IN BRIEF

- There are many post systems available for retaining a core, the major difference depending on whether the post is active or passive.
- Active (threaded) post systems provide improved retention compared with passive (smooth-sided or serrated) posts however, they introduce stresses into the root and are associated with higher failure.
- Following post space preparation, certain post systems require further modifications to the tooth prior to post cementation.
- The choice of luting cement is indicated by the post type, whether metal or quartz fibre.
- Adhesive resin luting cements should not be used as a routine for cementing metal posts.

Post and core systems, refinements to tooth preparation and cementation

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With a plethora of post systems available, it is often difficult to decide which one to use. This is made more difficult by the fact that new posts are introduced before existing ones are fully evaluated in laboratory and clinical studies. This paper therefore describes the different post types and the main advantages and disadvantages of each. In addition, the choice of post system will influence whether further tooth preparation is required and will dictate which luting cement and core material are most appropriate. Whilst the choice of post will, for many dentists, be driven by personal preference and a history of clinical success, there are certain pit falls to avoid and these are outlined.

RESTORATION OF THE ENDODONTICALLY TREATED TOOTH

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There is a multitude of posts available on the dental market, and as such choosing the ideal one is difficult. The basic principles of tooth preparation for the placement of a post have been discussed in the second of these papers, however, further modifications to the tooth preparation may be required for specific post types. This paper therefore reviews the different post types available and where appropriate what further tooth preparation needs to take place.

Posts (or dowels) can generally be divided into two main subgroups, depending on how retention is achieved. Active posts derive their primary retention directly from the root dentine by the use of threads. Passive posts on the other hand gain retention as their name suggests by passively seating in close proximity to the post hole walls, and rely primarily on the luting cement for their retention.[1] Each post type can further be subdivided according to its general shape, that is whether it is tapered or parallel sided. In general, active posts are more retentive than passive posts of a similar configuration, and parallel-sided posts are more retentive than tapered posts. Post choice should therefore be dictated by each clinical situation.

ACTIVE POSTS

Whilst active posts engage the root dentine with threads, they must always be cemented with a luting cement. This not only provides retention secondary to the threads, but is essential in creating a bacterial tight seal along the post length. Threaded (active) posts can be categorized further into self-threading or pretapped systems.

Self-threading posts

Self-threading posts have a shank (shaft) that is fractionally narrower than the post channel that is cut into the root and has a thread of wider diameter. Thus, as the post is screwed into place the threads cut their own counter-channel into the dentine. Self-threading posts can be either tapered or parallel in design. Probably one of the most commonly used tapered, threaded posts is the Dentatus screw (Fig. 1). Whilst it is more retentive than passive posts,[2] because of its tapered design, it introduces the greatest stresses within the root as it is inserted causing a wedging effect.[3] These stresses are exacerbated by the use of shorter posts (less than 5 mm), and when occlusal forces are added to the equation (Fig. 2). It has been suggested that these stresses can be reduced by unwinding the post by one-half of a turn, however, in reality little reduction is actually seen.

A novel post type, the Flexi Post, has been designed in an attempt to overcome the stresses that self-threading posts induce into the root

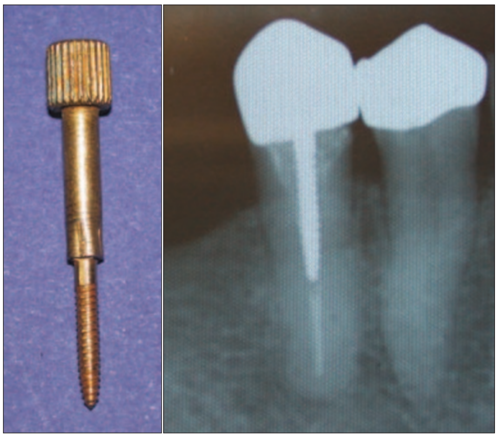

Fig. 1. To the left is a Dentatus screw post mounted in its driver and to the right is a radiograph of a Dentatus screw post in a lower single-rooted tooth. There is an obvious space apical to the post where complete seating has not been possible without further threat to root fracture due to the tapered post design.

Fig. 2. The use of a Dentatus screw post, with its self-tapping threads and tapered design creates large stresses in the root which in this case has led to catastrophic root fracture. The stresses induced into the root have been exacerbated by a relatively short post (shorter than the clinical crown height).

Fig. 3. Flexi Post having a split end design which collapses when screwed into the prepared post space. This post type is thought to induce less stress into the root structure.

Fig. 4. The Radix anchor post system consisting of, from left to right, a post space twist drill (penetration drill), a gauge to check the fit and orientation of the final post, a diamond-coated root facer (to produce a flat surface to seat the post head to), and the post itself mounted in a driver to screw the post into place. The post is first inserted without a cement lute, using an alternating half turn clockwise and a quarter turn anti-clockwise. The post is finally removed and cemented in place.

structure (Fig. 3). This is a parallel-sided threaded post with a split in its apical half. As the post is screwed in place, the split closes, transforming into a tapered post, absorbing some of the potential stresses. This post system has been popular in the USA and has been the sole subject of a multidisciplinary review.[4] In addition to this, a number of studies have demonstrated undoubted superior retention over other post systems.[5–9] Whilst this is a self-threading post, it is recommended that the post is screwed into the post channel initially without a luting cement, to cut a counter-thread on the post space walls. Following removal, the post can be reinserted and cemented definitively. Despite the 'collapsing' nature of the post design, which manufacturers claim reduces the stresses induced into the root, they are active posts and introduction of stresses is inevitable. The coronal half of the post is not split and it is in this area that the highest strain has been recorded in the root.[8,10]

Self-threading posts can also be of a solid, parallel design and these include the V-Lock and Radix Anchor Systems (Fig. 4). Both of these post systems have low-frequency sharp threads, which in the former extend the whole length of the post and in the latter are confined to the coronal portion of the post only. Thus if the root canal is irregular coronally or very flared, the threads of the Radix Anchor may not engage the dentine and as such do not influence the retention. As with the Flexi Post, it is recommended that the post is first inserted without cement, so cutting the counter-thread in the dentine. Following this it is removed and then reinserted with the cement lute. However, inserting the non-threaded apical portion and aligning the thread up with the prepared counter-thread in the dentine is difficult. Once the post has reached the full extent of the prepared channel, further rotation of the post introduces extreme stresses in the supporting structure.[10,11] It has therefore been suggested that when resistance to insertion is reached, the operator 'backs off' by one-half of a rotation.[11]

Pretapped posts

The Kurer Anchor post is an example of a pretapped post system (Fig. 5). Unlike the self-threading post systems, the pretapped post system has a high frequency thread around a parallel-sided shank. Once the post space preparation has been carried out the counter-thread on the internal aspect of the post hole is prepared with a thread cutter. The system also provides a Kurer Root Facer which flattens the root face onto which the head of the post seats. This unfortunately removes coronal tissue, which is important in creating a ferrule for the final restoration. During insertion of the post, the threads fit into the counter-threads and again it is important that the post does not engage the apical bevel created with the post space twist drill, as this will lead to excessive stresses.

There are two features of this post system which lead to high strain when the post is inserted. The first is that this post is not vented and the second is the high-frequency threads. The

Fig. 5. K4 anchor post system consisting of from left to right post space drill (width reamer) and root facer (similar to that of the Radix anchor system), a tapping device (thread cutter) which cuts the counter tap into the walls of the post hole, and the threaded post together with the driver above.

Fig. 6. Smooth-sided, tapered cast post and cores used to restore teeth 12, 11 and 22. All three are shorter and wider than required and inadequately extend to the prepared post hole. Tooth 22 also has no root canal filling.

absence of a vent means that it is more difficult for the luting cement to escape on insertion, however, the strains induced soon dissipate.[10] It has also been shown that stress patterns are distributed evenly along the whole length of the threads, thus with the higher frequency threads of the Kurer Anchor the higher the insertion strain is likely to be.[12] These posts should therefore be inserted at a low speed so allowing the strain to dissipate.[10] Despite the stresses and strains introduced in inserting posts, there is little information to support the fact that this leads to an increase in root fracture. The remaining amount of root tooth tissue is probably a more important determining factor of root fracture than the post type[13] and, once cemented, the higher frequency threads results in lower concentrations of stress under functional load[11] and these pretapped threaded posts prove to be the most retentive.[2,8,11]

There is division in the literature as to the use of active posts, whilst it is accepted that maximum retention is achieved, some would suggest that based upon this, the published research is clear that threaded posts are the method of choice for the restoration of endodontically treated teeth.[14] Others claim that because of the stresses induced into the root structure and the risk of root fracture, posts 'should be retained by cementation to the dentine walls of the root' and that 'active engagement of the dowel space by screw threads is contraindicated'.[15] A commonsense approach may be to reserve active posts for use when retention is compromised as in short or curved roots and use passive posts for other situations. Alternatively, improved retention could be achieved with the use of adhesive luting cements, which will be discussed later in this publication.

PASSIVE POSTS

Passive posts can either be custom made and cast in gold or non-precious alloys, or bought as preformed posts around which a core is built in the mouth or cast onto in the laboratory. Such posts can be tapered or parallel sided, and smooth or serrated.

Cast post and cores

The cast metal post and core has been the traditional, time-honoured method of restoring endodontically treated teeth. This has classically led to the production of smooth-sided, tapered posts conforming to the original taper of the root canal preparation, thus conserving tooth tissue and reducing the risk of post-perforation apically, which is a potential problem with parallel-sided post preparation (Fig. 6). However, such posts are known to exhibit the least amount of retention[2] and are associated with a higher failure rate compared to parallel-sided posts.[16]

In a frequently cited retrospective study (1–20 years) of 1273 endodontically treated teeth in general practice, 245 (19.2%) were restored with tapered cast post and cores.[16] Of these 12.7% were deemed failures. This failure rate was higher than that for the other passive post systems used (Fig. 7), despite the fact that it was the most commonly used post type. Of particular concern was the fact that 39% of the failures led to a tooth that was unrestorable and requiring extraction (Fig. 8). Thirty-six percent of the failures were due to loss of retention, which is consistent with what has been found in a laboratory study[2] and 58% were because of root fracture. It has been suggested that tapered smooth-sided posts have a 'wedging' effect under functional loading and it is this that leads to increased risk of root fracture.[17] Unfortunately, Sorensen and Martinoff (1984)[16] could not comment on the type of coronal tooth preparation carried out, but in a ten-year study of 138 teeth with a tapered cast post and cores only a 6.5% failure rate was recorded, with only two root fractures.[18] The lower failure rate and fewer root fractures was attributed to the presence of an adequate ferrule and careful tooth preparation.[18] Attention has also been drawn to the fact that the higher failure rate[16] may be due to the fact that nearly half of the posts were shorter than recommended from the literature (Fig. 9).[19]

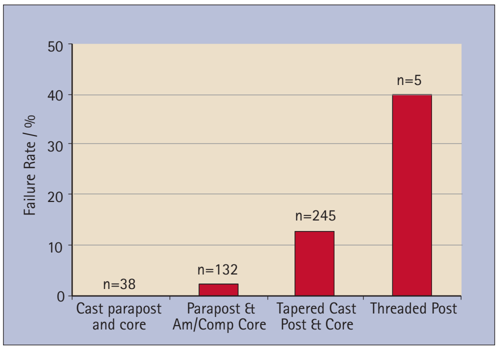

Fig. 7. The failure rate of various post systems over a 1–25-year observation period, based on data by Sorensen and Martinoff (1984).[16] The figures at the top of each bar representing the number of posts placed.

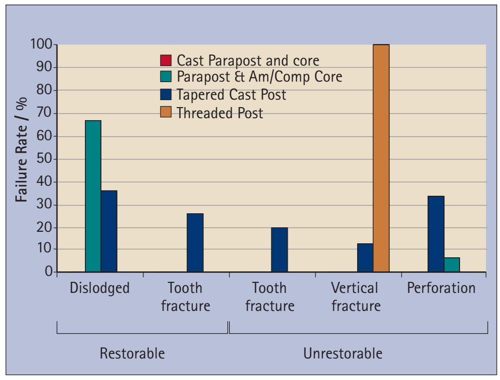

Fig. 8. The distribution of failures for each post type according to reason for failure and whether the teeth were restorable or not. Data is presented as a percentage of the total number in each post type. Based on data by Sorensen and Martinoff (1984).[16]

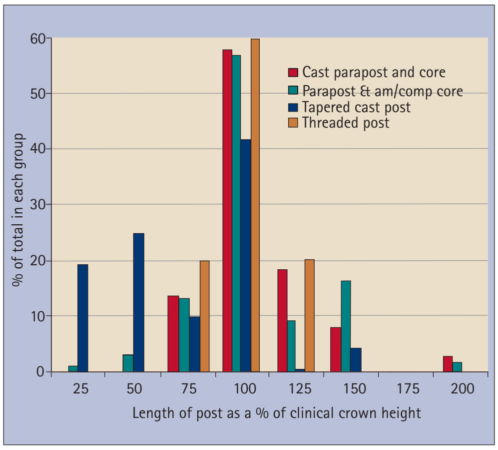

Fig. 9. The distribution of post length expressed as a percentage of the clinical crown height. Data is presented as a percentage of the total number in each post type. A greater proportion of tapered cast posts were shorter than the clinical crown height. Based on data by Sorensen and Martinoff (1984).[16]

In a clinical study of 456 tapered cast posts a similar cumulative failure rate as to that described by Sorensen and Martinoff (1984),[16] was noted over a four-to-five-year period (15%).[20] In this study, failure was also because of decementation.

The literature would appear to be divided over the use and success of cast tapered post and cores in the clinical setting. Extrapolation of findings from laboratory studies to the clinical situation should be taken with caution as clinically many factors can not be controlled for. It has been suggested that once a crown is placed over any endodontic restoration, the difference between treatment modalities beneath would be negligible and blurred making comparisons not possible.[21,22] Randomized clinical controlled trials provide the best clinical evidence, however, none have been performed comparing cast post and cores with other post types.[23,24]

A systematic review of the literature published between 1995 and 2000 identified 1773 publications in this field, however, only ten in vitro and six in vivo studies met the strict inclusion criteria. The results from a meta analysis carried out on the in vitro studies showed there was little difference in fracture mode between cast post and cores and directly placed post and core build ups. Inconsistencies within the data obtained from the clinical studies make it impossible to 'deem either cast or direct post and core restorations superior to the other'.[24]

The choice of post system used may depend on more fundamental practical issues. Cast post and cores can be more time consuming and involves an additional laboratory cost. The laboratory procedure itself may introduce errors associated with porosities within the casting thus increasing the risk of post fracture, although this has not been a significant finding within the literature reviewed.[25] Placement of burnout posts or wax into the post holes in working stone models may be difficult, resulting in cast posts of inadequate length compared with preformed systems. This has been a significant finding within the literature and has been associated with a higher failure rate.[16] Careful control of the casting technique, in particular the expansion of the investment material, will influence the dimensions of the cast post and hence the complete but passive fit of the post. A poorly seating cast post and core will result in increased marginal gap at the margins of the crown if made on the same model. Hence an additional dental appointment is required to fit the cast post and core and take an impression for the subsequent crown. It is probably for these reasons that preformed post systems with directly built cores have increased in popularity.

Preformed passive posts

Whilst tapered, preformed posts are available, their success is influenced by many factors such as the contact surface area between post and root dentine, the taper and shape of the post, the width of cement lute and the surface roughness of the post.[26] Because of this lack of predictability, manufacturers have taken the opportunity to produce parallel-sided serrated posts, so optimizing the retention achieved.[2] Tapered posts are self venting, that is, as the post is inserted, the taper of the post allows the excess luting cement to escape. This is not the case for precision fit parallel-sided posts. Cement within the post hole may prevent the post from seating because of the build up of hydrostatic pressure. Such posts are therefore vented to allow the excess cement to escape and the post to seat fully. Posts with horizontal serrations usually have a single vertical vent the entire length of the post, others have patterned recesses which interlink allowing the cement to escape. Such a post is illustrated by the Parapost System (Coltène/Whaledent), which has a patented raised diamond-shaped retention pattern (Fig. 10). Whilst less retentive and less resistant to compressive and tortional forces than active posts,[5,7] it is surprising to find that even though vented, such parallel-sided serrated posts introduce a similar amount of strain in the outer root surface on cementation.[10] This has been attributed to the hydraulic pressure build up within the cement lute, possibly because of insufficient venting. However, once seated, this strain is likely to dissipate, unlike with active posts. During function, the Parapost uniformly distributes the stress to the supporting tooth structure, with the cement layer acting as a buffer.

Fibre posts

Fibre-based post systems have been the subject of a recent systematic review by Bateman et al 2003.[27] The original fibre-based posts consisted of carbon fibres embedded in a polymer resin, usually epoxy resin (Fig. 11). The main advantage of these posts in that they flex slightly and under load distribute stresses to the root dentine in a more favourable manner than metal posts. Unfortunately, the carbon-fibre posts are black and unsuitable for use beneath all ceramic restorations. As a result, work was carried out on a tooth-coloured alternative, the silica-fibre or quartz-fibre post (Fig. 11).

These posts are a relatively new introduction to the dental armamentarium and most research has been carried out on the carbon-fibre posts in the laboratory. Few clinical studies have been carried out on the quartz-fibre posts which are more frequently used in practice, however, those that have been published suggest success in the short term. The systematic review undertaken suggests that based upon current literature there is a need for more extensive prospective randomized controlled clinical trails.[27] With the obvious benefits mentioned and the demand for high quality aesthetic dentistry, quartz fibre posts are only likely to increase in popularity.

METHOD OF POST CEMENTATION

All post space preparations should be clean, free from saliva and bacterial contamination and dry before the post is cemented. Use of the air from the three-in-one syringe may not be sufficient to dry at the apical region of the post hole, therefore after air drying, an absorbent paper point should be used. The actual method of post cementation is critical to ensure complete seating within the post space and that the luting cement adapts completely to both the dentine and post, thus completely sealing the interface between the two. The complete seating of the post can be ensured by measuring the prepared post space length with an endodontic instrument or periodontal probe and confirming that the post is inserted by the same amount. Cementation techniques include placing cement lute over the post and/or placing it in the post hole with a lentulo-spiral, paper point or an endodontic explorer. The most successful method was to place the cement into the post hole with a lentulo-spiral and coating the post before inserting[28,29] with a gentle pumping action to allow adequate venting of the post coronally.[30] If the cement is applied to the post alone a reduction in retention is observed.[31] Modifications to this technique will also depend upon what luting cement is used.

CHOICE OF LUTING CEMENT

Five main groups of dental materials are used to cement posts in situ; zinc phosphate, polycarboxylate, glass ionomers, resin-modified glass ionomers and composite resins. Zinc phosphate is the more traditional luting cement with a long and satisfactory history. It has been shown to give superior retention to polycarboxylate cement when tapered posts are used.[2] When parallel-sided serrated posts are used, there is little difference in retentive properties between zinc phosphate, polycarboxylate and glass ionomer[32,33] despite the latter two having adhesive properties.

Glass-ionomer cements are water-based materials and are susceptible to dissolution in a wet environment and dehydration in a dry environment. Microcracking during setting is not uncommon and failure in function may occur due to crack propagation. The addition of resin, in resin-modified glass ionomers, has the potential to overcome this, however, one study investigating the retention of posts under fatigue loading has shown no statistical significant difference between the two types of material.[34] A further study has even shown a reverse trend, with resin-modified glass ionomers having inferior retention to conventional glass ionomer.[35] The way in which the materials are mixed may also have an impact on retention, with encapsulated, mechanically mixed materials having a higher probability of post survival than hand-mixed glass ionomers.[36]

It has been suggested that the more conventional luting cements perform as well as composite resins.[37,38] However, if the smear layer is removed from the walls of the post space preparation a superior retention is achieved with the composite resin because resin can impregnate the dentinal tubules leading to micromechanical

Fig. 10. From left to right, the Parapost twist drill together with size matched Parapost XT and Parapost XH posts. The former post has an apical serrated pattern and a coronal 7 mm of threaded post, whilst the latter has a patented interconnecting diamond-shaped retention pattern which allows venting of the luting cement (Coltène/Whaledent, Altstätten, Switzerland).

Fig. 11. From left to right a carbon-fibre post (Composipost, RTD, France), two examples of translucent quartz-fibre posts, the DT Light-Post (RTD, France) and the Luscent Anchor post (Dentatus, Sweden), and the opaque Fiber White Post (Coltène/Whaledent, Altstätten, Switzerland).

retention.[39,40] This has been examined in a study in which 40% polyacrylic acid, 35% phosphoric acid, citric acid and a more dilute solution (0.2%) of EDTA were used to remove the smear layer.[41] In this study when the composite resin was used alone without a dentine bonding agent no improvement in bond strength was achieved. The use of a dentine bonding agent significantly improved the retention of posts cemented with composite luting cement.[41]

The logical progression has been to use adhesive resin luting cements such as 4-META based resins, C&B Metabond and Panavia EX. Panavia has been shown to be more retentive than zinc phosphate, glass-ionomer and polycarboxylate cements.[42] However, 4-META and C&B Metabond gave superior retention to Panavia, whose performance was found to be equivalent to a glass-ionomer luting cement tested.[43] Whilst not normal clinical practice, it has been suggested that the use of sodium hypochlorite after acid-etching the dentine, may cause deproteination of the demineralized tissue, potentially altering the bond strength. The use of hypochlorite in fact improves the bond strength of Panavia EX when used with ED Primer, and this was associated with an increased number of cylindrical solid tags formed in the dentinal tubules, compared to tapered hollow tags when no sodium hypochlorite was used.[44] A similar finding was reported by Ari et al (2003), with C&B Metabond giving higher bond strengths to dentine following treatment with sodium hypochlorite.[45]

Whilst superficially it would appear that there are huge benefits from the use of more retentive adhesive cements, a degree of retrievability is important. Occasionally, posts need to be removed to endodontically retreat teeth, or a post may fracture. Metal posts cemented with conventional cements such as zinc phosphate are removed by making a small gutter around the post followed by the application of ultrasonics.[46] This approach has been shown to be very successful and in a large clinical study of 1600 teeth from which posts were removed in such a way, and/or with the aid of an Egglers or Masserann kit, only 0.06% resulted in root fracture.[47] Adhesive resin cements make removal difficult, if not impossible, as the retention from a parallel-sided post can be as high as with an active, threaded post. When such posts are removed under force, up to 80% will result in root fracture.[8,48] Whilst failure to remove the post in a tooth with a failed root canal filling may lead to periradicular surgery or extraction, in a tooth with a fractured post, extraction is the only realistic option. Adhesive resin luting cements should not be used as a routine with metal-based posts, but reserved for those situations where retention is compromised. This is probably a favoured option compared to the use of active posts, however, patients should be made aware of the possible scenarios mentioned.

Whilst adhesive luting cements should not be used as a rule with metal-based posts the reverse is true for fibre-based posts, as these are removed in a different manner. Removal of fibre posts is achieved by progressively drilling through the middle of the post with specially designed reamers.[49] In the authors' experience this is not as simple as it would appear and further work in this field needs to be carried out.

A review of the literature on fibre-based post systems has revealed conflict in the retention of fibre posts cemented with resin-luting cements compared to metal-based posts similarly cemented. Most studies have found carbon-fibre posts to be either equally or less retentive than stainless-steel posts.[14] When failure occurs this has always been at the cement–post interface, thus there is benefit seen from a mechanically retentive fibre post design. However, creating the serrations on the fibre posts by machining can lead to cut fibres and posts that are less rigid and more susceptible to failure. Panavia 21 has been shown to have the highest bond strength to carbon-fibre posts, compared to C&B Metabond and Bis core. Using a newer adhesive resin (Scotchbond 1 and Rely X ARC), it has been shown that application of the bonding agent into the post space using a Microbrush, leads to an even distribution of tags formed along the whole length of the post walls. The Microbrush also leads to significantly more resin tag formation in the apical third of the post space than when a small plastic brush is used.[50] When using light-transmitting glass-fibre posts there is a choice of using either light-curing or dual/chemically curing resin-luting cements. One study has compared the two and has shown that the dual cured self-activating cement led to more uniform resin tag formation and better diffusion into the dentine than the light-cured variety.[51] In an attempt to simplify the clinical technique of using resin-luting cements that require acid etching of the dentine, rinsing, drying, application of the dentine bonding agent and finally the luting cement, 'one step' systems have been introduced. The 'three step' adhesive systems can create a wider micromechanical interlocking between adhesive materials and etched dentine than 'one-step' systems.[52]

It would therefore appear that the favoured cementation technique for fibre-based posts would be by acid etching using a Microbrush, thorough rinsing and drying using a three-in-one syringe and a paper point, application of the dentine bonding agent with a Microbrush and cementation with a dual or chemically cured luting cement.

POST HEAD AND CORE MATERIAL

Numerous studies that have been conducted on post types have concentrated on the configuration of the post within the root, however, the design and shape of the post head is also important as it significantly affects the retention of the core material.[53,54] Post heads can be of varying design, from the retentive discs radiating out from the Radix Anchor (Fig. 4) and Flexi Posts (Fig. 3) to the perforated round heads of the IntegraPost to the new retentive double round

Fig. 12. ParaCore (Coltène/Whaledent, Altstätten, Switzerland) and Build-It (Pentron Corp. Wallingford, CT, USA) fibre-reinforced core materials.

heads of the Parapost system (Figs 10 and 11).[55] The introduction of the rounded Parapost head has made a significant improvement in retention of both amalgam and composite cores compared to the conventional flattened head version[56] and this post performs as well as the perforated spherical head of the IntegraPost.[55]

As posts are mainly used in anterior or single-rooted teeth most core material will be of composite, resin-modified glass ionomer or glass ionomer. The major benefit of glass ionomer as a core material, is the frequently cited anticariogenic properties,[15] however, a systematic review of clinical studies has shown no conclusive evidence either for or against this alleged effect.[57] In general, composite has superior properties, giving greater retention and fracture resistance to preformed posts than either glass ionomer or amalgam.[54,58,59] This combination of composite and preformed post has also been shown to be more resistant to fatigue loading than cast post and cores.[60] Composite also has additional advantages, the most obvious are that it is adhesive to tooth tissue when used with bonding agents and is tooth coloured. When used with a tooth-coloured fibre post and an all ceramic crown, excellent aesthetic and translucent properties can be achieved. A resin-luting cement can also be used, utilizing the silane coupling agent on the crown's fit surface, so bonding the ceramic to the tooth and composite core. Finally, it is easy to use and the placement and preparation can be carried out at the same visit. Concern has been expressed over the possible expansion of the material in a wet environment such that a crown may not seat when fitted a week or two later.[61] Clinically this is not a problem as the technician places die relief on the master die in the laboratory and this allows for any microscopic exapansion.[62]

More recent dual-cured, fibre-reinforced core materials have been introduced such as ParaCore (Coltène/Whaledent, Altstätten, Switzerland) and Build-It (Pentron Corp. Wallingford, CT USA) (Fig. 12). These can be used in conjunction with core formers and being mixed in a double helix dispenser benefits from an even, bubble-free mix (Fig. 13). Whilst these have excellent handling properties, there is no known published data based on clinical trials using these materials.

WHAT TO AVOID

Because there are so many different post types on the market with different permutations of morphology (tapered, parallel or double tapered) and retentive design (active or passive), it is sometimes easier to look at what to avoid. In the authors' opinion:

- Tapered, threaded posts should be avoided at all costs because if screwed into place the stresses created in the root dentine can lead to root fracture. If these posts are used they should only be cemented passively and this leads to inadequate retention.
- Threaded posts in general should be avoided as the disadvantages outweigh the advantages. The main advantages are that they give better retention than a corresponding smooth-sided or serrated post, and generally are easier to remove by unscrewing. However, the stresses they introduce into the root leads to a greater risk of vertical root fracture. A number of these post systems also have root facers to flatten the root face to facilitate seating and stabilization of the post, but this simply removes more coronal tooth tissue that is available to create the ferrule effect. The improved retention once sought from threaded posts can now be achieved with adhesive luting cements.
- Do not cement metal posts with adhesive luting cements as a routine. This allows some degree of retrievability.
- Avoid ceramic posts as these do not flex like quartz-fibre posts. The material is brittle and if fracture occurs removal is extremely difficult.
- Avoid posts in multirooted posterior teeth where possible.

WHAT TO LOOK OUT FOR IN THE FUTURE

Post systems are introduced onto the market at an alarming rate. At present and in the future there is likely to be greater emphasis on quartz-fibre post systems and posts having dual function and double taper. The general trend toward more aesthetic dentistry will lead to the demise of metal-based restorations. To achieve good appearance, translucency throughout the entire restoration should mimic that of a natural tooth. This obviously starts with the post and core and the need for quartz fibre and composite technology.

As quartz-fibre posts are removed, when necessary, by drilling them out, the posts should be

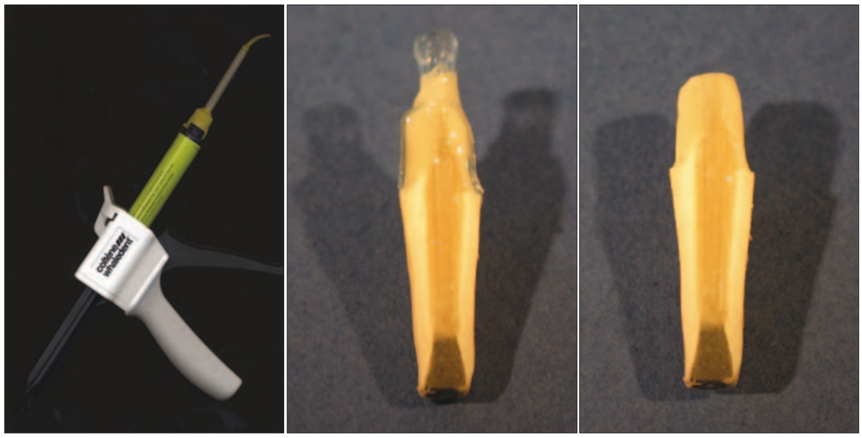

Fig. 13. The ParaCore dispenser, with a double helix mixer tip to the left, enabling the fibre reinforced material to be injected into a Core Former (middle) resulting in a homogeneously mixed core (right) (Coltène/Whaledent, Altstätten, Switzerland).

cemented with an adhesive luting cement. This leads to improved retention and as such the need for posts with parallel sides along their entire length are much less. As such manufacturers are concentrating on posts that conform to the anatomy of the root and posts with greater taper apically and more parallel coronally are being introduced. This has the advantage of reducing the risk of weakening the root apically or perforation, but still maintaining adequate retention.

From this review of the literature it is clear that there are many aspects to post retained crowns, their tooth preparation and cementation that can influence the long-term success of the restoration. In laboratory studies the components and methods are individually investigated, and the results highlighted in this review point toward better clinical practice. But once the individual components are put together in the final restoration the impact that each part plays may not be so profound. Greater differences in outcome are likely to depend on the operator and individual patients. Each clinical situation will dictate to some degree what post system will be used and for those situations where there is choice, personal preference, familiarity and cost will influence the final decision.

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