 **Indications and Contraindications**

Brewer (1975) believes the indications for overlay dentures are primarily when:

a) There is a poor prognosis for the complete denture, for example:
   
i) Height of the palatal vault makes retention difficult.
   
ii) When the mandible has a poorly defined sublingual space.
   
iii) When the maxilla needs pronounced vertical overlap for aesthetics.
   
iv) A unilateral case in the mandible to provide good function and aesthetics when a large amount of bone and soft tissue have been lost on the edentulous side of the arch.

b) When, because of the unfavourable crown/root ratio, the teeth may be of questionable value as abutments.

To these points Kotwal (1977) also adds that roots should be saved for full overlay dentures where:

c) The crown is carious but the root is intact.

d) Periodontally involved teeth which could not tolerate lateral forces after treatment but could tolerate axial forces remain.
For the ideal patient these indications would be valid. However to these points should be added:

e) The patient is willing and able to afford the time and cost of endodontic therapy, periodontal therapy, and restoration of the roots.
f) The patient understands the nature of the treatment.
g) Oral hygiene procedures are being satisfactorily performed and the periodontal condition of the teeth can be corrected.

Loiselle et al. (1972) suggest however that nearly 85% of patients in their study could maintain their oral hygiene requirements. This however does not indicate to what lengths patient education was carried out.

Contraindications for overlay dentures could therefore be listed:

a) When another method could yield superior results.
b) When a patient is not psychologically attuned to dentures or complete dentures.
c) When oral hygiene cannot be maintained.
d) When roots have an excessive undercut, e.g. the maxillary canine region (according to Kotwal, 1977, however, denture design may be modified to accommodate these roots).
e) In elderly patients when procedures may be too trying.
f) Where there is inadequate attached gingiva and mucoginvival surgery is not possible prior to the construction of the overlay denture.
CHAPTER 3

THE DEVELOPMENT OF ROOT CAP DESIGN

The concept of the root cap stemmed from removable partial denture designs utilising "telescopied crowns". The first reference to this is that of a telescopied crown patented by J.B. Beers in 1873.

Peeso in 1894 is said by Schweitzer et al. (1971) to have developed a system of removable bridgework supported by telescopic crowns. Essig described a root restoration very similar to present day overdenture gold copings in 1896. Telescoping gold crowns is a procedure which has fairly wide recognition now in precision partial denture design.

However, the concept of overlaying roots was not categorised until Prothero, in 1916, described the use of widely spaced teeth to support a whole denture base. He also described the "Gilmore attachment" and its use in combination with prostheses of this kind. Since that time, little reference was made in the literature until some European authors began to examine the advantages of this design. Authors such as Gerber (1951), Rehm (1952), Biaggi (1952), Dolder (1961) and Brill (1963) began to describe overlay dentures and their various attachment designs.

Fenner et al. (1956) empirically described, by use of models and tooth mobility studies, the effects of lateral forces by rigid compared to movable attachment to abutment teeth. Rehm (1952) described overlaying using a single front tooth to support the prosthesis. Biaggi (1952) and Löfberg (1953) also described methods of overlaying. Brill (1953) described the overlay as a "hybrid prosthesis" - an intermediary between a full and partial prosthesis. He describes their use
particularly for patients who have difficulty in obtaining retention in any other way; i.e. patients with xerostomia, macroglossia, cleft palate, patients with neurologic disturbances involving gagging elicited by dentures, bruxism, or other nervous habits where a partial denture would prove unsightly. Adaptation to full dentures is thus not as great a problem according to Brill (1953). If the teeth or tissues are overloaded they will not be able to adapt. Empirically Brill reasoned that the reaction to loading could be either degenerative or proliferative, thus if the loads on the tooth or root are within its tolerance, it will result in a proliferative response, which will increase the support of the denture. Decoronation should thus reduce the load to tolerable limits and allow cementoblasts to lay down new cementum, the periodontal fibres to organise and the lamina dura to be more calcified. If the tooth is not relieved of intolerable forces, adaptation will still occur resulting in increasing mobility. Leverage forces on the teeth are most easily reduced by the reduction of the crown/root ratio (see Fig. 3.1).

Empirical evaluation of force distribution to remaining teeth led some authors to the use of bar splinting of remaining teeth. Prince (1965) describes the rationale behind this thinking. He states that stresses involved with any prosthesis must be evaluated for the preservation of the supportive mechanism. Teeth with a poor prognosis, and weakened by periodontal bone loss, can be utilised if the loading which they can accommodate is evaluated and allowed for in the completed prosthesis. The residual ridge must be used for support if stresses to the teeth are to be minimised. In Prince's opinion, if periodontal breakdown and tooth mobility exists, this indicated bold changes in the oral environment to reverse this situation. In order to modify the forces to suit the tolerances of individual teeth, he believes that occlusal reorientation through repositioning, reshaping and provisional splinting may be necessary.
Fig. 3.1 - Left: Normal lever action between a clasp arm and a tooth.

Right: In a reduced clinical crown (the root cap) there are more favourable conditions.
It is true that, if a tooth has limited bony support, a lateral force applied further coronally would transfer greater stress than forces applied at a lower level. To this end, Prince (1965) described a method of round bar splinting between two crowned canines. The bar is attached in close proximity to the gingival margin to minimise the effects of lateral forces and the bar itself is round, giving an allowance for rotation of the clips around it. In this way Prince solves some problems associated with few remaining teeth, however the lateral forces of normal occlusion cannot be reduced in this manner and the teeth must also support the prosthesis.

A better system was described by Dolder initially in 1959 and later presented as a clinical study on 270 patients over a period of 8 years (1961). The Gilmore attachment described by Augsburger (1966) had been popular for a number of years, however Dolder was the first to discuss loading and tissue support for the prosthesis. Dolder describes his "bar joint" as providing retention of the denture base, whilst permitting the denture three degrees of freedom of movement. The articulation also hinders the destructive horizontal displacement of the denture and permits a partial load transmission onto the abutment system.

Miller in 1958 described a coping technique for complete dentures supported by natural teeth. Thin gold copings of 26 gauge were manufactured to cover the abutment teeth, which had been carved down to a thimble shape. Crown forms which fitted the thimble were then luted into the denture base. Thus the teeth were completely supporting the denture.

Morrow et al. (1969) describes a tooth supported overlay denture utilising a cast plate, with retention bubbles for the acrylic, which rests on cast gold copings over vital roots. Copings are prepared by reducing the abutments to allow sufficient space for an aesthetic artificial tooth and to improve the root/crown ratio. The preparations
are tapered towards the occlusal surface. Preiskel (1968) described the use of various precision attachments for use with overlay dentures, which have the effect of greatly increasing the retention and security for the patient. Many authors since that time have described techniques and attachments involved with overlay denture construction including Brewer (1973), Dodge (1973), Berger and Baskas (1974), and Lord and Teel (1974). Brewer and Morrow (1975a) describe many aspects of overlay denture design, methodology and rationale. Other authors have described various attachment usage with overlay dentures including, in 1974, Quinlivan's custom made precision attachment, bar joint overlays from Dolder (1961), Berger and Baskas (1974) and Marquardt (1976), supra-radicular attachments and intraradicular attachments described by Feldstein and Tertel (1976), Mascola (1976) and Jagger (1978).

Later authors such as Zamikoff (1973), Taylor et al. (1976a and b) and Defranco (1977) have suggested the use of more temporary restorative procedures for the root faces. The Zest and Mini-zest attachments\(^1\) are intraradicular attachments which are used in conjunction with a standardised diamond drill. Immediate placement in a decoronated tooth is possible, however, adequate coverage of the entire root face is not possible.

Research into attachment fixation by Gillings (1977) has led to the concept of magnetic fixation of overlay dentures. Ferritic metal root caps allow the retention and restoration of the root face.

Taylor et al. (1976a, b) describe the use of treatment dentures as a step towards overlay denture fabrication. Formulated along the same lines as Pound's "branching technique" of denture construction (1963), treatment dentures are constructed to restore function,

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aesthetics, lost vertical dimension, posterior occlusal contact and to re-establish the basic neuromuscular reflexes of the masticatory system. Old dentures can be modified by relining, adding teeth and converting the posterior teeth to a flat occlusal plane, or new dentures can be manufactured allowing the patient a period of grace between initial diagnosis and when healing of extraction sites and correct function can be established. According to Fenton (1976), unwanted teeth can be immediately replaced even using the original teeth for aesthetics. Initially the denture is a simple partial denture encompassing the remaining teeth, which is then modified gradually as endodontic procedures are carried out, and new teeth are added to the denture as the teeth are decoronated. While the patient wears this denture, the teeth can be assessed as to what type of restoration is most suitable. The patient's general attitude, oral hygiene and dexterity can be assessed and emphasised. This procedure provides the operator with valuable time in which to make these decisions.
CHAPTER 4

OVERDENTURE THERAPY - THE IMPORTANCE OF CASE SELECTION

The uses to which overlay dentures can be put are numerous, particularly when we are considering the restoration of the final few teeth in the arch.

However, overlay denture therapy must be generally divided into three broad categories:

4.1 The treatment of a deficient masticatory apparatus due to developmental causes.

4.2 The treatment of deficient mastic apparatus due to attritional damage.

4.3 The treatment of a different masticatory apparatus that has been initially healthy but has progressed to this point due to periodontal or carious causes.

4.4 Lack of loss of tooth structure and consequent loss of facial contour and vertical dimension of occlusion is commonly a factor in developmental and congenital diseases. These disturbances include:

4.1.1 Microdontia

4.1.2 Dentinogenises Imperfecta

4.1.3 Amelogenesis Imperfecta

4.1.4 Oligodontia

4.1.5 Enamel and Dentine Aplasia

4.1.6 Cleft Palate

4.1.7 Micrognathia

4.1.8 Cleiodocranial Dysostosis

4.1.9 Osteopetrosis
THE TREATMENT OF Oligodontia

Figure 4.1 Case suitable for overlay prosthesis.
Figures 4.2 and 4.3  Treatment of oligodontia with an overlay prosthesis.
4.1.1 **Microdontia:** Overlay dentures may be considered in cases of generalised microdontia described by Schafer et al. (1966) where many of the teeth are smaller than normal. This occurs very rarely, except in some cases of pituitary dwarfism. "Relative generalised microdontia" is more common and is due to inherited characteristics of jaw and teeth sizes.

4.1.2 **Dentinogenesis Imperfecta:** (hereditary opalescent dentin) - a common hereditary characteristic seen in equal frequency in both males and females. In this disease the enamel may be lost soon after eruption of the primary and permanent teeth, and once this happens the dentin undergoes rapid attrition. Koenig and Taylor (1973) and Gibbard (1974) describe the management of children and adolescents suffering from dentinogenesis imperfecta with the use of fluoride and education to rehabilitate the mouths of these patients.

4.1.3 **Amelogenesis Imperfecta:** The agenesis or hypoplasia of the enamel in this disease often is associated with attrition and extensive deposition of secondary dentin in these teeth with basically normal dentin according to Schafer et al. (1966). In severe cases of attrition, overlay dentures could be considered but normal treatment involves the build up of individual teeth as described by Gibbard (1974).

4.1.4 **Oligodontia** (partial Anodontia): see Figure 4.1. Total true anodontia is a very rare condition usually associated with ectodermal dysplasia. Partial anodontia which is severe, predisposes to a lack of growth of the alveolar process according to McDonald (1969), but in ectodermal dysplasia the skeletal development is often normal. The condition is most often seen in boys, and the primary molars have an unexplained tendency to become ankylosed. Defranco (1977) describes the treatment with overdentures of a partial anodontia case, as being a
reasonable, relatively fast and inexpensive mode of treatment. See Figure 4.2 and Figure 4.3.

In ectodermal dysplasias the anterior primary teeth in particular are typically conically shaped, facilitating overdenture manufacture.

4.1.5 Enamel and Dentin Aplasia: - according to Schafer et al. (1966) a rare condition in teeth characterised by atypical enamel and dentin - resulting in severe attrition and eventual pulp exposure due to lack of secondary dentin formation. As with dentinogenesis imperfecta, this condition could be suitable for overlay denture restoration with protection of the large pulp chambers.

4.1.6 Cleft Palate: This condition is sometimes very suited to treatment by overdenture prosthetics. When early surgical intervention has not been carried out, therapy to utilise malplaced teeth can often be best achieved with an overlay. Retentive coping designs provide protection and stability to cases which could prove otherwise impossible as a full denture case. Prince (1965) and Brabant and Brogan (1975) describe well the methods of restoration of cleft palate cases using overdenture designs.

4.1.7 Micrognathia: Overdenture therapy in these cases applies particularly well to the maxilla in Class III malocclusion cases where some lack of vertical dimension is associated. This situation may be due to a simple basal skeletal problem, or may have been exacerbated by surgery, as in the case of cleft palate, malignancy etc., or by lack of teeth - due to neglect and developmental factors. Brill (1953) describes a case of maxillary micrognathia treated by overdenture therapy.

4.1.8 Cleidocranial Dysostosis: This rare congenital syndrome is
characterised by the absence of clavicles, large fontanels and small frontal sinuses. Dentally, the teeth have markedly delayed eruption, delayed resorption of the deciduous teeth and often the presence of supernumerary teeth. Treatment has been often relegated to the extraction of all erupted and unerupted teeth, and the construction of full dentures. However, a number of writers (Weintraub and Yalisove, 1978, Hitchin and Fairley, 1974 and Kelly and Nakamoto, 1974) have described the use of overlay dentures to treat this problem.

4.1.9 Osteopetrosis (Marble bone disease): - another rare hereditary disease characterised by sclerotic bone throughout the body. As the bone is sclerotic, teeth eruption is retarded. Also, the possibility of osteomyelitis and fracture of the jaw are common with extractions of teeth, due to the nature of the bone. Woodward, Smith and Beck (1976) describe the use of overlay denture therapy in one of these cases.

4.2 Treatment of Deficient Masticatory Apparatus due to Acquired Defects

This involves treatment in a similar manner to the previous course in that often these patients have not necessarily had a history of dental neglect. However, in many cases this manner of treatment is required as a result of accidents, disease or misuse. In cases of severely abraded or eroded teeth, strict attention must be paid to the establishment of acceptable and correct vertical dimensions and occlusion. Severe attrition can occur at a rate faster than the eruption of the teeth and alveolar process, in which case loss of vertical height of occlusion is apparent. Brewer (1975) and Licht and Levertton (1980) describe the use of overdentures in the treatment of severe attrition.
4.3 The Treatment of a Deficient Masticatory Apparatus due to Neglect or Dental Disease

Loss of teeth through carious and periodontal causes over a long period eventually leads to a situation usually culminating in the extraction of all remaining teeth and the construction of full dentures. This is the most common area where overdenture therapy can be of value. Many authors including Morrow et al. (1969), Loiselle et al. (1972), Dodge (1973), Goerig (1974), Johnson et al. (1974), Lord and Teel (1974), Smith (1974), Brewer and Morrow (1975a), Taylor et al. (1976) and Kotwal (1977), describe overlay dentures as an alternative to complete tooth loss. Some authors such as Goerig (1974), Fenton (1976), Feldstein and Teitel (1976) and Parel (1983), may see the retained roots as a transitional phase whereby the patient can develop the skills of denture function before complete dentures are necessary. Most others see the overdenture as eventually utilising the roots as permanent structures functioning as a means of bone stabilisation or for denture retention and support. The long term viability of all these restorations depends on the patient's own maintenance of these roots. When oral hygiene and motivation are lacking, particularly in young individuals, submergence of the roots, either vital, as described by Levin et al. (1974), Whitaker and Shankle (1974), Reitz et al. (1977), Gound et al. (1978), Welker et al. (1978) and Delivans (1980), or non vital root submergence as described by Levin et al. (1974), Simon and Kimura (1974) and Welker et al. (1978) or by reimplantation of extracted, trimmed roots (Maurer, 1973) has been considered.

Morrow et al. (1969) suggests that tooth supported dentures be used if four or less retainable teeth are left in the dental arch. Some authors, for example Maurer (1973) describes a case with somewhat more abutments.
CHAPTER 5

TREATMENT PLANNING

Obviously treatment planning before overlay dentures are attempted is of the utmost importance. Pound (1963) suggests that before immediate dentures are made that "every effort should be made to preserve teeth that can be kept healthy and made useful". Certainly it is known that six lower anterior teeth remaining does not now necessitate complete denture construction. However, it is true that in many cases, particularly when there is periodontal breakdown, the teeth may be equally unsatisfactory in their present state to support a partial denture or fixed prosthesis (Defranco, 1977). Writers such as Prince (1965) believe that treatment plans involving crowns and splinting techniques provide the answer for "limited" abutments. However, the load must be evaluated so that stress on remaining teeth is consistent with their ability to bear it. Miller (1958) did note that in the case of tooth supported dentures the teeth he used "are subject to greater stresses than that for which the root structure and supporting tissues are intended and the odds against them remaining healthy is great; but in spite of the additional load, many are successfully serving as supports for denture prosthesis". "Many teeth which had a poor prognosis, outlived their estimated life expectancy for long periods of time".

Treatment planning must be based on thorough history taking and examination. Prosthesis design and eventual root cap design are closely associated with these factors and the patient's needs.
5.1 **The History**

5.1.1 **Medical History:** Patients with problems of a medical nature can either preclude or necessitate retention of roots. With a part medical history of haemorrhagic diseases, anaemia, blood dyscrasias, drug therapy, cardiac disease and rheumatic fever, alternatives to exodontia may be considered. Psychiatric and emotional data is useful before construction of any prosthesis particularly in the maintenance of an overlay denture. According to Reitz et al. (1977) age of the patient generally has an effect on their ability to accept a new prosthesis of any kind unless they are sufficiently motivated and their needs are well understood.

5.1.2 **Dental History:** Previous dental history gives an insight into the likely success or failure of a future prosthesis. Expectations that are higher than those which are achievable can be a problem according to Morrow and Brewer (1975). A record of previous care and motivation is essential in order that a change in the course of the disease process may be halted.

5.2 **Examination**

Thorough facial and intra-oral examination is essential when any prosthetic appliance is contemplated as described by Morrow and Brewer (1975) and Robbins (1981).

5.2.1 **Facial:** The function of lips and facial tissues, the movement of the jaw in speech, the appearance and shade of the teeth must all be noted. Evidence of disease or age in the fact is important in detecting underlying general disease or nutritional deficiency and active or chronic infection in the head and neck region. Angular cheilitis may be indicative of loss of vertical dimension. Maxillary sinus infection may
be indicated by redness and tenderness over the cheek and canine fossa and nasal discharge. Lymph nodes may be swollen. Extra-oral examination may also include palpation of head and neck muscles and the areas over the temporomandibular joints to establish the possible effects of the oral condition on the muscular apparatus.

5.2.2 Intra-oral Examination

(a) Peripheral Tissues:

(i) The mucous membrane should be checked for abnormality or active disease process.

(ii) Tongue movements are important. Limitation may mean disease or neoplasia. Overdevelopment may mean active tongue habits or growth into teeth space.

(iii) The tonsils and pharynx should be checked.

(iv) Salivary glands - overdevelopment of sublingual glands is often a problem.

(b) The Remaining Teeth and their Supporting Tissues

(i) Accurate charting of the dental status is extremely important. The number of teeth remaining, their position, the presence of caries (either root caries or coronal caries giving an idea of caries susceptibility). Morrow and Brewer (1975) state that rampant caries may be a negative factor in the success of overdentures. However these patients may have ideal bone structure and support, particularly if they are young patients. Oral hygiene instruction and extra care may be necessary. The presence of defective restorations, and the vitality of each tooth must be noted. The presence of attritional, erosive or
abrasive defects or any tooth fracture, give an indication as to the masticatory stresses involved. The periodontium must also be examined and charted accurately. The success or failure of this form of treatment depends greatly on the supporting tissues. The presence of gingival inflammation, the presence and depth of pockets, the amount of calculus both supra and sub-gingival, the amount of the recession, the gingival contour, the presence and degree of mobility, furcation involvements, presence and degree of overeruption and migration of the teeth and height of attached gingiva all have a significant effect on the treatment plan according to Jenson (1975), Jumber (1981) and Robbins (1981). Teeth may need extensive preparatory work to be viable abutments to any prosthesis. If a tooth or teeth are not able to be maintained in a healthy state, it is far better that they be dealt with early in the treatment. The patient's oral hygiene progress must also be assessed, both past and present, in order that on-going progress towards maintenance of the remaining teeth and prosthesis can later be established.

(c) Saddles and Peripheral Tissues

The adequacy of the supporting tissues plays a key factor. The size and length of the saddles which may provide support for the prosthesis, the height, cross sectional area and shape of the ridges are all important. Knife edge ridges may not provide satisfactory support. Exostoses may cause a fulcrum effect. The health and quality of the mucoperiosteum must be assessed through digital and visual examination. The presence of inflamed,
ulcerated or hyperplastic tissue is useful in assessing the response to the previous denture base. Lateral mobility tests of the mucoperiosteum gives valuable information as to the stress bearing ability of the tissues. Identification of severely undercut areas of denture base, for example maxillary tuberosity and canine eminence may complicate overdenture therapy, requiring surgical intervention or some modification of flange design. Frenal attachments should be noted and assessed for their function and displacing potential. Sulcus depth is important to note in regard to denture support area. Some idea of the rate of bony resorption may also be assessed. Functional movements may have a marked effect on sulcus depth and therefore the range of function normally used by the patient should be assessed.

(d) **Radiographic Examination**

This is extremely important as a source of information about all hard tissues. Bony contour and character can be assessed. Density of alveolar bone may indicate the rate of resorption after extractions and thus will influence the type of denture made. Reitz (1977) believes poor quality bone in a young patient may necessitate more advanced restorative procedures to prevent the early need for complete dentures. Radiographs also play a major role in abutment selection as described by Morrow and Brewer (1975). The bony support available for a prospective abutment must be known, also an assessment of the presence of any pathology, width of lamina dura and periodontal ligament, carious lesions, crown/root ratios, root canal morphology, and the presence of any retained roots and impacted teeth is of utmost importance.
(e) **Maxillo Mandibular Relationships**

Although an overlay denture may allow some leeway in tooth placement it still must follow many of the basic precepts of denture design. Diagnostic casts are useful in establishing the relationships of the ridges, the presence of deceptive occlusal contacts into intercuspal position. Preliminary occlusal adjustment may be necessary to stabilise the occlusal pattern before a prosthesis is made. Eccentric jaw positions, and evidence of parafunction is also useful. An assessment of vertical dimension of occlusion should also be made including the amount of interarch space which remains. Overerupted and migrated teeth, and tuberosity impingement should be noted. Variations in the relative sizes of the jaws should also be noted. Undesirable leverage between the prostheses may result if certain key teeth are removed, for example: Class III occlusions where a small maxilla opposed by a large mandible presents mechanical and aesthetic difficulties in complete dentures or inversely severe Class II occlusion where extraction of lower anterior teeth leaves no support for the mandibular full dentures and lack of firm occlusion as stated by Delivans et al. (1980).
SECTION 2

RETAINED ROOTS – THE ALTERNATIVES IN THEIR RESTORATION
CHAPTER 6

SUBMERGED ROOTS

The methods of retaining roots for use as overlay denture abutments are very diverse. They have been divided into definite groupings as described by Kotwal (1977) as follows.

1. Vital or endodontically treated roots, submerged under the mucosa.
2. Vital tooth root or teeth with no coverage.
3. Vital tooth root with coverage.
4. Endodontically treated tooth root with plug restoration.
5. Endodontically treated tooth root with coverage.
6. Endodontically treated tooth root with coverage plus a retentive device.
7. Endodontically treated teeth with retentive devices not associated with coverage.

Following research into mucosal coverage of vital roots in dogs by Poe et al. (1971), combined with observations by Herd (1973) that retained roots generally displayed no abnormalities, the way was opened for root submergence in man. Guyer (1975) suggests that root submergence may be indicated for the patient who has a history of poor oral hygiene. Continuance of this condition after several prophylaxes and oral hygiene instruction with a return of heavy plaque deposits and calculus formation may leave only this alternative. Other forms of treatment are obviously susceptible to failure.

The advantages in this form of treatment lie in the bony support which is maintained which provides stabilisation areas for the
prosthesis. It is particularly useful where rapid bone loss has already been demonstrated elsewhere in the mouth. A number of cases have since been reported which can generally be divided into three broad methods of submergence.

6.1 Methods of Root Submergence

i) Mucosal coverage of vital tooth roots as described by several authors including Welker et al. (1978), Garver et al. (1978), Garver et al. (1979) and Garver and Fenster (1980) being histologically confirmed by Herd in 1973, Johnson et al. (1974) and Whitaker et al. (1974) showing that the roots form a non-functioning type of periodontal membrane, attached to a cellular cementum which gradually extends into the pulp chamber, changing its morphology and causing progressive closure of the root canal by osteodentine. Garver and Fenster (1980) believe success is only assured with absolutely normal pulpal tissue. Any negative pulpal findings indicate a need for alternative methods of tooth retention other than vital root retention.

ii) Mucosal coverage of endodontically treated tooth roots. This method has been described by a number of authors including Goska and Vandrak (1972), Levin et al. (1974) and Thompson and Bowles (1980) on the principle that it is better that the pulp tissue doesn't play a part in the success or failure of the procedure.

iii) Reimplantation and mucosal coverage of extracted endodontically treated roots. This is advocated by two authors (Simon and Kimura, 1974, and Gound et al., 1978) in order to induce ankylosis of root to bone preventing the eruption of the submerged root.
Problems involved with submergence of roots can be overcome by treatment planning and adequate preparatory procedures.

6.2 Considerations in Root Submergence

As described by Delivans et al. (1980), considerations in tooth selection should be:

i) The tooth should have a small occlusal table due to difficulty of flap coverage.

ii) Adjacent teeth should not be present as intact bone around the tooth aids healing.

iii) Adequate thickness of cortical buccal plate over the retained roots. Buccal eruption has been described by this author and also by Simon et al. (1974). Dehissences may however be due to sharp root edges, abnormal denture pressures from ill fitting denture bases, or inadequately balanced occlusion according to Delivans et al. (1980) and Garver and Fenster (1980). Other bone resorptive factors may also play a role in determining root retention submucosally: disuse atrophy, ageing, intermittent pressure, organic disease, nutritional deficiencies and the effect of poor plaque control on denture surfaces, as discussed by Penhall in 1980.

iv) Teeth should not have severe undercuts to enable adequate peripheral contour of the denture.

v) Teeth should be adjacent to a wide zone of attached gingiva and a deep vestibule. Lack of height, of both the attached gingiva and the vestibule (quoted at 2-3 mm) may require pedicle and flap closure according to Welker et al. (1978) to reduce this tendency and provide less chance of early root exposure.

vi) Bilateral symmetry should be attempted for denture stability.
6.3 **Preparatory Procedures**

Garver et al. (1980) describe the necessity to establish pulpal health prior to vital root submergence. Also, in general, periodontal preparation before coverage is essential. Subgingival curettage and root planing should be performed prior to coverage as calculus "tags" may retard the regeneration potential of the periodontal tissues in infrabony defects according to Cook et al. (1977).

6.4 **Sequelae**

Long term results of these studies are not yet available, however Garver and Fenster suggest a "flow chart" of treatment for a condemned tooth. A number of alternative treatments may be possible before tooth loss is necessary. These may include endodontics for a failed vital buried root, surgical reburial, or even use as a normal overdenture abutment if the soft tissue covering the root breaks down. Another alternative has been suggested by Thompson et al. (1980): that of submergence of an endodontically treated root with a stainless steel insert cemented in the reduced root face. After healing, a threaded post is screwed into the stainless insert through an incision. This post is then used in a similar fashion to an implant for prosthesis support and, it is claimed, has an ideal attachment to the tissues.
CHAPTER 7
DESIGNS INVOLVING VITAL ROOTS

7.1 Overlying Vital Roots With No Dentinal Coverage

7.1.1 Indications

This procedure is particularly indicated when the existing dentition is deficient in vertical dimension due to:

a) Abrasion or attrition of the dentition which exceeds the rate of eruption.

b) Congenital and acquired defects of the dentition that is either badly aligned or too small, the dentition that is abraded or eroded due to some lack in its formation, or the dentition which retains a number of deciduous teeth due to lack of replacement by their permanent successors.

As has already been outlined these characteristics can occur in cases of

i) Cleft palate

ii) Oligodontia (see Figures 4.1, 4.2 and 4.3).

iii) Microdontia

iv) Cleidocranial dysostosis

v) Occasionally in cases of micrognathic maxillae.

(see Figure 1)

However, this type of restoration is contraindicated in cases of delayed eruption, e.g. ankylosis, hypothyroidism (cretinism), mongolism, juvenile myxedema, and hypopituitarism.
7.1.2 Preparation

In many of these cases aesthetics and function can be achieved readily and with minimal preparation. Preparation should include:

i) Demonstration that the patient can maintain ideal oral hygiene procedures and the periodontal status is optimum.

ii) A check made to ascertain that a sound layer of secondary dentine exists over healthy pulpal tissue with no inflammatory hypersensitivity problems.

iii) Prior to final impressions the teeth to be overlaid are minimally contoured to remove any sharp projections which may interfere with denture construction, polished and subsequently treated with a high concentration fluoride preparation.

iv) Home maintenance procedures are essential including oral hygiene instruction and weekly applications of topical fluoride gels, using the denture as a vehicle for its application.

7.1.3 Considerations

Consideration must be given to the probable effects of leaving the dentine tubules of these teeth unprotected, particularly in cases of severe abrasion. Sicher and Bhaskar (1972) recommend that the tubules of exposed dentine should not be exposed to any noxious stimuli. Insults by strong drugs, undue operative trauma, unnecessary thermal change or irritating filling materials on freshly exposed dentine surfaces, which contain approximately 30,000 odontoblastic processes per mm$^2$ of reparative dentine, as well as inflammation, may even lead to the total destruction of the pulp.

Carious penetration into dentine can be rapid due to its highly organic component, spreading along the dentinal tubules and invading bacteria may reach the pulp even through a thick dentinal layer.
However, the ageing process alters this situation due to the changed nature of the dentinal tissue. Changes that occur can be listed as:

i) Formation of reparative dentine

ii) Formation of sclerotic dentine (transparent)

iii) Formation of dead tracts which are sealed from below by reparative dentine as outlined by Sicher and Bhaskar (1972).

i) **Reparative Dentine:** Severe damage to the odontoblastic processes through extensive wear, erosion, caries or operative procedures may cause death of the odontoblasts. Subsequently, undifferentiated cells from deeper layers migrate to the dentinal surface and begin to lay down hard tissue or reparative dentine to seal off the injured area. Due to its rapid formation the tubules are twisted, their number greatly reduced and the dentine contains cells bound up in the matrix as it is formed. Reparative dentine is frequently separated from primary or secondary dentine by a deeply staining layer.

ii) **Transparent (Sclerotic) Dentine:** Sclerotic change in the dentine is characterised by the deposition of calcium salts in and around degenerating odontoblastic processes which may obliterate the tubules. The refractive indices of the affected dentine are equalised rendering these areas transparent in ground sections. The phenomenon occurs commonly around enamel lamellae that extend into dentine, underneath slowly progressing caries or on root dentine due to age change which begins at the apex and works coronally, as described by Nalbandian et al. (1960). Tubule occlusion, whether it be caused by mechanical introduction of debris as in cavity preparation, resin impregnation (Brännström et al., 1979), or other drug effects (Pashley et al., 1978 and Johnson and Brännström, 1974) have been shown to affect both the
permeability of dentine and in most cases the sensitivity of dentine. Sclerotic dentine thus can also be considered to be a defensive action by the tooth, which makes the tooth surface both denser and harder than normal dentine as well as cutting down the permeation of irritants into the pulp.

iii) Dead Tracts: Dead tracts in teeth are dentinal tubules which contain disintegrated odontoblastic processes which have died due to such injuries as caries, attrition, abrasion, cavity preparation or erosion. Reparative dentine seals these tracts at their pulpal end. Sensitivity in the areas characterised by dead tracts is obviously diminished. The colour of the tubules in ground sections appears black in transmitted light and white in reflected light.

7.1.4 Criteria for Selection

Criteria for selection of an abutment as being suitable for use as an overlay denture abutment without protective coverage of dentine depends obviously on a number of factors:

i) Careful history taking to establish the rate at which wear or erosion has occurred.

ii) Careful examination to establish the type of dentine which is present, its hardness, and sensitivity to mechanical and thermal stimuli.

iii) Radiographic examination to confirm pulpal vitality and proximity of pulp chamber to the surface.

Consideration must be given as to the future practicality of endodontics if it is envisaged at a future time. As time passes, a canal demonstrating a degree of occlusion would be expected to
continue this trend, making endodontics more and more difficult. Eventual utilisation of the tooth root must be considered.

iv) Patient assessment of their ability to maintain a healthy caries free root surface by the use of correct oral hygiene measures and chemical adjunctive treatments. Any doubt about the ability of the vital exposed dentine to remain vital and caries free necessitates either protection of the exposed dentinal surface or intentional devitalisation and root canal therapy of the abutment.

7.2 Overlying Vital Roots with Coverage of Exposed Dentine

7.1.2 Indications

In situations where passive retention of a vital root underneath a denture is desired it is frequently necessary to cover the exposed dentine with a metal coping of gold. Cementation of the metal coping provides protection against further erosion, abrasion or wear and against diffusion of irritants to the pulp and against carious attack into the dentine. It is definitely necessary to cover the dentine in all cases where:

i) The pulp is in close proximity to the root face.

ii) There is not adequate thickness of reparative or sclerotic dentine.

iii) The root face has needed more than minimal preparation to produce correct shape.

iv) The surface of the root face needs additional contours due to caries or hollowing.

v) Any sign of change occurs in the uncovered root face, indicating the inadequacy of an uncovered root face.
Adequate protection of pulps which are close to the surface can be achieved by adequate coverage with a suitable protective base, for example zinc oxide and eugenol or calcium hydroxide bases.

7.2.2 Considerations

A considerable variety exists in the shape of copings for vital teeth mainly due to the varied conditions of the teeth remaining to be overlaid. Factors to be considered include:

i) The degree of tooth structure lost.

ii) The amount of vertical height determined by the plane of occlusion and the vertical dimension.

iii) The width determined by the artificial tooth contour and flange shape.

iv) The necessity to provide retention and stabilisation for the overlying denture.

v) The necessity for the removal of undercuts in the coping.

vi) The necessity to reduce torquing forces on the tooth root.

vii) The amount of remaining bony support around the abutments and the root/crown ratio.

viii) The number of remaining usable abutments.

ix) The opposing dentition.

x) The necessity for attachment utilisation.

7.2.3 Coping Designs

Coping design on vital teeth depends on a combination of all these factors. Broadly, the designs can be divided into four categories as defined by Jumber (1981a).

a. Short coping design 1-2mm above the gingiva

b. Medium - short coping design 3-4mm above the gingiva

c. Medium coping design 4-6mm above the gingiva

d. Long coping design.
Figure 7.1  Medium-Short Copings to Restore Lower Anteriors

Figure 7.2  Medium-Short Copings 6 Years Later (note vertical abrasion resulting from denture loading)
Generally long or medium copings may be used on vital teeth depending on pulpal position. In cases of naturally worn dentition the medium-short or even short copings may be used. It is also common for short abutments to become longer after periodontal resolution. In adults the height of the coping can often be low due to pulpal recession. Short coping and medium-short coping designs for vital teeth can be grouped together.

A & B Short and Medium-Short Coping Design on Vital Roots (see Figures 7.1 and 7.2): Badly abraded vital teeth that have worn down, through attrition, abrasion, erosion, caries or fracture so they are virtually a root stump may utilise the short coping in some cases. The coping may resemble an endodontically treated design, however the underlying preparation must be different. Retention for the copings is usually necessary through the use of pins straddling the pulp. Attachment utilisation is usually not possible in vital preparations due to the limited amount of retention of the coping available.

Preparation: After periodontal resolution the axial walls must be prepared to provide maximum retention without undercut areas. A chamfer margin is necessary parallel to the gingival margin (ref. chapter on Periodontal considerations). Consideration should be made to the contour of the preparation in relation to final tooth placement. Flattening of the labial root face area may be necessary to allow room for the coping and overlaying teeth. Generally, it is best to follow the contour of the ridge. Retentive surfaces can often be achieved on proximal and lingual areas of the tooth root if extensive bone loss has occurred in these areas. After contouring has been completed, pin preparations (either parallel or tapered pin) can be utilised to
provide added retention and localisation of the coping. Short-medium coping height may have enough axial height to not require pin retention but auxiliary retention is usually recommended. Final smoothing is achieved with discing and fine finishing diamonds and burs.

The shape of the coping as suggested by authors including Brewer (1973), Morrow (1975a), Frantz (1975), Brabant and Brogan (1975) and Mascola (1976) is that of a short rounded dome which covers all exposed dentine with a minimum thickness of gold. Brewer (1973) suggests the thickness to be at least 1mm as he has experienced wear through copings under acrylic based dentures. Bruxism may still occur when the dentures are not worn so protection of the remaining root structure is essential in these cases. The dome shape of the coping is suggested to allow axial loading only to occur on the remaining root, according to Morrow (1975a) and Jumber (1981b) and also to allow easy positioning of the artificial tooth. On vital roots short copings must also be constructed to preserve periodontal health. Excessive undercuts should not exist otherwise gingival proliferation may occur. Jumber (1981b) also describes coping shape for periodontal, aesthetic, stability, support and retention factors. When copings are connected, close copings should have a connector which is slightly higher interproximally to allow good embrasures, whilst copings that are further apart should be connected with a short strut-like bar in contact with the gingival tissues along its length. Aesthetic coping design involves restricting the bulkiness of the coping, particularly in the upper anterior region. Short copings should closely follow the anterior alveolar ridge. The dome-like contour primarily provides support
Figure 7.3: Miller's Tooth Supported Denture Design Using Vital Teeth
in short coping designs and also some stability in medium-short
coping design where there exists 2-4mm height and some vertical
bracing surfaces. Short and medium-short copings provide by
their size very little actual retention.

C & D Medium and Long Coping Design

Telescopic crowns have been described since 1873 by J.B. Beers.
Miller (1958) described a method of denture support using vital
teeth, reduced in height to improve the root/crown ratio so they
could be used for overdenture support. The technique described
showed thin gold copings manufactured over teeth which have a
round coronal portion and a rather large shoulder (see Figure
7.3).

The gold copings are cemented, then a gold thimble is fitted to
overlay this thimble. Adequate shoulder preparation is necessary
to allow veneer thickness on the thimble. The design is not
greatly different from the telescopic denture designs of
Schweitzer et al. (1971) describing tooth supported overlay
dentures. Advantages in the use of telescopic denture design
have been described by a number of authors where the denture
becomes a rigidly fixed, tooth borne partial denture. Retention
of the denture can be achieved by milled channels, retention
studs or parallel surfaces. Lack of vertical dimension and
accommodation for the pulp limits the use of this technique on
vital and even non-vital teeth due to the need for longer
parallel surfaces to provide retention.

Yalisove (1966) described the "crown and sleeve" coping which
follows along the same lines as described by Miller for partial
prostheses. A machined secondary casting is provided with a space in
Figure 7.4: Yalisove's "Self-Releasing" Crown and Sleeve-Coping Retainer
the gingival two thirds to allow movement "due to the yield of the
periosteum". In fact many of Yalisove's designs resemble "long coping"
full overlay dentures. The more space allowed for torquing forces
adjacent to the gingival margin the less retention gained by the
parallel nature of the copings. These are described by Yalisove as
"self releasing" (see Figure 7.4) However, as pointed out by Prieskel
(1968), the more allowance made for movement increases the risk of
gingival damage or proliferation.

Zamikoff (1973) also described a "long coping" overdenture. He
states that, because the root to crown ratio of the overdenture is only
minimally improved there is the certain result that the stability of the
lower prosthesis is greatly improved due to the resistance to lateral
forces. However for this to be successful there are two points to be
taken into consideration:

1. The teeth need to be very well supported in bone.
2. Single or even two abutments may receive stresses that exceed
   physiological limits.

Zamikoff believes that long copings under overlay dentures are fraught
with possible problems for the patient. Artificial tooth placement with
this method is also a problem.

Preparation: The coping preparation over a vital tooth must follow the
guidelines of crown preparation on a short tooth. Protection for the
pulpal tissue must be of key importance. Preparation into the abraded
dentine may not be necessary in cases of abraded teeth. Retention of
the casting may be provided by retention pins which are placed to
straddle the pulp to prevent pulpal damage from thermal stimulation. In
overlay cases where there is not sufficient height pulpal protection
with tubuli sealants or non irritant cements may be considered.
Endodontics may be the method of choice where necessary to provide adequate space and sufficient retention for the root cap. Langer (1981) describes the use of the long coping or vital coping overdentures where fixed restoration is impracticable, i.e. insufficient teeth to support a fixed prosthesis, shortness of root length due to previous periodontal breakdown, where a fixed prosthesis with separate interconnected parts is impracticable or where the alignment of teeth for fixed prosthetic work is a problem. This type of treatment has only been considered by Langer when there are sufficient teeth to allow rigid support by the teeth to the removable prosthesis. The copings can be prepared with differing paths of insertion to the final prosthesis, in order to avoid sacrificing excessive tooth structure and possibly the vitality of the teeth.

Jumber (1981c) describes well the method of preparation for vital long coping or medium coping designs. Two types of preparation are described:

i) When the acrylic denture base will sit directly over the primary coping.

ii) When a metal or porcelain to metal secondary coping will telescope over the primary coping.

i) Preparation for coverage by acrylic resin involves

a) Reduction of the clinical crown as far as possible apically without exposure of the pulp.

b) Reduction of the tooth to form a definite taper particularly on the labial aspect to allow aesthetic denture setup.

c) Proximal preparation in the gingival half of the tooth crown to be approximately parallel whilst the occlusal half is tapered.
d) A chamfer or feather edge preparation with slight bevel marginally.

Coping design for this preparation should once again be taken into account - periodontal health, aesthetics, stability and support, retention and possibly its use with auxiliary attachments. Periodontal architecture must be maintained and this can more easily be achieved by long copings if they are well tapered to eliminate excessive undercuts. When splinting embrasures can be normally achieved when copings are close together, sitting away from the ridge when they are further apart or lightly contacting the tissues if connected by a bar.

Aesthetic design for long copings requires room on the labial for tooth placement and the conical shape of the long copings also provided stability and support. Retention in long coping designs can be provided by frictional resistance from the proximal walls, particularly in the gingival third. Parallelism to other copings in the area also provides retention. The amount of retention depends greatly on the amount of load the abutments are likely to withstand. The less the number of abutments and the less their bony support, the more the trend towards the self releasing design of Yalisove (1966). Jumber (1981a) describes three functional mechanisms of telescopic dentures.

i) Rigid design

ii) Resilient design

iii) Stress-broken design.

i) Rigid design is used if there are numerous abutments giving tripodisation or these abutments oppose a full or resilient prosthesis. Here forces are directed to the mucosa only to the degree that the teeth move in their sockets.
11) Resilient design is suggested when there are less teeth and their stability is questionable. Resilient design is achieved by the use of the same coping pattern as the rigid design, however spacing of 0.5-1.0mm over each coping means the mucosa is compressed by this amount before the abutments become loaded.

iii) Stress-broken design - when abutments are located in a single plane it is suggested the overlay denture is allowed to rotate rather than act resiliently. Rotation is allowed by creating space labially and lingually on each coping thus creating a fulcrum across the occlusal surfaces of the abutments and causing loading of the distal ends of the saddles during mastication.

Long coping designs involving secondary metal copings can be used similarly except tooth preparation needs to incorporate a heavy shoulder preparation to allow secondary coping and possibly porcelain fused to gold fabrication. The shoulder with bevel margin should extend well around onto the proximal surfaces and may only apply to large teeth with well receded pulps.
CHAPTER 8
ROOT CAP DESIGN INVOLVING ENDOdontically TREATED TEETH

8.1 Endodontic Considerations

Most commonly, reduction or removal of the crown of a tooth to facilitate overlay denture placement necessitates removal of the pulp and obturation of the root canal with root filling material. Although theoretically any tooth can be utilised for overlay denture construction, if the treatment is to be successful and the retained root ultimately useful, then each tooth must be considered individually. Many factors may negate the success of endodontic therapy and thus the suitability for a tooth as an overlay abutment.

8.1.1 Contraindications

Wakai (1980) lists various contraindications to endodontic therapy including:

1. Severe untreatable periodontal disease.

2. Complete crown fracture very close to the crown cervix or vertical fracture.

3. Extensive destruction of the pulp chamber, root canal or the furcation area making the tooth non-restorable.

4. Lack of strategic importance.

5. Malformation of the teeth preventing treatment or restoration; for example, complex labyrinthine root canal systems allowing no possibility of successful treatment.

6. Teeth with multiple canals with no possibility of obturating all the canals.
7. Extensive resorption either internal or external resorption.
8. Unfavourable crown to root ratio. This may be of less importance in overlay denture construction.
9. The predictable failure of a tooth; for example developmental grooves which ultimately lead to periodontal communication with the apex, as seen commonly on maxillary lateral incisors.
10. Severe malposition which renders it an ultimately unfavourable abutment.
11. Limited accessibility to the tooth disallowing successful therapy.

And in the Root Canal itself:

12. Abrupt curvature of the root canal may make endodontic therapy impractical.
13. Excessive calcification of
   a. The pulp chamber creates difficulties in gaining entrance to the canal.
   b. The root canal rendering the middle and apical third of the root canal unnegotiable.
14. Foreign particles lodged in the canal including amalgam and gold particles and fragmented endodontic instruments.
15. Dens in Dente indicating inability to successfully obturate a complex system other than surgically.
17. Taurodontism.
18. Inaccessible bifurcated canals which will not allow adequate sealing.
19. An immature apex indicating the need for apexification procedures in both vital and non-vital teeth.
20. Complexities of morphology of the root canal system possibly including:
   a) 'C' shaped canals
   b) three rooted premolars
   c) furcations in the canals especially in mandibular premolars
   d) three rooted mandibular molars
   e) maxillary molars with more than the usual canals which are impossible to discover and debride.

21. Excessive crown or root damage caused by:
   a) traumatic injury or fracture, particularly vertical fractures
   b) root perforation - although if repaired this may not be a problem.

Consideration must also be given to the patient's:

1. Present physical condition
2. Current treatment and medication
3. Past medical history about general health or diseases
4. Past dental history related to the success or failure of treatment procedures.

However, as pointed out by Glick (1965), many of these contraindications are not absolute and can be overcome with care.

8.2.2 Considerations in Morphology of the Root Canal

The utilization of a tooth root as an overlay denture abutment depends upon:

1. Whether or not the canal can successfully be obturated, which is related to access and morphology
2. The position of the tooth root in the dental arch and its importance
3. The length of root supported in bone.
Endodontic factors have an influence not only over the success of a root abutment but also upon its utilization.

1. Correct Obturation - The recommendations of a number of authors including Ingle (1965), Nguyen (1980) and Grossman (1981) are to seal the canal to eliminate any portal of entry to the periapical tissues and to totally obliterate the root canal space; however, as pointed out by Barker et al. (1973), complete pulp extirpation and obturation is not always possible with reliance on the reparative potential of retained pulp remnants or the efficacy of the inflammatory reaction to achieve success. Barker found that, in general, maxillary anteriors, including canines, are generally operable to the apex whilst maxillary premolars are considerably more difficult to prepare and fill. Conversely, the mandibular anterior and canine teeth are much more difficult to mechanically prepare and fill than the mandibular premolars.

Characteristics of Root Canals in Different Teeth:

Maxillary Central Incisors have one main canal, 20% with lateral canals and 10-25% with accessory canals.

Maxillary Lateral Incisors have a pulp chamber similar to the central incisor except comparatively narrower. Distal curvature occurs in 53%; accessory canals occur in 31% and lateral canals in 22% of cases.

Maxillary Canines: The canals are frequently narrowed mesiodistally except apically. Only 39% of canals are straight. According to Barker (1973), apical and lateral canals are not common.

Maxillary First Premolars: In summary, Barker found that both first and second premolar teeth were very complex. Literature suggests between 79.3% and 55% of first premolars have either two roots or an apical bifurcation, and, according to Hess (1925), up to 2% with three roots.
Apical ramifications occur up to 64% (Green, 1960) and lateral canals occur in 18% (Hess, 1925).

Muehler (1933) divides the first maxillary premolar into five categories:

a) Two roots, two canals 68.40%
b) One root, two canals joining near the apex 16.15%
c) One root, one canal, bifurcated near the apex 6.92%
d) One root, two distinct canals 6.92%
e) One root, one canal which is broad buccolingually 1.55%

Usually then, the canal shape exists as either two narrow round canals with funnel shaped openings or as a buccolingually broad canal bifurcating the possibly joining again along the root canal system.

Maxillary Second Premolars: These teeth have a single root in 90% of specimens. However, the canal may divide half way down the root, just short of the apex or may terminate in fine branches. Apical ramifications occur more commonly than in first premolars, according to Green (1960).

Muehler (1933) divides anatomy as follows:

a) Flat tapering canals 8.59%
b) Flat with the apical half of the canal round 1.56%
c) Two roots, two canals 1.56%
d) One root, two canals which are joined at the apex 1.56%
e) One root, one canal bifurcated at the apex .78%
f) One root, two distinct canals 12.5%
g) One canal, flat buccolingually 72.66%
h) Bifurcated middle third 0.78%
i) Denticles 6.0%

Mandibular Central and Lateral Incisors: These teeth are anatomically very alike. Green (1964) describes them as single rooted, the root
canals appearing narrow labially commonly with a distal curve (23%) and a labial curve in 13% of cases. Labiolingually the canals are broad, especially at the cervical line and narrow at either end. Commonly there is a middle third division. Rankine-Wilson and Henry (1965) found 40.5% had two canals, 87% of these in which the canals rejoined at the apex to form a common canal.

**Mandibular Canines:** According to Barker (1973), the most common occurrence is one root and one canal. Deep grooving of the proximal surfaces of the root may lead to partial division of the canal into a labial and lingual portion, and while in most instances the canals reunite in the apical third, complete division with separate apical openings are by no means uncommon. Division of the root is occasionally seen. When single, the canal appears as a thin ribbon from the labial aspect, but when viewed proximally, it often expands considerably towards the lingual below the cervical line, narrowing and becoming round only in the apical third. Commonly the canal bifurcates into a fork-like termination of the apex.

**Mandibular First Premolars:** Usually this tooth has a simple root and canal form of a single rooted tooth. The mesial grooving can occasionally develop into two root apices but often two canals reunite at the apex. Hess (1925) found only 2.7%, while Meuhler (1933) found only 4% with bifurcated apices. Apical ramifications have been found by authors in up to 90% of cases.

**Mandibular Second Premolars:** Usually these teeth have a single root, the existence of bifurcated and trifurcated roots being very rare. Mesiodistally the canals may be narrow and conforming to the curvature of the root but buccolingually the canal dimensions may be quite wide and irregular, presenting recesses of various size. Hess found 7.5% had
bifurcated canals whereas Muehler found none.

8.2.3 Treatment Planning in Relation to Endodontics

Apical ramifications reported vary between 49% and 94%. From an endodontic aspect the success and utilisation of the tooth root as an overdenture abutment depends on canal morphology. Complexities in canal anatomy must be considered in treatment planning for an overlay denture. Teeth with a tendency towards canal complexity may indicate construction of long coping type designs. If endodontic preparation is planned, a number of factors must be considered:

i) Timing - should the root canal therapy be embarked upon before reduction of tooth length or at the time of reduction?

ii) Vital or non vital endodontic therapy: Vital endodontics is often necessary and may be completed at one sitting.

iii) Access preparation: Maximisation of access cavity preparation is possible. Decoronation before endodontic therapy to allow direct access to pulp chamber is ideal, especially when limited vertical opening and access is the case. Sufficient tooth structure can be easily left to allow rubber dam placement.

iv) Suitability of endodontically treated tooth for restoration with root cap or other restoration: If the treatment plan envisages a highly retentive attachment fixation for the denture, the root canal preparation and filling must be of an acceptable and compatible material to allow removal and preparation for a retentive post, e.g. laterally condensed gutta percha as compared to silver point root fillings. Apical seat preparations must be well defined and master cone adaptation well done to avoid apical leakage, according to Allison et al. (1965).

Kwan and Harrison (1981) show a positive apical seal has been
demonstrated to show no apical leakage even when post preparation is within 2.44mm of the apical seal and done immediately after root filling. Therefore preparation to within 3-4mm of the seal should be safe. Silver cone root fillings should not be disturbed by post hole preparation.

v) Ability to successfully obturate the canal.

vi) Value of the tooth as an abutment.

vii) Length of remaining endodontically treated tooth root in bone.
The length of the root greatly affects the type of restoration that will be utilised after root cap placement. Precision attachment utilisation depends on ideal post preparation. Short or very widely flaring canal shapes may contraindicate highly retentive attachments.

8.2 Restoration of the Endodontically Treated Tooth Root

1. Intraradicular plug restoration of root canal

2. Intraradicular attachments

3. Extraradicular coverage of root face (without precision attachments)
   A) short copings
   B) medium short copings
   C) medium copings.

4. Extraradicular coverage of root face for attachment fixation.

8.2.1 Intraradicular Plug Restorations (see Figure 8.1)

Often treatment of the remaining root after endodontics may be restricted to just restoring the canal orifice with a plug of restorative material. This is most commonly done in amalgam although any type of permanent restorative material could conceivably be used, for example: composite materials, glass ionomer cement, and gold foil.
Figure 8.1  Intra-radicular amalgam plug restorations used for overlay denture abutments
If the length of root is particularly short and the patient's oral hygiene is satisfactory, plug restoration of the root canal is an acceptable method and is described by several authors including Georg (1974), Jenson (1975), Frantz (1975), Defranco (1977), Toolson and Smith (1978) and Robbins (1980). After obturation of the reamed and filed root canals the root filling is removed to 3mm below the gingival margin, sealed with a suitable base material (zinc oxide and eugenol or zinc phosphate cement) in the case of amalgam and in the case of composite, glass ionomer, or gold foil restorations, any hard setting, low solubility compatible base material (Figure 8.2).

A simple occlusal Class I cavity form can be developed achieving the requirements of:

1. Adequate depth of restorative material for strength and seal.
2. Sufficient extension to adequately overlap the endodontic access preparation and incorporate any knife like projections of the root canal at the sectioned level.
3. Undercutting of the box preparation using a half or one round bur to allow adequate retention form.
4. Maintaining adequate thickness between the cavity margin and the root face gingival margin to provide enough strength to resist fracture of the remaining dentine.

The height at which the root is sectioned above the gingival level may be influenced by a number of considerations.

1. Need for space to place an adequate thickness of prosthesis.
2. Likelihood of fracture of remaining root surface due to lack of support.
3. Need for retention in the prosthesis as opposed to the need to reduce the height of the root in order to reduce the stress placed upon it.
INTRARADICULAR PLUG RESTORATION

1. Amalgam or
   (Composite
   Glass ionomer cement
   Gold foil
   Gold inlay)

2. Sealing base

3. Root filling

Figure 8.2  Diagram of typical plug restoration.
4. The effectiveness of the oral hygiene measures on a higher root face. A flat surface flush with the gingiva requires less work to clean than a tooth form with long lingual, buccal, mesial and distal surfaces. Two or more closely approximating abutments also make these considerations important.

Robbins (1980) believes that the amalgam plug type of restoration is indicated in most cases of overlay denture construction for periodontal reasons as long as the tooth and restorations are polished to a glass like finish and 0.4% stannous fluoride gel is used daily to reduce the risk of failure due to caries, as described by Shannon and Cronin (1975) and Key (1980). As Robbins (1980) also states, the height and shape of the abutment determines the method of cleaning. If the abutment has a low profile the "scrub" method can be used. If the abutment is taller the scrub method may be ineffective in cleaning the lateral surfaces of the abutment. In this case a sulcular technique may be required.

Other authors also describe the use of amalgam plug restorations. Morrow (1975b) describes their use particularly with immediate overlay denture construction and emphasises the importance of polishing the root face. Defranco (1977) also describes the sectioning of teeth 1-2mm above the gingiva then rounding the root face over which he describes as being particularly suitable for patients with corrected periodontal problems who are left with roots short on bony support. Goerig (1974) and Frantz (1975) list reasons for amalgam restoration of root faces:

1. The gingival margin is easier to clean and maintain.
2. The impracticality of reducing the teeth, constructing gold copings and inserting the denture at the same appointment.
3. The added cost of gold copings.
4. The additional height of gold copings (the gold coping needs to be at least 1mm thick according to Brewer and Morrow, 1975).

Thus the benefits gained from an amalgam restoration are those of a retained root with retention of alveolar bone and the consequent stabilisation of the prosthesis and the benefit of proprioceptive sensations from the remaining teeth.

8.2.2 Intraradicular Attachments

Restoration of an endodontically treated root face with an internal restoration includes any attachment which leaves an exposed cut dentinal surface remaining on the root face - e.g. the zest attachment, magnetic keeper plugs.

These attachments require the polishing and contouring of the exposed dentinal surface to a desirable shape and also need chemical protection of the surface. This type of restoration does also have the advantage of not adding any extra height to the tooth preparation.

The characteristics of Zest anchors and magnetic keepers are such that both can be utilised in combination with gold copings as described by Jumber (1981e) or stainless steel coping techniques.

Descriptions and characteristics of intraradicular anchors will be discussed in the chapter on attachment fixation of overlay dentures.

Extraradicular Coverage of the Root Face

Root cap coverage of the endodontically treated tooth root must be viewed from a different aspect as coverage concerned with vital coping placement. Root caps may serve a different purpose to that of pulpal protection, retention of prosthesis, support and stabilisation which have been considered when discussing vital tooth copings. In fact, Lord and Teel (1974) believe that a cast gold coping with a root canal
post is used only when tooth structure is not adequate for acceptable contour with an amalgam restoration and this may be supported from periodontal aspects according to Jewson (1975). DeFranco (1977) also found that if there is a history of caries and if home care is not drastically improved, then the placement of a cast coping does little in preventing carious lesions on the abutment teeth due to the susceptibility of margins finished on cementum. However, it is also true that if home care is improved then copings can indeed be a success. Welker and Kramer (1978) believe that the remaining tooth structure usually only consists of cementum and dentine and gold copings serve to protect them from damage such as abrasion, erosion, attrition and traumatic insults and also to give the optimum contour to the tooth. It is true that in many cases, particularly young teeth the dentine may not yet have sclerosed.

The use of copings on treated abutments is also related to the nature of the stresses that will be applied to those abutments. If the denture design were completely resilient, the shape of the coping for correct load distribution would not matter. However, at a later stage the denture could become more tooth supported and hence the shape of the coping becomes important. Thus also the retentive aspects of the copings must be discussed in the light of the nature of the load they are meant to resist. Coping designs are divided into two groups. Those designed for use without retentive attachments and those designed for use with retentive attachments. Zamikoff (1973), Morrow (1975) and Jumber (1981c) describe coping designs in relation to function.

These can be divided into short, medium short and medium length preparations. Although long copings may be used for endodontically treated teeth they are usually relegated to use on vital teeth.
8.2.3 Copings for Restoration of the Endodontically Treated Root Without Attachment Utilisation

Restoration of the endodontically treated roots is indicated when stability and support for the overlay denture is of importance. Correct shape and resistance to abrasion are necessary if abutments are carrying load for any period of time. Retention in medium copings is possible through the parallelism of the coping. It is believed by some authors that some resistance to caries is achieved by coverage of freshly exposed dentine and if the patient can afford this treatment it should be considered. Indeed good oral hygiene makes their prognosis more favourable.

A) Short Height Copings: The main factors in preparation are designed simply to provide the requirements of the coping and to establish resistance and retention form for the function of the root cap. Also the preparation should incorporate the convenience form established for the endodontics and replace any carious defect.

8.2.3.1 Root face preparation for short root caps should entail:

i) According to Duckmanton and Taylor (1975a) reduction of the crown to leave 5mm above the gingival crest, then a 10° chamfer is cut around its circumference ending 0.5mm above the epithelial attachment.

ii) The root is then further reduced until the chamfer is 1.0mm long.

iii) Ideally the root face should be flat, or have two faces inclined at an obtuse angle to each other, but its final shape will be determined by the epithelial attachment contours. If other root faces are involved alignment to these should be considered for insertion. Morrow (1975a) suggests a design which allows for a rounded contact between the tooth coping and the base of the denture taking into account maximal reduction to allow for
maximal mechanical advantage and sufficient reduction axially to provide space for aesthetic placement. Jumber (1981c) also mentions shaping on three different presentations of root face.

a) Where the gingival margin is even and uniform the occlusal cut should be uniform giving the face of the root a flat or slightly convex form.

b) Where there is extensive bone loss lingually do not follow the gingiva lingually but just round off the occlusal corner of the preparation.

c) Where aesthetics are important, in the upper anterior region for example, follow the rounded contour of the ridge to allow for the coping as well as the denture teeth.

d) Proximal walls of the preparation should be as parallel as possible to provide for retention and these must also be parallel to any other copings to be connected.

e) Resistance to rotation form is usually incorporated in the occlusal surface of the root face either as a tapered groove or Keyway (Morrow, 1975a), a 1.0mm indentation in the form of a cross (Jumber, 1981c) or a seat box preparation (Duckmanton and Taylor, 1975a), all of which provide extra thickness over the central area of the casting.

f) Retention: Requirements for retention of a non-anchoring root cap need not be great. The function of a short root cap is mainly supportive and the shape, either dome or cap design is not usually retentive. Morrow (1975a) describes a short dowel, either tapering or parallel, used to achieve retention. Otherwise parallel pins are used for retention, particularly when the root cross sectional area is small and the teeth used have more than one root. Although not distinguishing between short copings
for attachments and short copings without, Jumber (1981f) and Duckmanton and Taylor (1975a) believe that there must be sufficient retention for the casting to resist the considerable forces transmitted by the prosthesis. The post preparation should be long enough and rigid enough not to split the root and ideally oval in cross section. Retentive posts can be of virtually any design including tapered, parallel walled, stepped, threaded or custom made designs and pin systems can be either tapered or parallel. Splinted short copings require paralleling of post preparations usually indicating tapered posts if done freehand. Paralleling jigs, e.g. the Paramax system¹ is required for parallel posts. (See chapter on Post Considerations) (Figures 8.3 and 8.4)

8.2.3.2 Coping Requirements: Short copings with no attachments must still follow the requirements of good periodontal contour, aesthetic allowance and stability and support shape, in exactly the same manner as those outlined for vital abutment coping considerations. The shape of the coping also depends on the loading the roots are likely to be required to withstand. If no loading is envisaged then dome shaping of the root caps is of no importance. Shaping to allow for maximum space for the teeth setup and denture strength is important. Denture "support" by roots has been described by a number of authors including Miller (1958), Yalisove (1966), Morrow et al. (1969), Morrow, Powell et al. (1969), Crum et al. (1971), Brewer (1973), Morrow (1975a) and Richard et al. (1977). If the denture actually rests wholly on the teeth the copings should be designed to maximally transmit forces in a favourable manner to the teeth and the surrounding bone. Although Zamikoff (1973)

¹ Whaledent International, New York N.Y. U.S.A.
Figure 8.3 Example of a Short Coping on the Left. Used in conjunction with precision attachment copings

Figure 8.4 A Short Coping After Five Years - Note wear on the bearing surface
describes the use of mobile teeth as denture abutments using short copings which provide only vertical loading on the root he nevertheless states that denture relief is necessary to avoid overloading the tooth on initial placement. To resist coping wear as shown by Brewer and Morrow (1975), some authors such as Miller (1958), Morrow (1975a) and Yalisove (1966) suggest the use of either gold or cobalt chromium bearing surfaces where the denture is contacting the tooth coping. Morrow, Powell et al. (1969) describe a bearing surface which meets the coping in a convex shape which corresponds to a concave shape on the occlusal surface of the root cap. This indentation provides a centralised contact between the bearing surfaces as well as some degree of rotation. Lateral stabilisation is provided greatly by the teeth in this design. Bearing surfaces generally do provide more accurate fitting of the coping surface, therefore reducing wear due to reduction in movement.

Morrow (1975a) describes a method for fabricating a metal base supported by dome shaped copings. The fitting surface of the cobalt chromium casting incorporates a tissue fitting surface and has retention beads to allow mechanical union to the acrylic. Over the abutments, from the zone 1-2mm below the gingival margin extending to two-thirds the height of the coping, the casting is relieved by 0.5mm tapering to nothing incisally. This, believes Morrow, allows a ball and socket contact between the coping and the metal base and reduces lateral stresses on the abutment during functional loading of the dentures. Relief, particularly around the gingival area should be limited to 0.5mm due to the risk of gingival hyperplasia into the relief space. Other factors in favour of metal bases include:

1. The greater strength and resistance to distortion of a metal base.
2. Tissue response is more favourable to metal rather than acrylic.
3. Jaw relationship records can be adapted well to metal bases.

However as pointed out by Taylor and Duckmanton (1976), relining of bases can be a real problem unless a grid metal casting is used.

B. **Medium-Short Root Cap Preparations:** described by Jumber (1981c) (as-distinct from short preparations) are for teeth when a more favourable root/crown ratio is required but where a higher coping is required, for example for splinted copings. The preparation is similar to that done for short root caps except the root face is left dome shaped and 4-5mm high, with the proximal walls parallel for better retention of the copings on the abutment. Auxiliary retention by posts or pins is still recommended. Medium-short copings are designed to provide stability as well as support even though the overall form is conical, extending 2-4mm occlusally. (Figure 8.5)

C. **Medium Height Root Caps:** once again defined by Jumber are used when roots have good bony support and when optimizing root/crown ratio is not necessary. Preparation consists of tapering the facial and lingual surfaces, particularly the facial surface for aesthetics. Proximal surfaces remain relatively parallel for retention of the coping. The heights of the prepared teeth are 4-6mm and therefore do not necessarily need auxiliary retention according to Jumber. These copings are typically used as abutments in telescopic overdentures when retention of the denture is provided through frictional contact between parallel walls of the copings. They are also well suited to use of auxiliary attachments such as bars, Ipso clips, I.C. attachments, Octalinks, Cekas and even cantilevered attachments as discussed in the chapter on Attachment Fixation.
MEDIUM HEIGHT COPINGS

Figure 8.5  Medium Height Coping for Use with a Magnet
CHAPTER 9
THE CHARACTERISTICS OF ATTACHMENT FIXATION

History

Precision attachment fixation for overlay dentures became popularised in Europe early this century even though the idea originated in Switzerland in 1898 according to Crum et al. (1971). Authors such as Rehm (1952), Biaggi (1952), Dolder (1961), Lofberg (1953) and Brill (1953) were all describing works on overdentures and attachment fixation in the early 50's. Preformed attachments have developed from their early designs. Bar fixation, for example the Gilmore attachment (Gilmore, 1913), the Dolder bar (Dolder, 1961), the Ackerman bar and the CM bar and rider also became popular for overlay denture retention in the 50's.

Subsequently Brill (1953), described a stud attachment that was custom made and which he believed distributed forces to the abutments in an ideal manner. Augsburger (1966) described the Gilmore attachment, which, unlike the Dolder bar could be adapted to an irregular ridge and was attached by a number of clips. Prieskel (1967, 1973) described various attachments that could be used for complete overlay dentures including bar and stud fixation. Kabcenell (1971) described the Ceka attachment which can serve in a number of functions and which allows easy replacement. Quinlivan (1974a and b) describes an attachment which can be custom fabricated using an acrylic resin pattern obtained from a self made mould. Dodge (1973) describes another attachment, which is a

1. Metaux Precieux, Neuchâtel, Switz.
2. Cendres and Métaux, Biel Bienne, Switz.
simple V shaped attachment, the "Baker clip", which is designed to snap over a pair of 12 or 14 gauge round wire fashioned as a bar, either inter abutment or in a cantilever arrangement.

The Hader bar is another attachment which is cast from a plastic pattern described by Mensor (1978). Stansbury (1976) and Crum et al. (1972) describe a custom made attachment which simply involves a cast rest and clasp arms incorporated inside the denture which fits a simple stud shaped casting which could be used for either a vital or non-vital tooth.

These simple designs have gradually given way to the use of precision made manufactured attachments which potentially have the advantages of constant performance, replaceability, predictability, and longevity due to the constancy of metallic components and design variability. A predictable resiliency for instance can now be prescribed for a case by the use of a suitable attachment, for example the Zest Anchor described by authors such as Zamikoff (1973), Mascola (1976), Feldstein and Teitel (1976) and Jumber (1981e) which is designed specifically for roots of poor prognosis until their future has been determined.

Evaluation of a range of attachments has been carried out by a number of authors. Mensor (1978) and Prieskel (1968) describe the use of several key attachments. Taylor, Duckmantan and Boyks (1976) describe technical procedures involved with a select number of attachments and the philosophy behind these procedures. Matsuo (1970) and Mensor (1973, 1975) described a chart in which attachment configurations and features are listed to allow easy selection for the operation.

Precision attachments for overlay denture use include:

1. Ancrofix\textsuperscript{1} (Figure 9.1)

1. Metaux Precieux, Neuchâtel, Switz.
Figure 9.1 The Ancrofix Attachment
Height 3.2mm and width is 4.2mm. It is a conjuctor type of attachment used in Class I-IV anterior and posterior positions. It has a simple assembly and is used in resilient or non-resilient cases allowing tissue movement. Vertical and rotatory movements are possible. The patrix may be flattened to allow deactivation of rotatory movement. The lamellae are adjustable on the matrix (with the teflon ring).

**Advantages** of the Ancrofix include

- a) Interchangeability of the attachment with the Introfix attachment
- b) Rotational movement reduces torquing on the abutment
- c) Adjustability of retentions is easy
- d) Simplicity of design.

**Disadvantages** include

- a) no spacer is provided for resilient processing
- b) difficulty in relining is caused due to the teflon ring
- c) torquing is possible if the unit is overtightened
- d) a paralleling mandrel is needed for multiple units.

2. **Anderes - Schönenburger Attachment**

   (Not currently available in Australia)

   It is 3-4mm in diameter and is a conjunct type. It is used in Class I-VI cases, in anterior or posterior. It is of simple assembly and has resilient and non-resilient applications. Vertical resilience only comprises tissue resilience allowance. The frictional retention of the lamellae is adjustable and the components are interchangeable and replaceable. It is made from gold and platinum alloy.

1. **Métaux Précieux, Neuchâtel, Switz.**
3. Baer and Fäh (B & F anchor) and BF Cylindrical Stepped Anchor\(^1\) (Figures 9.2 and 9.3)

Dimensions are 2.2mm x 3.1m non-resilient and 2.6mm x 3.3m resilient. It is a conjunctor type attachment used in Class I-VI anterior and posterior cases. It is a simple assembly with the resilient type comprising tissue resilience allowance only. Vertical movement occurs on a cylindrical stub. A PVC ring surrounds the matrix arm. It has adjustable - non-interchangeable components in gold and platinum alloy.

**Advantages** include

a) the B & F anchor is one of the smallest attachments (2.2mm)

b) retention is adjustable

c) the system is simple in application.

**Disadvantages** include

a) the cylindrical form may cause torquing in some applications

b) non replaceable parts

c) difficulties with teflon ring when relining

d) a paralleling mandrel is needed for multiple units.

4. Biaggi resilient anchor\(^1\) (Figure 9.4)

The dimensions are 3.4mm in height and 4.2mm wide. It is a conjunctor type, used in Class I-VI anterior and posterior cases. Simple assembly, it can be used in resilient or non-resilient cases but basically for resilient cases, relying on tissue movement and an allowance is made for vertical and rotatory movements of small magnitudes. Adjustable components are provided in both the matrix (lamellae) and the patrix (split ball). Matrix components are

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Figure 9.2  Baer and Fäh Anchor

Figure 9.3  Baer and Fäh Cylindrical Stepped Anchor
Figure 9.4  Biaggi Resilient Anchor
replaceable. Made in platinum and gold alloy.

Advantages include

a) the adjustability and replaceability of components
b) rotation and resilience are present to a certain degree to guard against torquing
c) relining procedures are easier
d) wear is reduced by split ring.

Disadvantages include

a) no pre ring is provided for retention lamellae
b) a paralleling mandrel is required for multiple units
c) components are more complex
d) rotatory movement may be undesirable in some cases.

5. **Batteiti Resilience Anchors** \(^1\) (Intraradicular design) (Figure 9.5)

Height: 3mm anchor, 3.4mm resilience anchor (0.4mm vertical translation). They can be used in Class I-VI cases in anterior or posterior positions and are ideal for small removable bridges with additional anchorage. They are of simple assembly and used in resilient or non-resilient cases. Vertical translation only is possible. The adjustable patrix (split pin) is also replaceable. Made in platinum/gold alloy for casting onto root caps, for soldering to the removable framework or for processing in resin. There may be a problem of alignment in multiple cases and no rotatory movement could stress the root.

Advantages include

a) interchangeability from fixed to rotatory action
b) replaceability and adjustability of components
c) the intraradicular junction reduces torque.

Figure 9.5  Battesti Resilient Anchors
Disadvantages include:

a) more complexity in design
b) it cannot be used in narrow roots
c) it needs a paralleling mandrel for multiple units.

6. **B & C Anchor** (Brill) (Not available in Australia)

This custom-made anchor to the design of Niels Brill, has dimensions 2.5mm high and 2.5mm wide. Vertical translation .5mm. It is a conjunctor type, suitable for Class I-VI anterior or posterior cases. Used in resilient cases, it relies on the spring activity allowing vertical and rotatory movements in all directions. It is of simple construction, relying on suggested palladium alloy for the male unit and springs being of spring hard clasp wire (0.6mm) inserted into chrome stainless steel alloy tubes 0.7mm internal diameter as used by orthodontists. Components are easily adjustable and female portions easily replaceable. Paralleling is not necessary.

7. **Ceka 691 692 693** (Designed by M. Tielemans) (Figure 9.6)

A conjunctor type anchor. Height 4.5mm, vertical translation .5mm, suitable for Class I-VI anterior and posterior applications. The unit is of simple assembly, having both resilient and non-resilient applications, the resilient type allowing vertical, hinging and universal movement by tissue resistance. Retention is achieved by both frictional resistance and by spring clip. The system is designed for use in both bar and cantilever arrangements. The male lamellae are adjustable and replaceable. Parallelism is not absolutely essential but becomes more so with multiple units. Processing is simple by either in mouth lift out or laboratory processing.

Figure 9.6  Ceka Rigid and Resilient Attachments

Figure 9.7  Conod Anchor
Advantages include

a) the replaceability and adjustability of the unit
b) the relatively simple processing and relining procedures
c) the adaptability to either resilient or non resilient applications
d) tapered posts facilitate insertion and removal.

Disadvantages include

a) the size of the unit takes up excessive space in the overdenture
b) torquing is a risk during adjustments and due to the excess height
c) the resilience function is allowed by the undersized matrix, which may allow too much movement and imprecision in the occlusion.

8. Conod cylindrical friction grip Anchors¹ (Figure 9.7)

A conjunctive anchor in 3 sizes - 3.5mm, 4.5mm and 5.5mm high and 2.4mm wide. Indicated for removable bridges, partial and overlay dentures, Class I-VI anterior or posterior applications. This anchor is strictly non-resilient, involving a frictional split pin retention arrangement, which is adjustable but non-replaceable. The matrix housing is in ceramicor, the matrix is in OSV metal.

Advantages include

a) the versatility of a variety of sizes of attachments
b) the simplicity and adjustability of the unit
c) processing is simply achieved in single units.

Disadvantages include

a) unit is non replaceable

b) the rigidity would cause torquing of abutments in some cases

c) the need for mandrel placement in multiple cases.

9. **Dalla Bona Ball-Anchor** (No. 604) A spherical resilience anchor (Figure 9.8)

Of conjunctive type suitable for Class I-VI anterior and posterior application. It has a simple assembly, the overall height is 4.0mm and width of 3.6mm, with a vertical movement of 0.4mm. It is used mainly in partial or overlay dentures where vertical and rotatory movements are required to compensate for tissue resilience. Retention is achieved through spring friction via the lamellae of the matrix inside the PVC ring, which are adjustable but not replaceable. The metal washer used in processing allows .4mm movement. The lamellae are asymmetrical to prevent metal fatigue too early. Processing can be done in the mouth or in the laboratory. A paralleling mandrel is available for multiple cases.

**Advantages** include

a) the relative durability and low cost of the attachment

b) the simple construction and processing

c) the resilient capability, both rotational and vertical

d) the adjustability and replaceability of the matrix.

**Disadvantages** include

a) the risk of damage to the PVC ring during processing

b) the need for paralleling mandrel in multiple units

c) the non-replaceability of the matrix

d) the ball design may allow pivoting of the denture base and tipping forces.

Figure 9.8  Dalla Bona Ball-Anchor

Figure 9.9  Dalla Bona Cylindrical Anchor
10. **Dalla Bona Cylindrical Anchor (No. 604a)**\(^1\) (Figure 9.9)

Also a conjunctive type anchor and using a similar system as the 604 but using a cylinder rather than a ball. Suitable in Class I-VI anterior and posterior situations. Overall height is 3.3mm (non-resilient) or 3.7mm (when 0.4mm spacer is used for resilient use) and 3.6mm wide. Tissue resilience allows slight movement. Retention is frictional, adjustable but non-replaceable as with the 604. The light lamellae and PVC ring provide 'soft' retention. Being one of the smallest attachments, it is suitable in many tight occlusal situations. Simple processing, varied application, and low cost make it very suitable for overlay dentures. Torquing of the tooth, however, can occur and a mandrel is provided when multiple units are used.

**Advantages include**

a) the "soft" lamellae and PVC ring  
b) the simple construction and processing  
c) durability and low cost  
d) can be used in resilient or non-resilient cases  
e) replaceability of the matrix.

**Disadvantages include**

a) the risk of damage to the PVC ring during processing  
b) the patrix is non replaceable  
c) the need for a paralleling mandrel for multiple units  
d) torquing can still occur if too little support is provided for the denture.

11. **The Bona Buffer Anchor (604P) Stress Breaker Anchor Bona 44.02.9**\(^1\) (Figure 9.10)

The Bona buffer is a similar but larger designed ball with a

1. **Cendres and Métaux, Biel-Bienne, Switz.**
Figure 9.10  The Bona Buffer Anchor

Figure 9.11  The Gerber Retention Cylinder
flattened top to allow the action of a spring. This is also a conjunctive anchor, height being 5.2mm. Application is possible for Class I-VI posterior/anterior positions. Its assembly is more complex, due to the spring. It is of a highly resilient type allowing .8mm of the vertical movement through a replaceable spring. Retention is provided through the lamellae and PVC ring. As with other Dalla Bonas, the matrix and patrix are Elidor metal.

Advantages include

a) replaceability of matrix components

b) the rotational and vertical movements available

c) relative ease of use, processing and its low cost

d) the "soft" retention of the lamellae and PVC ring.

Disadvantages include

a) the bulk of the unit

b) the excessive movement, .8mm being twice as much as normal tissue resilience

c) the male component is not replaceable

d) the requirement of a paralleling mandrel in multiple cases

e) the risk of damage to the PVC ring.

12. **Gerber Retention Cylinder 686 and 686a**¹ (Figure 8.11)

This attachment is a well known conjunctive type attachment available in 2 sizes - the 686a 4.00mm high and 4.00mm wide and the 686 5.00mm high and 4.4mm wide. Also suitable in Class I-VI anterior or posterior application and is used in removable bridges, partial and overlay dentures. The unit has five components, the soldering base being interchangeable with the Schubiger screw block system. This is

¹. *Cendres and Métaux, Biel-Bienne, Switz.*
basically the non-resilient form which allows no movement after snapping together. Retention is provided through a split steel ring held in place by a threaded bush. The component split ring is adjustable and the retention core and threaded bush are replaceable. The matrix housing is made in either elitor, ceramicor or steel, the bush, retention core and soldering base are made of OSV. Therefore the attachment life is indefinite, processing is simple in office or laboratory. Accessory tools are necessary and paralleling mandrels are used for parallelism. Torquing of the teeth can occur and the anchor is relatively expensive.

Advantages include

a) the interchangeability, the replaceability and the adjustability of the system gives an indefinite life to the system
b) the easy processing

Disadvantages include

a) special accessory tools and mandrels are required
b) the relative expense of the system
c) torquing can occur if too few abutments are used.

13. Gerber Retention Buffer (No. 696 and 696a) Cylindrical Resilience Anchor with Return Spring \(^1\) (Figure 9.12)

This is the resilient version of the Gerber Retention Cylinder. Again in 2 sizes: 4.7mm (696a) and 5.2mm (696) high. It is suitable for Class I-VI anterior and posterior cases, partial and overlay dentures where vertical translation is required. It has a more complicated design involving nine components: the solder base is OSV; the

Figure 9.12  The Gerber Retention Buffer
retention cone is OSV, a spacing ring for mounting (which makes up the 
patrix); a threaded bush is OSV; a split ring is steel; a plain bush is 
OSV; a return spring in steel, a copper disc again for mounting and a 
housing for the matrix in either 18/8 stainless steel or in Elitor. 
Resilience provided is 0.4mm, only in the vertical axis. The resilience 
load is actively achieved by the steel spring, which maintains the 
distance in an unloaded position on the tissues. Retention is provided 
by the split ring. The retention is adjustable and components such as 
return spring, split ring, bushes and retention core are all replaceable, 
making the service life of the attachment infinite. The attachment can 
easily be made non resilient by retaining the copper disc in the 
housing. Processing studs and paralleling mandrels are available. 
Paralleling is necessary in multiple cases and adequate space is 
necessary due to its height and width (4 or 4.4mm). Torquing can occur 
due to the height of the retention core cylinder. Replacement of the 
resilient spring is recommended every 4 months.

Advantages include:

a) the easy serviceability  
b) the lack of torquing on abutment teeth  
c) the height  
d) that non-parallel abutments can be used  
e) the increased durability over other intraradicular nylon  
   systems.

Disadvantages include:

a) the complex assembly  
b) difficult localisation of the prosthesis on insertion and  
   the resultant gingival trauma  
c) the difficulty of cleaning the matrix - objects tend to  
   lodge in the orifice.
d) excessive resilience and mobility in the attachment may overload the supporting tissues

e) the availability of the attachment and components.

14. Ginta Attachment

This attachment is not available in Australia. It is of the intraradicular conjunctive type and suitable for overlay denture technique in both anterior and posterior positions. The matrix consists of a metal housing which is cemented into the root by use of preforming drills, developing a dowel space of 7mm, reducable to 5mm. The matrix consists of a longitudinal double spring with retention bend, which is imbedded into the acrylic. The design allows vertical and horizontal resilience to a small degree with little or no torquing on the root. Retention is by frictional resistance through the double spring, which can be adjusted or replaced easily.

Advantages include:

a) the easy serviceability

b) the lack of torquing on abutment teeth

c) the height

d) that non-parallel abutments can be used

e) the increased durability over other intraradicular nylon systems.

Disadvantages include:

a) the complex assembly

b) difficult localisation of the prosthesis on insertion and the resultant gingival trauma

c) the difficulty of cleaning the matrix - objects tend to lodge in the orifice.

1. Whaledent International.
d) excessive resilience and mobility in the attachment may overload the supporting tissues

e) the availability of the attachment and components.

15. **Gnör Anchor** (615 and 615a) Cylindrical Friction Grip Anchor

(Figure 9.13)

A conjunctive attachment suitable for Class I-VI anterior or posterior applications. Two sizes include the 3.5mm high by 2.6mm wide (615) and the 4.3mm high by 3.3mm wide (615a). They can be used in removable bridges, partial and overlay dentures. The assembly is basically simple in type and is of a non-resilient type, using an adjustable, replaceable frictional sleeve and bush, which is screwed into a housing to make up the matrix and a simple soldering base and post unit which forms the patrix. The patrix is of OSV alloy as is the frictional sleeve and bush unit. The housing may be of either elitor or ceramicor, depending on the usage.

**Advantages** include:

a) the choice in attachment size

b) the replaceability of the retention element

c) the simple construction

d) the provision of rigid fixation.

**Disadvantages** include:

a) the potential torquing on the abutment due to its rigidity makes it only suitable for cases where sufficient support can be provided by teeth

b) a paralleling mandrel is necessary for alignment

c) the male component is not replaceable.

Figure 9.13: The Qmür Anchor

Figure 9.14: The Introfix

Figure 9.15: The Kurer Stud Attachment
16. **Introfix**\(^1\) (Figure 9.14) is another conjunctive anchor used in Class I-IV situations and in anterior and posterior positions. It is available in two designs: either 4.7mm or 6mm in height. It is suitable for fixed removable bridgework, overlay partial dentures or for tooth supported complete dentures. The system is non-resilient. The patrix consists of a soldering block, which is identical to the Ancrofix screw block and a split spring post which threads into the bar. The matrix is a simple retention housing, which is attached in the denture or framework. The retentive element works by frictional resistance and is adjustable and replaceable and mode is gold/platinum alloy.

**Advantages** include:

a) its simplicity

b) the provision for conversion to a more resilient overlay denture by replacement with Ancrofix componentry

c) the service life of the attachment is indefinite

d) the rigidity of the attachment

e) the attachment is vertically resilient whilst maintaining retention

**Disadvantages** include:

a) torquing of the abutments can occur if insufficient abutments are used to completely support the prosthesis

b) a paralleling mandrel is required for alignment

c) processing in the mouth is difficult.

17. **Kurer Stud Attachment**\(^2\)

A spherical resilient anchor of the conjunctive type suitable for

1. Metaux Précieux, Neuchâtel, Switz.

Class I-IV anterior and posterior applications. The attachment is of simple assembly, which allows vertical and rotatory movements to compensate for tissue resilience. Retention is achieved through spring friction via the lamellae of the matrix. The matrix lamellae are adjustable but not replaceable. In combination with the coping technique it allows reasonable flexibility in path of insertion. Made in EN 58A stainless steel.

Advantages include:

a) a post system is included with the attachment
b) a path of insertion variation is possible
c) the ball shape allows rotational movement around the abutment.

Disadvantages include:

a) the post system may not be suitable for the root form, for example root fracture could be risked in a narrow root if a screw in post is used.
b) the abutment roots must be close to parallel to allow the denture's insertion and the attachment rotational function.
c) a screw-through coping is technically more complex.
d) tipping of abutments can occur with ball attachments.
e) processing of matrix is best done in the laboratory.
f) difficulty in relining procedures.
g) the components are non replaceable.

18. The O-50 Attachment System\(^1\) (Figure 9.16).

It is an attachment system combining the 'O' ring concept of the

Quinlivan Snapper (19) with the preformed post design of the Zest Anchor (24). The conjunctive anchor is suitable in Class I-IV situations and is available in one sized patrix but which has 5 different patrix angles from 0° to 20° to allow for divergence in abutments. The patrix is 3.2mm in height whilst the preformed post is 3.8mm in depth. A 5mm seat is incorporated which may be cemented to be flush with the root face. The matrix consists of a simple 'O' ring 4.2mm in diameter and 1.3mm thick, which is embedded in the processed denture.

Advantages include:

a) its use on divergent abutments
b) the simplicity of the system
c) no paralleling mandrels are required
d) simple processing and replacement of 'O' rings
e) short enough to be used in short space areas
f) no castings are necessary.

Disadvantages include:

a) the root face may not always be the required shape for the preformed mandrel
b) vertical resilience is difficult to achieve
c) the patrix may wear but is non replaceable.

19. Quinlivan Snapper\(^1\) involves a prefabricated ball shaped resin casting pattern for the male component and a resin cap with 'O' ring inside, which is processed into the denture and which fits the male stud. The male pattern is cast with the coping pattern. This system is again a conjunctive type of attachment suitable

1. Not available in Australia.
Figure 9.16: The O-SO Attachment System
for Class I-IV anterior and posterior applications where room will allow. The overall height and width is 3mm and its best application is for overlay dentures where precise retention is not needed. The assembly is simple in type and manufacture and processing are also simple. The attachment allows rotational movement through the resilience of the rubber ring and the ball shape of the patrix. No vertical resilience is possible. Retention is provided through the rubber O ring which is easily changed.

**Advantages** include

a) the ease in patrix paralleling by alignment in the wax up
b) no special tools or mandrels are required
c) a very short height gives space advantages
d) rotational movement is possible
e) the easy maintenance of O ring retention
f) the assembly procedure is easy.

**Disadvantages** include:

a) the variability of the patrix due to casting procedures
b) the resin cap needs complete replacement in positioning changes
c) the patrix may wear in time against the acrylic contact depending on the casting alloy.

20. **Regulex Anchor** (formerly the Guglielmetti)\(^1\) (Figure 9.17).

This involves a system, which is applicable to bar, coping, and slide attachments. A conjunctive anchor which is applicable in all cases Class I-IV anterior or posterior applications. Height of the

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anchor is 4.5mm and diameter being 3mm. This anchor is solely used for non-resilient cases and provides rigid tooth supported fixation. The female component is a housing of ceramicor alloy for retention in the denture. The male component consists of a cylindrical conical soldering base in OSV and an adjustable cone also in OSV, which screws into the soldering base. Retention is provided through four lamellae each with a knurled edge which is adjustable and replaceable.

**Advantages** include:

a) the interchangeability of components to allow use with slide attachments, screwed anchors and screwed slide attachments and bars to allow use in rigid unilateral and bilateral saddles, removable bridges, partial prostheses, screw retained constructions, prefabricated and individually cast bars or crowns screwed onto cast root caps.

b) the small size

c) the adjustability and replaceability of the male component

d) the taper facilitates insertion and removal

e) the relative durability

f) the female housing can be picked up in the mouth or processed in the laboratory.

**Disadvantages** include:

a) rigid fixation may put excess torque on abutments if there is not a sufficient number

b) paralleling mandrels are necessary for alignment and processing

c) no mechanism for resilience.
Figure 9.17: The Regulex Anchor
21. *Rothermann Eccentric Anchor* (old No. 746) Cylindrical snap grip anchor¹ (Figure 9.18).

This conjunctive attachment is applicable in Class I-IV cases where height requirements are small. Height is only 1.1mm but overall width is 4.6mm. This version is solely used for non-resilient cases and has a simple assembly procedure. Retention is provided through the spring action of 2 encircling arms which snap over the lip of the cylindrical patrix. The lip undercut is of greatest depth at the level of the groove mark at which point the arms of the matrix must be aligned. The components are not replaceable, however the arms of the matrix are adjustable. The matrix (since 1972) is made in elasticor metal which has been tempered and hardened. The patrix is in OSV with a solder bar for soldering to the top of a root cap.

**Advantages** include:

a) alignment of attachments is not critical and soldering can be done freehand

b) torquing on the abutments is minimal due to the higher elasticity of the metal in the matrix

c) retentive force can be minimized by adjustment of the arms

d) the attachment is very low in height and can be used in minimal height cases, although it may require more room than most in width.

**Disadvantages** include:

a) acrylic processing can lock in retention arms necessitating precoating with rubber or adjustment after processing

Figure 9.18: The Rothermann Eccentric Anchor

Figure 9.19: The Rothermann Eccentric Resilient Anchor
b) processing in the laboratory is necessary to avoid "lock in" in the mouth

c) relining and rebasing procedures are difficult

d) lingual bulk in the finished denture can be a problem.

22. **Rothermann Eccentric Anchor** (old No. 747) Cylindrical Resilience Anchor\(^1\) (Figure 9.19)

This anchor is the resilient version of the 746, also suitable for Class I-IV cases. The height of the resilient form is 1.7mm including 0.60mm vertical translation. Overall width is the same at 4.6mm. The difference in the attachment is simply the increased height of the patrix and the inclusion of 2 processing spacers which allow for the resilience of the tissues. One spacer is adapted over the root face and the other is cemented to the top of the patrix. Retention is again provided by the encircling arms' spring action. Vertical and some rotational movement is possible due to this design.

**Advantages** include:

a) the height advantage in cases of short vertical dimension

b) the resilience function allows for both vertical and rotational movement

c) a latitude of 10° in parallelism

d) the adjustability of arms allows minimal retention

e) the soldering technique is easy.

**Disadvantages** include:

a) laboratory processing and relining is necessary to prevent locking onto the patrix by acrylic

b) the C ring has no spacers
c) the bucco-lingual bulk makes the facing placement difficult
d) tilting of denture in removal or insertion can result in deformation of the retentive arms and thus loss of retention or "lock in" on removal, causing excess torque on abutments.

23. **Schneider Anchor.** Cylindrical Snap grip anchor\(^1\) (Figure 9.20).

For removable bridges, partial and overlay dentures. Suitable for Class I-IV dentures. Again a conjunctive anchor of the non-resilient type, the anchor is 3.7mm in height and 3.6mm wide. The anchor consists of a patrix with a soldering base and post with retention grooves and a matrix which is made up of 2 parts: the housing which has a retention flange and a threaded bush which screws into the housing and which has 6 retention leaves. The attachment is thus adjustable via the leaves and the threaded bush is also replaceable allowing good serviceability.

Retention is provided by spring and frictional resistance. The patrix is manufactured in OSV alloy, as is the threaded bush. The housing can be in either elitor or ceramicor.

**Advantages** include:

a) the attachment provides adjustable retention and replacement of female component easily

b) the housing can be picked up in the mouth easily
c) the service life is indefinite
d) the suitability for rigid overlay dentures
e) the shorter height than some other fixed attachments that have replaceable components.

Figure 9.20: The Schneider Anchor
Disadvantages include:

a) the requirement of paralleling mandrels for exact parallelism

b) the localisation of the denture and the insertion may be difficult due to square shape of patrix head

c) torquing of abutments will occur if there is an incorrect selection or a lack of adaptation of the base.

24. The Zest Anchor (Figure 9.21)

This attachment is a complete system which integrates post and root cap design in the matrix.

Classified as an intraradicular attachment, it is suitable for Class I-IV cases and is particularly suitable for overlay dentures. The attachment provides for rotational, horizontal and vertical resilience. The overall height of the system is 8mm but this includes the post of the matrix. A true comparison to other systems reveals a height above the root face of only 2mm. The matrix consists of a standardised sleeve of 6mm height (3mm post and 3mm housing) which is cemented into the prepared root face. The root canal and root face is first prepared by the use of a diamond sizing drill. The matrix can be used either without a coping cemented directly onto the root face or incorporated into a wax pattern and cast onto for use with a coping. The patrix consists of a white nylon post with a ball end to provide positive "click in" rotation and a cylindrical pick up base which is incorporated in the acrylic. The overall height of the patrix is 5mm, 3mm of which is below the root face.

Figure 9.21: The Zest Attachment
Other components include:

a) The male spacer: a red nylon spacer which is used in direct pick up processing to provide a space for the male component in the denture for direct processing of the male in the mouth.

b) The blue nylon male centring sleeve which fits over the male and maintains the male position whilst processing.

c) A support cap: which allows localisation of the denture, and lateral stabilisation but no retention.

d) Blue transfer male, the simulated male incorporating a centering sleeve used during processing in the laboratory and trial insertions and for relining procedures. Being of a smaller diameter it has only slight retention and is thus picked up easily in an impression.

e) The red substitute female: for processing procedures.

f) A ceramic rod for cast on procedures to the female.

g) A drill, used to prepare the master model for a male spacer.

h) A diamond sizing drill to match the external shape of the matrix.

This system is a resilient type allowing 0.5mm vertical movement but also rotational and horizontal movement through the nylon post. Retention is provided through the nylon ball which engages the internal undercut of the female.

Advantages include:

a) the leverage forces on abutments are reduced to an absolute minimum due to the intraradicular design and the resilience of nylon post according to Defranco (1977)

b) the ability to be used on short roots

c) the use as a transitional attachment for "training" in full denture wear
d) the ease of pick up of the patrix in the mouth

e) non parallelism of abutments presents no problems according to Jewson (1975)

f) no paralleling mandrels are necessary in processing due to the ball design

g) they are simple and inexpensive to use

h) the adaptability to an immediate denture technique according to Feldstein and Teitel (1976)

Disadvantages include:

a) that when used without a coping, the root face may be susceptible to caries attack if not protected with fluoride

b) the difficulty in cleansing out matrix housing

c) the difficulty in localisation for insertion of the denture and the consequent risk of gingival or patrix damage. The patrix is susceptible to bending, which makes insertion impossible

d) the nylon patrix wears easily, particularly in the presence of an abrasive dentrifice

e) the nylon patrix has a water absorption problem that encourages bending, breakage or difficulty of insertion.

25. The Mini Zest

This attachment is the small version of the standard Zest attachment. The female segment is shorter in length (3.25mm) and the diameter has been reduced to 3.5mm. There is a corresponding diamond sizing bur which finishes the preparation of the surface. Jumber (1981e) recommends the Mini Zest when

1. APM-Sterngold - San Mateo, Burlingham, Calif.
1. the root diameter is small, e.g. upper laterals, some bicuspids, roots, lower anteriors, and in pulp chambers of multirooted teeth.

2. the endodontic restoration diverges from the path of insertion.

**Advantages** include:

a) the Mini Zest solves the problem of size that an intraradicular attachment of the size of the standard Zest would involve

b) the Mini Zest is more adaptable to a cast-in coping combination where a post may be adapted to the correct angulation

c) an equivalent retention due to the same male component being used.

**Disadvantages** include:

a) that when not used with a coping the lateral wall of the cavity should be undercut to provide more retention

b) the auxiliary components (red substitute female and the male spacer and localising collar do not adapt as well to the Mini-Zest.

Otherwise the same factors apply as to the standard Zest Anchor.

9.2 **Bar Attachments for Overlay Dentures**

Bar attachments can be divided into two groups:

1. The **Bar Unit** which must be used when an adequate number of teeth exist to completely support the prosthesis. The only stress breaking possible is in a vertical direction. No rotational movement is
possible as the bar provides rigid fixation and frictional retention. Bar units are very suitable in replacement of gross tissue loss cases where splinting of the teeth provides sufficient rigidity for support. Bar units can be either prefabricated or custom made.

2. The Bar Joint. Generally the bar joint is designed to provide rotational with or without vertical movement. The bar is either round or rounded to allow rotation during mastication. Splinting of abutments provides a better distribution of load to the abutments. This function can only occur if the bar is straight and as described by Prieskel (1973) the bar is best positioned perpendicularly to a line bisecting the angle between the posterior ridges to allow distribution of the forces evenly.

A bar joint could also be used as a bar unit and becomes thus if it is bent in any direction, i.e. rotation of the appliance depends on there being a straight bar and adequate relief provided over the copings for resilience of the tissues. Occurrence of a posterior abutment negates the use of the bar joint as stability is now created in 3 planes, hence indicating the bar unit design.

Bar adaptation to the tissues can be difficult in some cases. In these cases it may be possible for bar units to be bent e.g. Ceka, Dolder, and Regulex bars can be bent after annealing. Round bars, e.g. 12 or 14 gauge round bar used with Hader, Ackerman, Baker clip and CM clip can more easily be adapted to the tissues. However custom made bars either using plastic forms, for example the Hader bar or moulding techniques such as using a Dolder bar shell and duralay or modification by wax addition and milling techniques can achieve perfect tissue adaptation.

Bar shape determines the type of resilience. A completely round,
straight bar allows no limit to rotational movement other than by the abutment coping shape. Pear or oval shape bars limit rotational movement by their effect on the retaining clip.

Bar Attachments Available Include

9.2.1 The Ackermann System (Figure 9.22)

For removable bridges, precision partial dentures and overlay dentures. Suitable for Class III-VI cases, where a bar joint is necessary. It consists of 3 types of bars; the round 1.9mm diameter, the oval bar 1.5mm by 2.5mm and an egg shaped bar 1.65mm by 2.5mm and available in varying lengths 5mm, 10mm and 15mm. The riders are retentive clips 3.6mm in length with retentive arms located buccolingually perpendicular to the long axis of the bar. The round bar and clip are simple to use and assemble and are most commonly used. The oval and egg shaped bars are more difficult to bend to arch shape accurately. Resilience is provided by both vertical and hinge allowance of movement to allow for tissue movement. Retention is provided by the arms of the clips which can be multiple, adjustable and replaceable. The alloys are gold, platinum alloys.

Advantages include:

a. the small size of bar and clips allow easy use
b. the round bar particularly can be easily adapted to any contour
c. the easily adjustable clips.
d. vertical and rotatory resilience through a copper spacer in processing.
e. the easy placement of short clip segments

1. Metaux Precieux, Neuchâtel, Switz.
The Ackermann bar and clip system consists of
1. clip
2. spacer (only for mounting)
3. round bar
   or
4. egg shaped bar

Figure 9.22: The Ackermann Clip and Bar
f. bar shapes vary for use with the same clips

g. the splinting effect provided by bar fixation

h. use with Schubiger screw block means removability for maintenance or change in design

i. the benefits of a wrought bar construction.

Disadvantages include:

a. more difficulty in cleaning next to the abutment and under the bar

b. a weakening effect of the channel space inside the denture

c. clips are difficult to direct process in the mouth due to acrylic lock-in and the clip wings are facing in the wrong direction for denture placement

d. no spacer is provided for clip arms so adjustment after processing is difficult

e. path of insertion difficulties can occur with round bars.

9.2.2 Andrews Bar

A conjunctive bar unit system for Class III-VI cases. It consists of the Anterior Mini and Anterior Regular and the Posterior Mini and Posterior Regular sizes. The bars are curved and come in different diameters with corresponding retention riders. They are 4mm in height and are more complex to assemble although the action is a simple friction grip by the retentive riders. They are non resilient bars which allow no movement and the components are not interchangeable but are adjustable. The alloy is semi-precious and requires special soldering.

1. APM-Sterngold, San Mateo, Burlingham, Calif.
Advantages include:
   a. the semiprecious metal is less costly
   b. the benefit of a wrought bar construction.

Disadvantages include:
   a. the complex mechanical joining
   b. the problems of soldering non precious metal
   c. the awkward bulk of components make use in overlay dentures difficult.

9.2.3 Baker Clip

A conjunctive bar joint clip designed for use in any bar application when a standard round bar may be used. It is suitable for Class III-VI applications in anterior and posterior positions. There are two sizes, 3mm height to fit a 14 gauge bar and 4mm height to fit 12 gauge bars. Both sizes come as 6mm lengths, which can be divided into 2 segments. No retention in acrylic is provided and must be obtained by soldering wire to the top of the clip, or by grooving the surface and bending the ends. Assembly of the unit is simple and it gives vertical and hinging resilience to compensate for tissue movement but the vertical displacement can only be minimal. The spring retention is adjustable and the alloy is gold and platinum for serviceability.

Advantages include:
   a) the simple assembly
   b) the adjustability of the spring clips
   c) the use of multiple units for easy location on bars
   d) a joint action allows tissueward movement
   e) the round bar design allows easier bending and adaptation
f) coupling with a Schubiger screw block enables later modification to the design.

Disadvantages include:

a) no clip retention is provided meaning added technical procedures to either solder or bend retention to the clip are required

b) that soldering alters the elasticity of the clip and may lead to earlier loss in retention

c) joint movement is the main resilient action

d) path of insertion difficulties can occur with round bars

e) the weakening effect on the denture base necessitates a cast strengthener.

9.2.4 Ceka Bar Unit (Figure 9.23)

This bar consists of a rectangular bar which is interspersed with one or more Ceka Studs. This bar system is conjunctive, suitable in case types III-VI, anterior and posterior situations. The height is 4.5mm and the unit is rigid when no processing spacer is used and there are parallel surfaces in contact. The retention is provided by the spring action of the split flanges in the male stud. This is adjustable and the stud is replaceable, most wear occurring on the stud lamellae. The metal solder base is incorporated in the denture. The components are made in 3 alloys; gold silver platinum; gold platinum; and ceramax cobalt-casting alloy 1300c.

Figure 9.23: The Ceka Bar System
Advantages include:

a) the replaceability of the male stud
b) the adjustability
c) the easy pick up processing in the mouth or lab processing
d) the positive positioning in the mouth
e) retention which is achieved without soldering.

Disadvantages include:

a) the segments of bar have a fixed spacing distance between bar elements, thus leading to wastage in cutting elements to length
b) the expense of the system
c) the bar is more bulky facio-lingually than desirable due to the rectangular shape and matrix contour
d) the difficulty in contouring the bar to the tissue form and bending difficulties make it necessary to use the plastic bar forms for casting.

9.2.5 Ceka Bar Joint

This is the same in every respect except for the addition of a processing spacer between the stud and the bar matrix which allows resilience into the function of the attachment. The height of the unit and other aspects are the same as are all the comments regarding replaceability and adjustability. The stud has a universal joint movement, but when it is used in the bar situation only vertical resilience is obtainable, as the rectangular shape of the bar effectively stops rotational movement. The advantages and disadvantages are the same as listed for the Ceka Bar unit.

Bar-anchor systems almost identical to the Ceka System include

1. K.C. system (Konig)
2. Regulex (C.M.) 51 bar
3. Vario-Anker (Degussa)
4. Wolf Attachment (Heraeus).

9.2.6 C.M. Bar

A conjunctive bar 10mm high x 1.8mm wide which can be used in cases III-VI Applegate classification. It is suitable with the copper template to adapt it to an irregular ridge. This rider is fabricated by casting a sleeve, which fits the bar or by use of a square shaped Gilmore clip which fits size 1.8mm.

Retention is provided by the parallel sides of the bar and it is a non resilient design generally suitable for splinting several roots. It is generally manufactured in OSV alloy.

Advantages include:

a) the wrought bar may be more suitable than a customised bar but heat treatment is necessary after adaptation and soldering.

b) time may be saved in the adaptation of the bar to the ridge shape

c) an optional rider system

d) rider placement and pick up in the mouth is possible.

Disadvantages include:

a) the height of the bar makes it difficult to position the facings

b) the wastage of metal in contouring

c) the expense of the unit

d) the weakening effect on the denture base necessitates a strengthener.

Generally these considerations make it unsuitable to use for overlay dentures.

9.2.7 C.M. Clip\(^1\) (Figures 9.24 and 9.25)

A conjunctive clip similar to the Ackerman Clip which comes in two styles; one with short flanges and one with long flanges. The short flange rider is more popular and must be used on straight segments of bar. The long riders have no curled edge and flatter retention wings and could be used where the bar is an irregular shape and the length of the flanges are needed to maintain contact. The rider is 2.7mm high and 2.6mm long and is designed to fit a round bar of 1.9mm diameter. The retentive wings, as distinct from the Ackerman Clip, are orientated in the long axis of the bar. A 0.5mm spacer is provided to allow vertical resilience. The resilience provided allows for tissue movement and functions both by vertical movement or by rotational movement. Without the spacer bar, the rider functions only rotationally. The clip is adjustable and replaceable. The bar comes in a maximum length of 200mm. The metal of the bar is either in OSV or Protor 3 for soldering to the root caps. The riders come in Elitor for processing in resin. OSV bar wire is recommended if the bar traverses a long distance due to its superior rigidity. Bars come in the annealed state and must be heat treated after bending and soldering.

1. Cendres and Métaux, Biele-Bienne, Switz.
Figure 9.24: The C.M. Clip and Bar
Figure 9.25: The C.M. Clip and Customized Bar used in a case splinting three abutments
Advantages include:

a) the orientation of the retention flanges allows easier processing and resin pick up in the mouth
b) vertical and rotational resilience is possible
c) the suitability for non-resilient use as well
d) the adaptability to Hader bar use.
e) the adjustability for retention
f) the clips can be placed at any point and in any number on the bar
g) the long flange riders can be adapted to an irregularly bent bar and still give retention but this limits the rotational resilience.

Disadvantages include:

a) no spacer is provided for flange expansion during processing
b) the bar size is limited to 1.8-1.9mm
c) path of insertion difficulties can occur with round bars.

9.2.8 Dolder Bar Unit¹ (Figure 9.26 and Figure 9.27)

A conjunctive bar, suitable for Class III-VI cases positioned anteriorly or posteriorly. The unit is available in 2 sizes, 3.5mm high and 2.8mm wide and the micro size of 2.7mm high and 2.1mm wide. The shape of the bar is of an inverted U with the top of the bar being round in shape. The assembly is simple and its action non resilient. The retention is achieved by the friction grip of the rider sleeve, which is the same outside space as the bar and which has a retention grid for acrylic processing soldered to the top. The sleeve can be cut into segments for positioning on an uneven ridge shape. The bar can be

¹. Cendres and Métaux, Biel-Bienne, Switz.
THE DOLDER BAR UNIT

Figure 9.26: The Dolder Bar Unit Components.

Figure 9.27: A Short Dolder Bar Unit Splinting Two Abutments.
custom fabricated by using the sleeve as a template for an acrylic pattern, which can be helpful when adapting it to an uneven ridge. The retention is adjustable but not easily replaceable. Gold and platinum alloy is used (Elitor). The maximum length of the bar is 200mm and 50mm channel length.

Advantages include:

a) the rounded top of bar allows for easier insertion of prosthesis
b) the easy adaptability to divergent roots by soldering to a Schuiberger screw block
c) the longer channel length means less wear, less frequent adjustment, and better retention possible
d) the rider can be sectioned easily for placement on smaller straight segments
e) the retention grid provides retention and also acts as a strengthener for the acrylic.

Disadvantages include:

a) the unit is rigid allowing no resilience
b) bending and adaptation to an unevenly contoured ridge is difficult, necessitating custom forming of an acrylic bar
c) the larger size may be too bulky
d) no spacer for the arms of the rider is provided for processing
e) rebarring and relining procedures are difficult
f) it is an expensive system
g) wastage can occur due to the limited lengths of the bar unit.

The Dolder bar unit is suitable for overlay dentures where there are
enough teeth for complete tooth support, and there is enough bucco-
lingual width to allow room for the bar.

9.2.9 Dolder Bar Joint\(^1\) (Figure 9.28)

This is an oviform bar and channel in two sizes: the 4.55mm high x 2.8mm wide standard size, and the Micro Dolder Bar 3.5mm high x 2.10mm wide.

Both are conjunctive, suitable for Class III-VI anterior and posterior cases. The bars have been designed for vertical and rotational resilience, the standard has a 1.05mm high spacer in brass and the micro has a 0.75mm spacer. The channel is exactly the same shape as the Dolder bar unit channel, an inverted U shape, with a retention mesh spot welded to the apex. The rider segments can be sectioned to place them on an irregular shape of ridge. Retention is achieved by the spring action of the flange of the channel, which is adjustable by pressing the side walls of the channel together. The retention wings can be modified to provide more space for tooth arrangement, although it is not recommended for soldering to be done to the channel, which causes a change in the elasticity. The bar and the channel are both made in elitor. Maximum length of the channel is 50mm and the maximum length of the bar is 200mm. A special processing jig must be used for processing, relines and repairs, which eliminates the undercut of the oviform bar.

Advantages include:

a) vertical and rotational resilience - up to 1.05mm of vertical movement is possible

b) the problems of round bar insertion are eliminated

c) the riders and bar come in any length

Figure 9.28: The Dolder Bar Joint.
d) the retention grid provides retention but also strengthens the acrylic over the bar

e) the bar is the correct height for a Schügerl screw block.

Disadvantages include:

a) the unit is still bulky, even more so than the Dolder bar unit and may cause difficulty in setting the teeth

b) relining and rebasing are difficult as the retention mesh does not allow easy removal and acrylic tends to flow behind the flanges of the channel

c) no spacer behind the channel flanges is provided

d) the bar is difficult to adapt to an irregular ridge contour

e) that although it is claimed the retentive grid strengthens the acrylic, the weakest point of acrylic is still over the abutments.

9.2.10 The Gilmore Attachment (Figure 9.29)

This attachment has been manufactured, but as suggested by Augsburger (1966), the attachment can be easily manufactured in the laboratory from gold-platinum alloy plate, 0.36mm thick, and an eleven gauge gold bar. The prefabricated Gilmore attachments from Europe are 4-5mm long and 3.7mm in height and made from .4mm thick gold alloy and are very similar to the Baker, Ackerman and C.M. clips. Retentive arms are formed from punched out segments buccolingually or by accessory tags on the facial or lingual side of the clip in the axis of the bar. The design allows for horizontal and rotatory movements but no spacer is provided for processing. The American pattern also includes an internal clip attachment which is very much shorter, 0.7mm high and 6mm long and

1. Degussa, Placentia, Calif.
Figure 9.29: The Gilmore Clip.
0.3mm thick which just engages into the undercut of an 11 gauge bar. This style allows no vertical resilience, only rotation. The custom made laboratory design suggests a pattern 3.7mm high, 5-6mm long and 0.36mm thick gold platinum alloy with allowance for vertical resilience.

A straight bar design is recommended for an effective hinging action, otherwise torquing forms develop.

**Advantages include:**

a) the unit is relatively inexpensive if it is custom made.

Other advantages are listed as for the Ackerman system.

**Disadvantages include:**

a) the difficult availability

b) the custom made clip has no retention device available to retain the clip in acrylic - retention must be cut, bent or soldered onto the channel.

c) path of insertion problems with a round bar - the attachment can easily rotate slightly while processing.

9.2.11 The Hader Bar System

A conjunctive system of plastic components, which can be used to form a customised bar and plastic rider system. It is suitable for Class III-VI posterior and anterior applications. The bar form is a keyhole shaped plastic pattern 5mm high, the rounded top being 1.9mm in diameter. The riders are 4mm high and 5mm long and provide medium range retention through the elasticity of the plastic. The riders are held in the denture by a rod form on top of the plastic flanges and the whole attachment whilst not adjustable can be replaced readily in the denture by means of a placement handle. A CM clip can easily be added if more

long term retention is needed.

Advantages include:

a) the system is very inexpensive

b) resilience is provided through the elasticity of the plastic riders

c) the custom bar allows easy contour to any shape of ridge

d) the replacement of riders can be carried out by the patient.

Disadvantages include:

a) the retention is not as strong for as long - it is non adjustable and it wears rapidly

b) the bar is cast, not wrought, therefore thickness is needed for strength

c) the rider is bulky and weakens the denture base over the bar.

9.3 Auxiliary Attachments for Overlay Dentures

Attachments which are used in conjunction with other precision attachments to provide retention for overlay dentures can be described in two groups:

Screw connectors and Pawl connectors.

9.3.1 Screws. These connectors can be used where any two segments need to be rigidly joined. Screws can be designed to be permanently fixed (if the head is removed and polished down) or removeable (if the screw head is countersunk into the outer segment).

Screws are typically used for overlays when telescoping copings are to be used, as in the case of bar fixation of two roots with divergent root canals.
Screws must be positioned so that they are accessible for a screwdriver for ease of placement and removal. This may be either from the labial or from the occlusal. Screws can be used either in a cross pinning technique, where the screw is placed at a divergent angle to the path of insertion of the secondary coping or by a screw down action, where the screw is placed in the same axis as the path of insertion of the secondary coping. Tightening of the secondary casting to the first is only possible with a screw down function.

9.3.1.1 C.M. Screw and Tube System

This system is suitable for all screwed constructions. It consists of a screw, a countersunk collar and a threaded tube. A steel fixing pin is provided to locate the tube in the pattern for casting. The screw comes in 5 diameters; 0.80mm, 1.00mm, 1.20mm, 1.40mm and 1.60mm and a variety of lengths from 2.80mm to 9.40mm. The tube can either be cast onto or soldered in place and provides the thread for the primary casting. The countersunk collar can only be cast onto, due to its retention collar and is provided for the secondary collar. The outer diameter of the collar ranges from 1.70mm to 2.90mm for the largest screws. The collar height also ranges from 0.80-1.40mm. The screws are in OSV, the collar and tube are in Ceramicor.

9.3.1.2 C.M. Threaded Wire and Sleeve

A similar system as the screw and tube system except there is no fixing collar. Threaded wire up to 5.0mm in length can be sectioned and shaped to provide a screwdriver slot, which is polished and rounded to give later access. Tube lengths come in 5.00mm lengths and a steel fixing pin is provided for casting stabilisation.