Bridge design, part five: selection of abutments as retainers in bridgework

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Following his look at aesthetic enhancement for bridge restorations, Paul Tipton looks at the use of abutments in bridgework

Roberts (1970) looked at the success rates of individual retainers when used as either minor retainers (anterior abutment in a fixed-movable bridge) (Figure 1), or major retainers (to which the pontic is rigidly joined) (Figure 2).

Retentional demands made on minor retainers are far less than for major retainers and therefore more conservative tooth preparation is often possible. However, should the minor retainer become uncemented the effects are far more severe than if the major retainer in a fixed-movable bridge fails. In the latter case, the major retainer falls out complete with pontic, and the patient immediately attends for treatment. The minor retainer, however, is held in place by the fixed/movable joint and should it become uncemented, caries will rapidly occur underneath it, often with catastrophic results.

MINOR RETAINERS

The most retentive preparation is the full crown, but as previously mentioned in fixed/movable bridgework, the retentional demands on the minor retainer are less.

The three-quarter crown is therefore an ideal minor retainer (Figure 3), especially in the posterior region having a success rate similar to the full crown (Roberts 1970) and more importantly is a much less invasive style of tooth preparation and one which is greatly under-used by most dentists (Khan 1960).

The three-quarter crown also allows easier cementation and testing tooth vitality is more easy and predictable with the partial rather than the full crown (Khan 1960). However, in some cases where a display of gold may be unacceptable to a patient (Figures 4 and 5) Roberts suggested that an MOD inlay might be satisfactory,

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Figure 1: Fixed-movable bridge

Figure 2: Fixed-fixed bridge

Figure 3: Three-quarter gold crown as a minor retainer in mandible

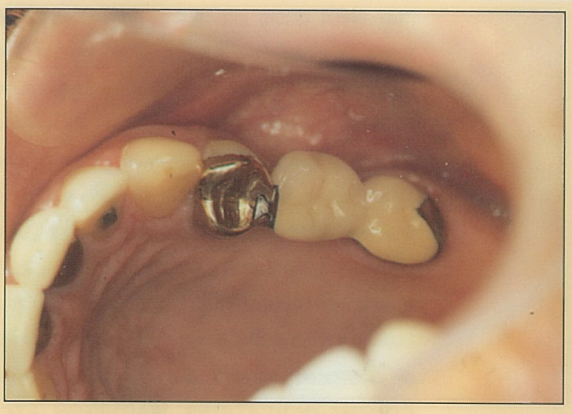


Figure 4: Three-quarter gold crown as minor retainer in maxilla

Figure 5: Display of gold from three-quarter gold crown

although there is a definite increased failure rate. Kaufman (1961), however, concluded that onlays were preferred to inlays, and inlays should be avoided wherever possible because of the problems of caries, stress distribution, retention and the potential for fracturing cusps.

In the anterior region the full crown is the most retentive, and also the aesthetic choice, especially on incisor teeth (Figures 6 - 10). The three-quarter crown can often be considered when the canine is used as the minor retainer, where the patient will allow gold to be shown on the incisal edge.

Posts when used as a minor retainer also showed poor success rates (Roberts 1970) although Schwartz (1970) found only a small percentage failure due to

Figure 6: Missing central incisor and denture in place

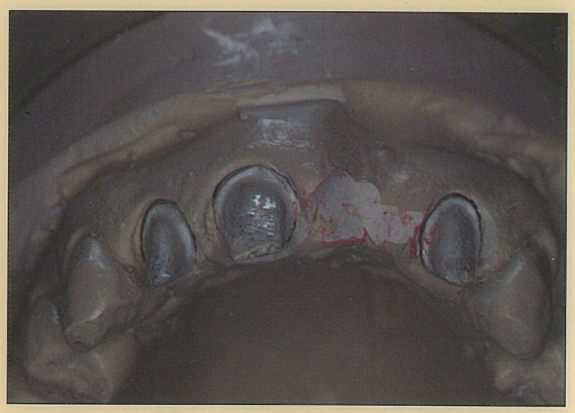


Figure 7 (left): Tooth preparations and ovate pontic soft tissue sculpturing

Figure 8 (right): Silver dies on a Geller Model and adjustment for ovate pontic

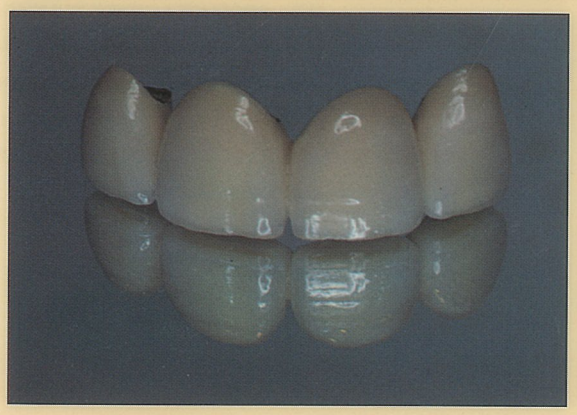


Figure 9 (left): Four unit fixed anterior bridge

Figure 10 (right): Fixed bridge in situ

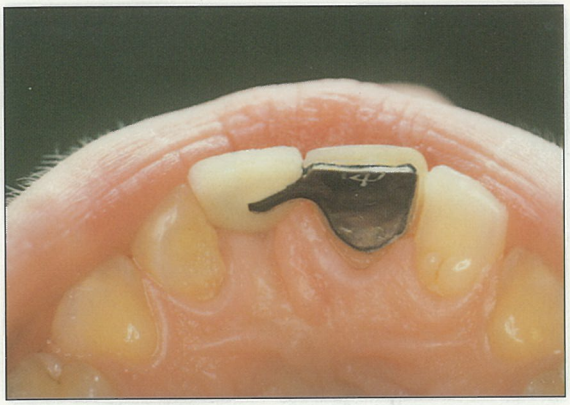


Figure 11: Major retainer in form of a Maryland wing

cementation when using post crowns as abutments, which may be due to the differing techniques used in the US (see later).

Burgess (1989) investigated several preparation techniques for adhesive retainers, including proximal extensions, grooves, labial wrap around, and occlusal rest seats. The control group was the posterior three-quarter crown preparation, which has already been discussed. By the incorporation of mesial and distal grooves, maximal palatal coverage and rest seats the retention of the adhesive wing can be as retentive as the three-quarter crown, making this a possible retainer for use as a minor abutment, or a major abutment in a cantilever situation (Figure 11).

MAJOR RETAINERS

When discussing major retainers the distinction between a major retainer in a fixed-fixed bridge versus the major retainer in a fixed-movable should be made. The retentional demands on the major retainer in a fixed-fixed bridge are far greater than the major retainer in a fixed-movable because of the stress breaker connector in the fixed-movable bridge dissipates some of the stress from the cement lute to the periodontal ligament of the major retainer. The relative failure rates of various types of major retainer indicate that in fixed-fixed bridgework the full crown should normally be the retainer of choice and that the three-quarter crown is contra-indicated. In a study on the resistance and retention of three-quarter crowns, Kishimoto (1982) showed that the resistance and retention rates of

Figure 12: Missing canine tooth and post in the lateral incisor

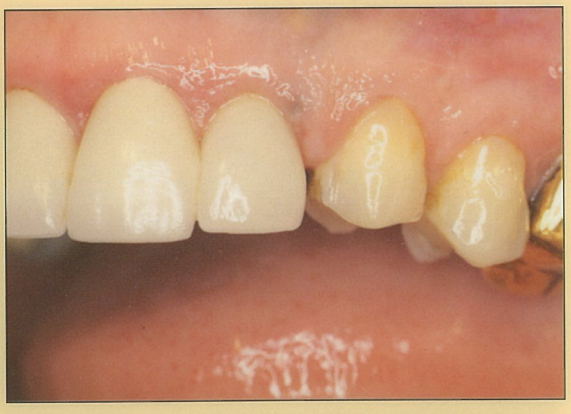


Figure 13: Close-up view showing lack of space for the canine pontic

Figure 14: Removal of the post retained lateral incisor and tooth preparations after orthodontics

Figure 15: Ovate pontic soft tissue sculpturing

Figure 16: Lab-made prototype restorations

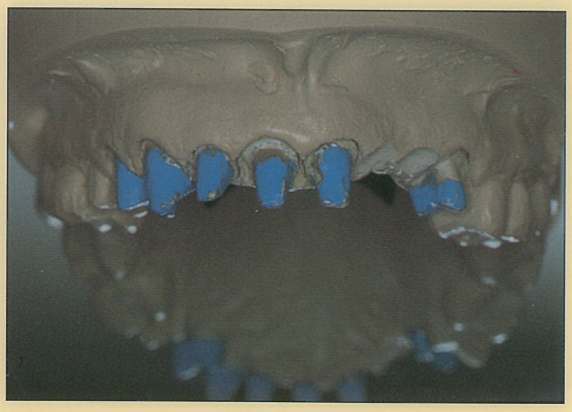


Figure 17: Geller model and silver dies

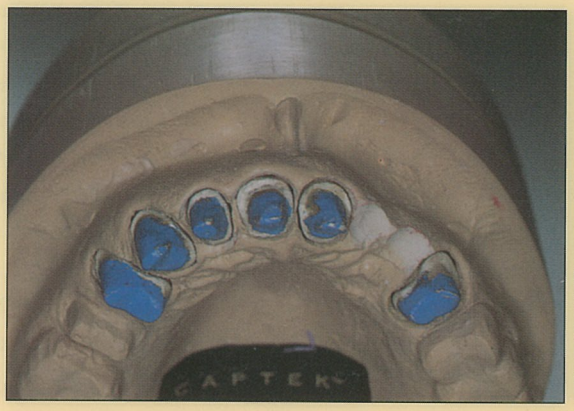


Figure 18: Close-up of model adjustment for ovate pontic areas

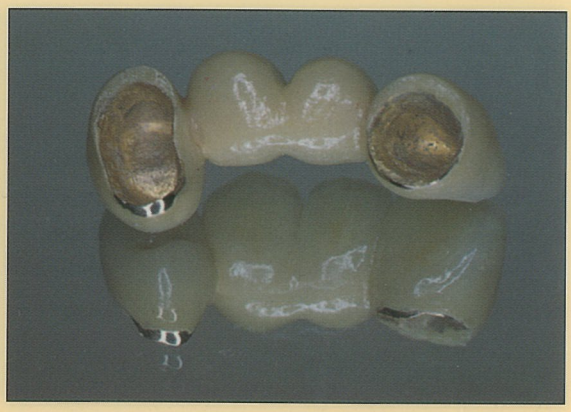


Figure 19: Captek four unit fixed bridge with porcelain butt margins

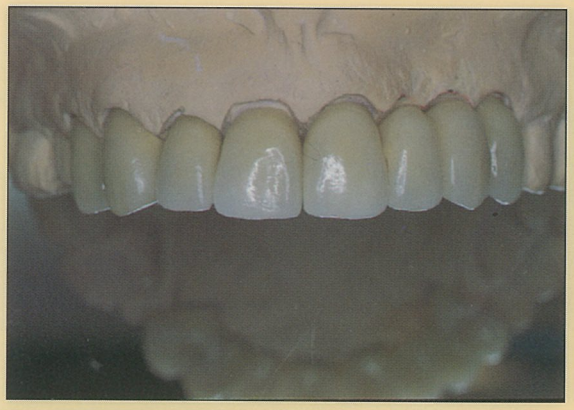


Figure 20: Crowns and bridge on the model

Figure 21: Crowns and bridge cemented in the mouth

Figure 22: Close-up view of the anterior teeth

Figure 23: Close-up view of the fixed bridge

three-quarter crowns were approximately half those of full crowns. When considering the major retainer in the fixed-movable design, however, the posterior three-quarter crown (where applicable) is a very satisfactory major retainer and can often be very aesthetic as well as being a minimal type of preparation.

POSTS IN ANTERIOR TEETH

Roberts (1970) deemed the post-crown unacceptable as a major retainer due to its poor success rate (with a failure rate of 4.35% per year). The failure rate of the post-crown when used as a minor retainer was only slightly better at 4.26%, indicating that the use of root-treated teeth and post crowns in bridgework would present problems and their removal may be advisable (Figures 12 to 23). This failure rate may be due to the flat top style of post-crown preparation previously taught at many UK universities (and still often used) which reduces the retention of the post crown as forces on it are directed along the post and to the cement lute and internal aspects of the root. Keeping supragingival dentine during preparation not only increases retention but also redirects forces down the periodontal ligament thus taking the stress away from the cement lute and internal (weak) dentine (Figures 24 to 26).

Mattison (1982) also showed that it is the bulk of the remaining tooth structure rather than the post and core that provides strength and resistance to fracture for the endodontically-treated tooth recommending that the post preparation should not remove too much dentine. This obviously has an effect on the design and size of access cavities prepared by the endodontist. The smaller the access cavity the stronger the residual crown/tooth complex, would seem to be the conclusion.

Figure 24: As much supragingival dentine as possible is kept in post preparation

Figure 25: Post cemented with wide cement lute

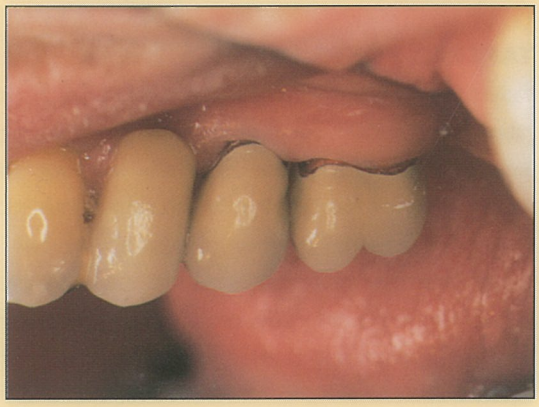
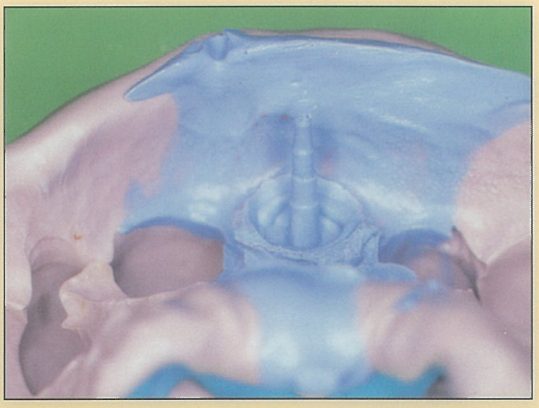
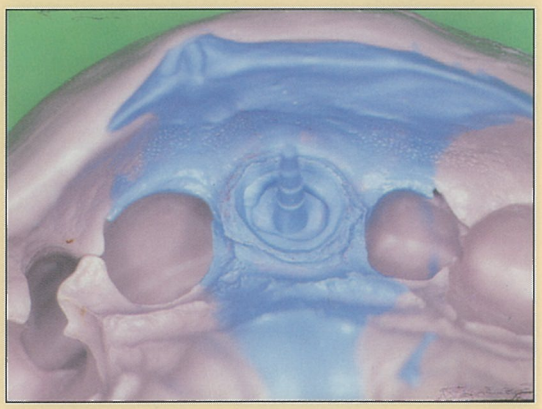


Figure 26: Crown cemented with ferrule effect





Figures 27 & 28: Shenker post impression

Figure 29: Supragingival dentine

TYPES OF POST: PARALLEL SIDED POSTS

The superior retentive abilities of a parallel sided post and core over tapered ones are well known (Standlee, 1978). Increasing post length will further increase retention (Johnson, 1978), as long as an apical seal of at least 4mm remains (Bourgeois, 1981). Additional retention is provided by serrated posts (Colley, 1968) and sand-blasted posts (Newburg, 1976). Parallel-sided posts can often however cause a widening of the preparation in the apical areas as increased length is required. The parallel-sided post is also more difficult to cement and causes an increased amount of stress on the root apex during cementation procedures.

Figure 30: Gold post with apical relief

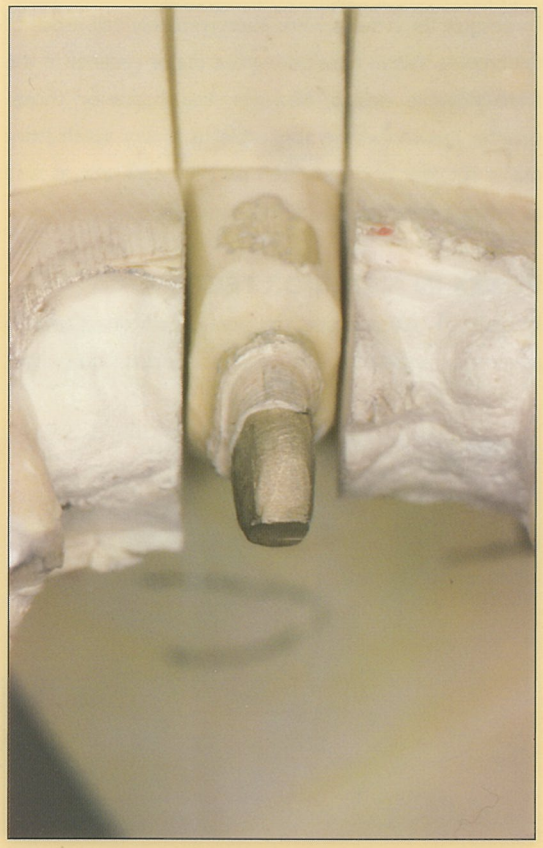


Figure 31: Gold post and core on silver die

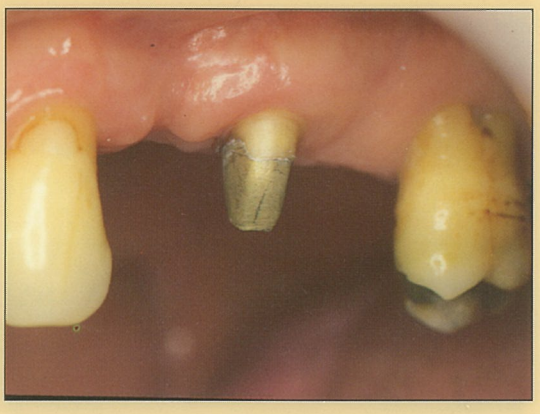


Figure 32: Gold post and core cemented in the mouth with wide cement lute

TAPERED POSTS

Tapered posts require less tooth removal during preparation than parallel-sided posts, thus increasing the amount of residual dentine left inside the root. The shape of the post is determined by the shape of the root canal being prepared. As most root canals are oval in shape rather than round, additional anti-rotation preparation features are not usually required. However, the literature suggests an increase in the splitting of teeth with tapered roots and higher coronal stresses (Standlee, 1972).

SHENKER POSTS

The problems with both parallel sides and tapered posts led Shenker to describe his approach of a series of parallel sided preparations whilst leaving the overall shape tapered to keep internal dentine. This method uses the Oppo-Post kit (Optident) during preparation starting with the thinnest post preparation bur and gradually 'walking back' out of the root canal with a succession of longer burs, creating a stepped shape. Attention must be paid to the smoothing of the possible sharp line angles inside the root by using 'Gates Glidden' burs. The overall effect is for a post which is stepped with a series of parallel sides when viewed labially and still overall tapered for anti-rotation when reviewed mesially. (Figures 27 and 28).

THREADED POSTS

Threaded posts exhibit greater resistance to displacement compared with non-threaded posts but are difficult to place (Law, 1976) and can create high stress levels and root fracture (Standlee, 1972). For these reasons they should be avoided where possible.

CARBON-FIBRE POSTS

Recently, carbon-fibre posts have been used in conjunction with composite cores to build up the root-filled tooth prior to preparation for a crown or bridge abutment. These posts increase the retention of the restorative material in the remaining tooth structure by using dentine adhesives and composite luting cement to bond the post to the root. This distributes stress more uniformly along the root, thus avoiding stress accumulation at weak points, increasing overall tooth resistance. Asmussen (1999) stated that carbon-fibre posts have a module of elasticity similar to dentine and thus 'bend' as one with the tooth during function, which may be a major advantage of these posts.

FERRULE EFFECT

Stress concentrations, which could lead to cement or post failure, have been shown to be more evenly distributed in those preparations where residual sound dentine has been incorporated into the core (Henry, 1977) (Figure 29). In fact, Hoag (1982) emphasised this point by stating that the post and core technique may not be as significant as the placement of the crown with margins one to two millimetres beyond the margin of the core. This is termed the ferrule effect.

CEMENTATION

Venting is required during cementation to allow excess cement to escape to minimise apical stresses. Trimming the apical 1mm of the post to allow for a reservoir of cement further reduces apical stresses (Figure 30). The cement should be placed and smeared inside the canal using a paper point as opposed to spiral filler which deposits too much cement in the canal and can cause increased stress during the cementation procedure, as the post becomes more difficult to seat. The post should fit passively in the canal prior to cementation and only hand pressure used to seat the post into the canal. This can lead to a wider than normal cement lute (Figures 25, 31 & 32) with the corresponding recommendation that the crown can be fabricated only after the post has been cemented, in order to reduce crown margin discrepancy and improve crown seating. A long bevel 60° angle should be added to the shoulder preparation to further increase the ferrule effect (Figure 26 & 33).

Figure 33: Crown with bevelled margin over post and core

ROOT FILLED POSTERIOR TEETH

The design of post retention for posterior abutment teeth is determined by the amount of coronal tooth structure remaining. If there is at least one residual cusp with sound supporting dentine, the tooth may be built up with a Nayyar core (Nayyar, 1980) incorporating amalgam into the pulp cavity and part way into the root canals. Bonding the amalgam core into the tooth with the latest generation bonding agents such as 'One Step'

and 'Resinomer' (Optident) can further strengthen the tooth.

Shillingburg (1981) stated that when no cusps are left standing a cast post and core should be fabricated using the longest root available for the post (i.e. distal in lower molars and palatal in upper molars). There are also several techniques available that allow a number of posts to be placed in divergent roots of multi-rooted teeth, although Pameijer (1985) suggests that it is usually impractical and unnecessary to strive for posts in every canal of multi-rooted molars. As previously mentioned the margin of the restoration should extend at least 2mm below the margin of the core even if this requires crown lengthening surgery to ensure an adequate ferrule effect (Hoag, 1982).

Nyman and Lindhe (1979) further emphasised that in order to minimise the risk of root fracture, a gold collar (ferrule) should circumscribe the neck of the tooth. They quoted the work of Sans (1965) who showed that the strength of root-filled teeth with a metal post and collar was more than ten times the corresponding strength of teeth without a collar, and that the wider the gold collar, the higher its retentive capacity.

It is wise, however, when working with posts or root filled teeth as abutments to minimise retentional demands on the cement lute of the post and core by incorporating a fixed-movable connector and placing extra stress on the periodontal ligament of the other abutment. In such cases the fixed-movable attachment is adjusted so that there is greater play between male and female. ■

CONCLUSION

The selection of abutments as retainers for bridgework is complex. The literature suggests however for maximum success especially in fixed/fixed bridgework, root filled, post retained restorations, partial veneer and adhesive restorations should be avoided.

The next article in this series will concentrate on cantilever bridgework.

REFERENCES

Asmussen E et al (1999). Stiffness, elastic limit, and strength of newer types of endodontic posts. *J Dent* **27:** 275

Bourgeois RS and Lemon RR (1981). Dowel space preparation and apical leakage. *J Endo* **7:** 66

Colley IT et al (1968). Retention of post crowns. An assessment of the relative efficiency of posts of different shapes and sizes. *Br Dent J* **124:** 63

Henry PJ and Bower RC (1977). Post core systems in crown and bridgework. *Aust Dent J* **22:** 46

Hoag EP and Dwyer TG (1982). A comparative evaluation of three post and core techniques. *J Prosth Dent* **47:** 177

Khan AE (1960). Partial versus full coverage. *J Prosth Dent* **10**: 167

Kaufman EG et al (1961). Factors influencing the retention of cemented gold castings. *J Prosth Dent* **11:** 487

Lau VMS (1976). The reinforcement of endodontically treated teeth. *Dent Clin North Am* **20:** 313

Mattison GD (1982). Photoelastic stress analysis of cast-gold endodontic posts. *J Prosth Dent* **48:** 407

Nayyar A et al (1980). An amalgam coronal-radicular dowel and core technique for endodontically treated posterior teeth. *J Prosth Dent* **43:** 511

Newburg RE and Pameijer CH (1976). Retentive properties of post and core systems. *J Prosth Dent* **40:** 538

Nyman S and Lindhe J (1979). A longitudinal study of combined periodontal and prosthetic treatment of patients with advanced periodontal disease. *J Periodontal* **50:** 163

Pameijer JHN (1985). *Periodontal and Occlusal Factors in Crown and Bridge Procedures*. Dental Centre for Postgraduate Courses, Amsterdam, Holland

Roberts DH (1970). The failure of retainers in bridge prostheses. *Br Dent J* **128:** 117

Sans F et al (1965). *Dubbels Taschenbuch Fur Den Maschinenbau*. Berlin, Heidelberg, New York. Springer - Verlag

Shillingburg HT (1981). *Fundamentals Of Fixed Prosthodontics*, 2nd ed. Quintessence Publishing Co Inc Chicago

Standlee JP et al (1972). Analysis of stress distribution by endodontic posts. *Oral Surg* **33:** 952

Standlee JP et al (1978). Retention of endodontic dowels: effects of cement, dowel length, diameter and design. *J Prosth Dent*: **39:** 40