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COMPARISON OF MECHANICAL PROPERTIES OF VARIOUS POST AND CORE MATERIALS

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Statement of problem : Many kinds of post and core systems are in the market, but there are no clear selection criteria for them.

Purpose : The purpose of this study was to compare the flexural strength and modulus of elasticity of core materials, and measure the bending strength of post systems made of a variety of materials.

Material and Methods : The flexural strength and elastic modulus of thirteen kinds core buildup materials were measured on beams of specimens of 2.0 × 2.0 × 24 ± 0.1mm. Ten specimens per group were fabricated and loaded on an Instron testing machine at a crosshead speed of 0.25mm / min. A test span of 20 mm was used. The failure loads were recorded and flexural strength calculated with the measured dimensions. The elastic modulus was calculated from the slopes of the linear portions of the stress-strain graphs. Also nine kinds commercially available prefabricated posts made of various materials with similar nominal diameters, approximately 1.25mm, were loaded in a three-point bend test until plastic deformation or failure occurred. Ten posts per group were tested and the obtained data were anaylzed with analysis of variance and compared with the Tukey multiple comparison tests.

Results : Clearfil Photo Core and Luxacore had flexural strengths approaching amalgam, but its modulus of elasticity was only about 15% of that of amalgam. The strengths of the glass ionomer and resin modified glass ionomer were very low. The heat pressed glass ceramic core had a high elastic modulus but a relatively low flexural strength approximating that of the lower strength composite resin core materials. The stainless steel, zirconia and carbon fiber post exhibited high bending strengths. The glass fiber posts displayed strengths that were approximately half of the higher strength posts.

Conclusion : When moderate amounts of coronal tooth structure are to be replaced by a post and core on an anterior tooth, a prefabricated post and high strength, high elastic modulus core may be suitable.

CLINICAL IMPLICATIONS

In this study several newly introduced post and core systems demonstrated satisfactory physical properties. However when the higher stress situation exists with only a minimal ferrule extension remaining a cast post and core or zirconia post and pressed core are desirable.

Key Words
Post and core material, Flexural strength, Bending strength

The main function of the post is to retain a core and distribute the occlusal stresses along the remaining root structure. The literature has shown that a post does not reinforce the endodontically treated tooth. [1-6] As a general rule, when there is less than half the coronal tooth structure remaining, a post and core is indicated. The ferrule extension, defined by Sorensen and Engelman [7]as the remaining tooth structure coronal to the crown margin, plays a critical role in the prognosis for success of the restored endodontically treated tooth. A ferrule length of 1mm above the crown margin approximately doubled the failure threshold compared to when no ferrule extension was present .[7] In fatigue testing, studies evaluating the ferrule effect showed the coronal extension should be 1.5 mm [8] to 1.25 mm .[9] When the ferrule extension is relatively short, increased stresses are placed on the core buildup material. This in turn places increased demands on the strength of the core material.

In the restoration of endodontically treated teeth a core buildup is usually retained by a combination of posts, tooth preparation features or a bonding system. With the proliferation of high translucency ceramics for fixed prosthodontics clinicians have placed increasing importance on the esthetic qualities of post and core materials. Many dentists have moved away from dark cast metal post and cores in favor of white or translucent fiber or ceramic posts. With esthetics as the primary goal, a wide variety of core materials with disparate properties are used by clinicians in the restoration of endodontically treated teeth. Greatly diverging philosophies have developed regarding the priority of and desirable properties of the core and post materials used.

Some clinicians and manufacturers have developed the theory that a post material having a lower elastic modulus similar to dentin tooth structure should be utilized. [10-14] Placement of a dentin adhesive, direct fiber and composite post and core restoration has even been advocated. [15,16] Others [17-20] believe that a high stiffness post better distributes stresses to the root and provides greater clinical longevity. These theories have to date remained untested in clinical trials which is partly due to the difficulty in isolating the variables for study. Considering that all-ceramic crowns have a higher strength when supported by a higher elastic modulus substrate material [21] these lower elastic modulus materials may be undesirable.

Use of a prefabricated post mandates the use of direct core buildup. Due to the esthetics, ease and speed of fabrication in one appointment, composite resin is by far the most popular core material in clinical practice. Although the cast post and core may have a dark appearance it does have the advantage of being unified into one piece with significantly higher physical properties than composite resin cores or fiber posts.

In 1989, Kwiatkowski and Geller [22] introduced the concept of a cast glass ceramic post and core with the rationale that they would not change the translucency or color of the pulpless tooth. While outstanding esthetics were achieved, the glass ceramic was deficient in strength. In dentistry, zirconia ceramics have the highest fracture toughness, a high Weibull modulus and considerable flexural strength. The superior mechanical properties and esthetics of zirconia have made it a promising material for endodontic posts. The first ceramic posts made of tetragonal zirconia polycrystals (ZrO_2-TZP) stabilized by 3 mol% Y_2O_3 were augmented by bonding two O-rings of zirconia as a retentive head. [23] Using this zirconia post system required a fairly involved protocol of cementing the zirconia rings and then adding a hybrid type composite resin . [23] To achieve a unified post and core, Schweiger et al. [24] developed a pressable glass-ceramic ingot that allowed waxing and pressing a core directly onto a zirconia post (IPS Empress Cosmo Ingots, Ivoclar vivadent, Amherst, NY). The durability, strength and stiffness of the core buildup material can have a marked effect on the life of the buildup and hence the survival of the crown or prosthesis that it supports. Determination of which physical properties of buildup material will best characterize and predict clinical performance and longevity is challenging.

The purposes of these studies were to 1) compare the flexural strength and modulus of elasticity of core buildup materials, 2) measure the bending strength of post systems made of a variety of materials.

I. FLEXURAL STRENGTH AND ELASTIC MODULUS OF CORE BUILDUP MATERIALS

Material and Methods

A variety of core materials such as amalgam, composite resins with different polymerization modes, glass ionomer, glass cermet, resin modified glass ionomer (RMGI) and ceramic were tested (Table Ⅰ). The flexural strength and elastic modulus were measured on beams of specimens of 2.0 × 2.0 × 24 ± 0.1mm(Fig. 1). The high-copper

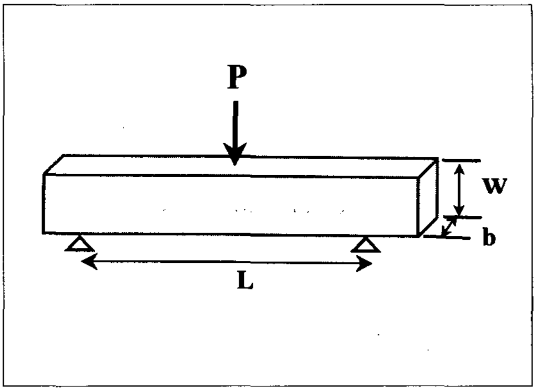

Fig. 1. Specimen geometry for the determination of flexural strength. FS = MC/Ic, where M = (L/2) *(P/2), C = (1/2)*W, Ic = bW^3/12, FS = 3/2(PL/bW^2). For b and W are in mm, P in lbs and L = 20 mm.

Table Ⅰ. Core materials investigated for flexural strength and modulus of elasticity properties. Letters in bracket are abbreviation of brand

Brand	Classification	Color	Manufacturer
Bis-Core(BCL)	Light-cured composite resin	Yellow	Bisco, Schaumburg, IL
Bis-Core(BCD)	Dual-cured composite resin	Yellow	Bisco, Schaumburg, IL
Light-Core(LC)	Light-cured composite resin	Clear	Bisco, Schaumburg, IL
Core Paste(CP)	Autocured titanium reinforced composite resin	White	Den-Mat, Santa Maria, CA
Luxacore(LCN)	Light-cured composite resin	Natural	DMG GmbH, Hamburg, Germany
Luxacore(LCB)	Light-cured composite resin	Blue	DMG GmbH, Hamburg, Germany
Clearfil Photo Core(CPC)	Light-cured composite resin	Clear	Kuraray America, New York, NY
Ti-Core(TC)	Autocured titanium reinforced composite resin	Natural	EDS, Hackensack, NJ
IPS Empress Cosmo Ingot(COP)	Pressed ceramic	Natural	Ivoclar Vivadent, Amherst, NY
Miracle Mix(MM)	Glass Cermet	Black	GC America, Alsip, IL
Tytin(TN)	High copper amalgam	Gray	Kerr/Sybron, Romulus, MI
Fuji IX(FX)	Glass ionomer	White	GC America, Alsip, IL
Relyx(RX)	Resin-modified glass ionomer	Natural	3M ESPE, St.Paul, MN

amalgam(Tytin, Kerr/Sybron, Romulus,MI) was triturated according to the manufacturer's instructions, placed into the mold, and condensed in a conventional method. The amalgam was carved and burnished flush with the top of the mold. It was allowed to set 20 minutes before removal to prevent fracture of the specimens. Composite resin core materials, glass ionomer, glass cermet and RMGI were mixed following the manufacturers' instructions and injected into the mold. A glass slab was placed over the material to form a flush surface with the top of the mold. Light cured specimens were illuminated in the molds in a dental light-curing unit(Triad II, Dentsply International, York, PA) for 120 s from both the top and bottom surfaces. After removing the specimens from the mold, an additional 60s of light curing was performed on both surfaces. For the ceramic core beams, modelling resin (GC Pattern Resin LS, GC America, Alsip, IL) was used to make patterns and were invested in Speed Investment (Ivoclar Vivadent, Amherst, NY). The patterns were burned out and IPS Empress Cosmo Ingots pressed with an EP500 pressing furnace (Ivoclar Vivadent, Amherst, NY) at 920℃. All specimens were ground to the final dimensions with 600 grit paper and stored in water at 37℃ for 24 hours before testing .

Specimens (10 per group) were loaded on an universal testing machine (Model TT-B, Instron Corp., Canton, MA) at a crosshead speed of 0.25mm/min until failure. A test span of 20 mm was used. The failure loads were recorded and flexural strength calculated with the measured dimensions. The elastic modulus was calculated from the slopes of the linear portions of the stress-strain graphs. Data were analyzed with analysis of variance and Tukey multiple range comparison tests.

Results

Analysis of variance(F ratio 102.2, P<.001) and Tukey multiple range tests(P<.05) showed significant differences between materials tested for flexural strength. Flexural strength means and standard deviations are illustrated in Fig. 2. Mean values ranged from 24.5(SD 4.2) MPa for Fuji IX to 139.5(SD 8.1) MPa for Tytin amalgam. Clearfil PhotoCore and the Luxacore composite resins had strengths approaching that of amalgam. As expected, the strength of the glass ionomer and RMGIs were very low. The strength of the glass cermet material was so low that the bar specimens broke during the setting up of the loading tip on the Instron testing machine.

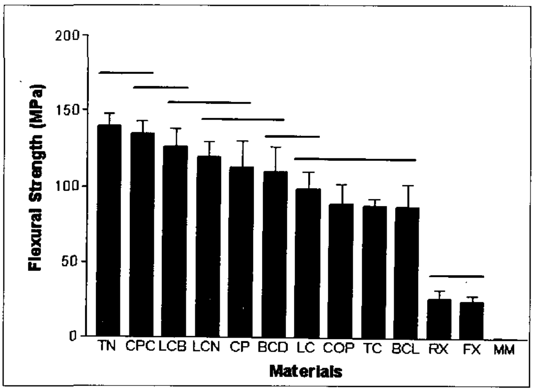

Fig. 2. Flexural strength means and standard deviations in MPa. Groups in same horizontal lines are not significantly different.

Analysis of variance(F ratio 165.36, P<.001) and Tukey multiple range tests(P<.05) revealed significant differences in modulus of elasticity between core materials. Elastic modulus means and standard deviations are displayed in Fig. 3. The mean value ranged from 7.33(SD 0.5) GPa for Ti-Core composite resin to 57.2(SD 1.4) GPa for Tytin amalgam. Elastic modulus of CosmoPost core

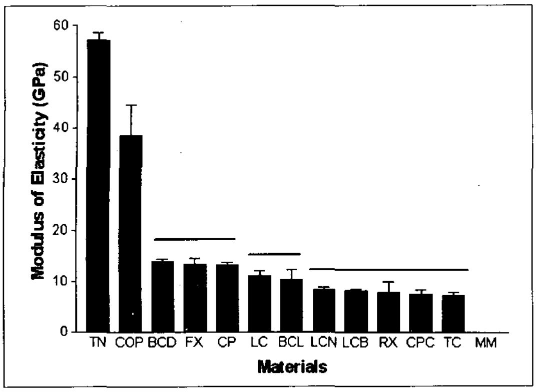

Fig. 3. Modulus of elasticity means and standard deviations in GPa. Groups in same horizontal lines are not significantly different.

and amalgam were significantly higher than the other materials tested. The relative order of core materials for flexural strength and elastic modulus was quite different.

II. BENDING FORCE OF PREFABRICATED POSTS

Material and Methods

Commercially available prefabricated posts made of various materials (Table Ⅱ) with similar nominal diameters, approximately 1.25 mm, were loaded in a three-point bend test until plastic deformation or failure occurred. A test span of 13.0 mm was used on an Instron testing machine with a crosshead speed of 0.25 mm per minute. Ten posts per group were tested and data were examined with analysis of variance and Tukey multiple comparison tests.

Results

An analysis of variance showed significant differences between groups (F ratio 82.76, P<.001) and Tukey multiple comparison tests showed significant differences in bend strength between the post systems(P<.05)(Fig. 4). The stainless

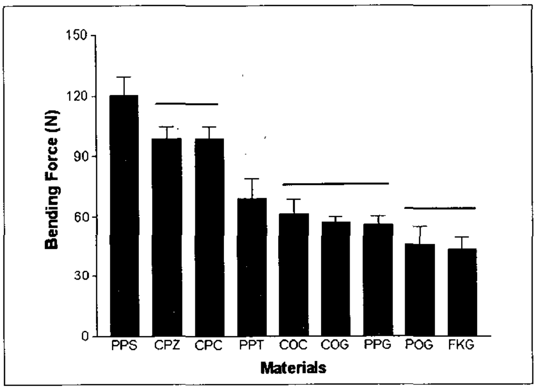

Fig. 4. Bending force means and standard deviations in N. Groups in same horizontal line are not significantly different.

Table Ⅱ. Post systems examined for bending force. Letters in brackets are abbreviation of brand

Material	Brand	Manufacturer
Stainless steel	Parapost(PPS)	Coltene-Whaledent, Mahwah, NJ
Zirconia	Cosmopost(CPZ)	Ivoclar Vivadent, Amherst, NY
Carbon fiber	C-Post(CPC)	Bisco, Schaumburg, IL
Titanium	Parapost(PPT)	Coltene-Whaledent, Mahwah, NJ
Carbon fiber	Core Post(COC)	Den-Mat, Santa Maria, CA
Glass fiber	Core Post(COG)	DenMat, Santa Maria, CA
Glass fiber	Parapost(PPG)	Coltene-Whaledent, Mahwah, NJ
Glass fiber	FRC Postec(POG)	Ivoclar Vivadent, Amherst, NY
Glass fiber	FibreKor Post(FKG)	Jeneric/Pentron,Wallingford,CT

steel post was significantly stronger than the other post systems. The zirconia(Cosmopost) and carbon fiber posts(C-Post) were similar but significantly stronger than the titanium post(Parapost). As a class of materials, the glass fiber posts had the lowest strength of any material tested and had values approximately half that of zirconia(Cosmopost) and carbon fiber (C-Post) posts. The DenMat carbon fiber post had a bend strength about half that of the Bisco carbon fiber post.

DISCUSSION

Because the core becomes an integral part of the load-bearing structure of the damaged tooth, it should provide a satisfactory properties for retention and resistance of a cast restoration. All of the direct placement core materials require bulk of material for strength. Therefore, the small dimensions of core material available in an anterior tooth preparation further compromise the strength of direct placement core materials. Complicating matters further is that the simple presence of the post within the core weakens the core when its function is to retain the core.[25,26]

Composite resins and RMGIs have a number of disadvantageous properties when used as core materials. Composite resin cores have greater microleakage than amalgam under crowns.[27] Polymerization shrinkage of composite resin tests even the best dentin adhesives. Evidence has recently emerged showing that the self-etching primers can cause inhibition or retardation of polymerization of composite resins due to the acidic environment. In comparing the dimensional stability of core materials, composite resin cores absorbed moisture up to one week before reaching an equilibrium while amalgam was stable at two hours .[28] Resin-modified glass ionomers have even greater problems of hygroscopic expansion when used for cements or core build-ups. Many studies have reported a large amount of linear expansion with this class of material.[29,30] Sindel et al. [30] using pressable ceramic caps on molars discovered after 12 months water storage, that compomer or RMGI for core buildups or luting resulted in cracking of all the caps while none of the crowns supported by composite build-ups and resin cements cracked. Other reports have confirmed that the RMGIs are unsuitable for cements and cores under the lower strength all-ceramic crown systems .

Significant advancements appear to have been made in strengthening composite resin core materials. In this study Clearfil PhotoCore and the Luxacore composite resins had strengths approaching that of amalgam. The three highest strength composite resin core materials were light cured. Clinically, to insure complete polymerization the core material would have to be applied incrementally. As expected, the strength of the glass ionomer and RMGIs were very low. A number of other studies have also shown the same relationship of amalgam being strongest followed by composite resin and finally that glass ionomer is too weak to be used as a core material. [31-35]

Of the direct placement materials, amalgam has the most desirable properties such as high strength, high stiffness and dimensional stability, but has significant disadvantages such as discoloration of tooth structure from corrosion byproducts which preclude its use in anterior teeth. Also, when amalgam is placed around the retentive head of the prefabricated post and the tooth prepared to proper dimensions for an anterior crown, pieces of the amalgam may break off. Amalgam used as a coronal radicular core without a post has been shown to provide an excellent foundation for the restoration of posterior endodontically treated teeth. [36]

When the majority of an anterior tooth preparation is comprised of a buildup material, many of the materials investigated would simply not be strong enough. Combining the disadvantages listed above and the flexural strength findings of the present study, for clinical practice it would rule out the use of glass ionomer, RMGI and the bottom half of the composite resins tested. Another consideration then is whether the low elastic modulus of even the strongest composite resin is acceptable. Short term clinical studies have shown several of the composite resin core materials have worked well.[37] A 10-year retrospective study on root resected endodontically treated teeth found that the majority of failures did not take place until 7 to 10 years after restoration.[38] Most materials and techniques will work for the first four years .[38] The glass-ceramic core material results create an interesting turn in the physical property measurement results. The present study found that it behaved nearly the opposite of the composite resins. The glass-ceramic core had a strength in the range of the lower strength composite resins yet it had an elastic modulus that was about five times greater than the two highest strength composite resins and nearly three times that of the highest elastic modulus composite resin (Bis-Core Dual) (Fig. 2 and 3). The modulus of elasticity of the glass ceramic was about 73% of amalgam, 49% of Type III gold, 45% of human enamel, 36% of Au-Pd alloy, and 24% of a Ni-Cr alloy.[39,40] Early clinical study results on zirconia post pressed glass-ceramic cores (CosmoPost) are promising but long-term evaluation is needed.

Kovarik et al.[35] were able to correlate the initial flexure of the post-core-crown restoration of core materials with their fatigue life. Amalgam cores had about one-third of the initial flexure of composite resin cores. In fatigue tests, 67% of amalgam cores survived 10^6 cycles while only 17% of composite cores survived. All of the glass ionomer cores failed early by about 220,000 cycles. The glass ionomer cores all showed fracture around the post head due to inadequate strength. The composite resin cores had adequate strength (no core fractures were observed) but 50% of failures were due to cement failure at the crown-core interface and 40% by post fracture. These modes of failure were evidence of the composite resin core's low modulus of elasticity. Fatigue tests offer a more valid characterization of materials closer to the clinical failure mode. With the technique advocated by Hornbrook and Hastings[16] with direct fiber placement along with a resin cement to fill the canal and form the core, one would expect this foundation restoration to have an extremely low stiffness, low resistance to deflection and low fatigue life. Sorensen and Martinoff[4] found in their retrospective study of 1,273 endodontically treated teeth that of the six methods of intracoronal restoration the cast Parapost and core had the highest success rate.

The use of prefabricated posts creates concerns as to the quality of the bond to a directly placed core material. A short ferrule extension not only increases the stresses on the core material itself but also tests the bond of post to core material. Innovative head designs of the post have been developed for better retention and reduced stress. But, the presence of the post within the body of the core still reduces the strength of the core.[25,26]

Although clinicians have considered the carbon fiber post to have a relatively low elastic modulus, the present study showed in a bending force test mode that the carbon fiber post is relatively stiff and strong. The carbon fiber post (C-Post) was similar to the zirconia post and significantly stronger than a titanium post. Other studies have shown that in comparison to prefabricated metal posts, the Composipost (RTD, Meylan, France) was also comparable in strength and stiffness .[41,42] Different from the current study, Asmussen et al.[42] found that the zirconia posts were significantly stronger than carbon fiber posts (Composipost). Several studies have shown that a high stiffness, high yield strength post is desirable. [20,43] A previous study found that the rigidity of the carbon fiber post exceeded that of the stainless steel posts tested in transverse bending. [44]

Since the post is primarily responsible for transmitting the occlusal forces to the remaining tooth structure and fundamentally serves to retain the core buildup, the physical properties of the post are critical. If the functional occlusal forces exceed the elastic limit of the post it will cause separation of the core due to permanent deformation of the post. No matter how tough the core material, eventually the core will breakdown resulting in either caries or dislodgement of the crown or fixed prosthesis.

If the modulus of elasticity of the post is too low the breakdown process can be more insidious. A low stiffness core material further contributes to the problem. Cementation of a crown on a low stiffness core potentially creates a problematic situation. With cyclic fatigue loading in the functional occlusal environment over many years, the low elastic modulus post and core will flex microscopically, gradually causing the breakdown of the cement. As the cement cracks and is pulverized, the saliva will washout of the margin allowing ingress of bacteria and further axial penetration of the saliva. This point in the clinical progression has been termed preliminary failure by Libman et al [8] and is clinically impossible to detect because the margin adaptation in the unloaded state appears undistrubed.

With continued cycles of fatigue loading and cement breakdown, the force transmission to the entire restorative complex becomes more exaggerated. With greater movement, the crown cement breaks down further, creating more movement which then tests the bond between core and post with the excessive flexure of the coronal portion of the post. The core separates from the head of the prefabricated post and breaks down. Flexure of the post also breaks down the cement that secures the post in the canal even if the post has been adhesively cemented. These considerations coupled with the finding that water storage reduced the strength and stiffness of carbon fiber posts by 65% [12] adds further concerns as to the longevity of prefabricated posts and composite resin cores. All of these phenomena lead to the ultimate catastrophic failure of the entire restorative complex. Most of the events are impossible for even the most astute clinician to detect until it is too late and the system brakes down. The breakdown cycle may take seven to ten years to occur. [38]

The different coefficients of thermal expansion of the various components create yet another potential source of deleterious effects on the bonds between the tooth-post-core-cement-crown complex. The combined effects of thermal cycling, fatigue loading and aqueous environment test the bond between materials and break down the materials. This is why it is desirable to unify the post and core in one material for long-term stability. A cast metal post and core is currently the only method that allows this goal. The zirconia post and pressed glass-ceramic core also achieve this goal to a great degree but based on the results of the present study does not have the overall strength of the cast metal post. Many dentists elect for expediency and do not want to use the necessary two appointments for fabrication and cementation of the cast post and core.

The diameter of the post systems tested in this study were all within 1.25 mm. A problem with some previous studies has been a lack of standardization of the diameter of posts tested. Cormier et al. [45] tested post strength with diameters ranging from 1.5 to 1.8 mm. The smallest diameter post had the lowest strength. Asmussen et al. [42] pointed out that in Isidor et al's [46] fatigue testing study that endodontically treated teeth restored with Composipost (1.8 mm diameter) had a higher resistance to fracture than when restored with the Parapost (1.5 mm diameter). Asmussen et al's[42] data demonstrated that the 1.8 mm Composipost was actually stiffer than the 1.5 mm metal Parapost.

The diameter of the new alternative fiber and zirconia post systems tend to be significantly larger than conventional stainless steel or titanium post systems. In an attempt to standardize the post sizes, Cormier et al. [45] used the largest diameter #7 Paparposts to be comparable with the non-metallic post systems. The authors typically used a #3 or #4 cast Parapost. Increased dowel diameter makes little difference in retentive capacity [47] and many studies have shown that it is the remaining tooth structure that makes the tooth stronger and resistant to fracture. [48-51] A disadvantage of these large diameter post systems is that additional tooth structure must be removed to accommodate their large diameters thus weakening the tooth. The astute clinician should realize that there are numerous clinical situations where many of these large diameter posts would be contraindicated because strength conferring tooth structure should not be removed in order to accommodate a large diameter post.

Cormier et al. [45] performed an interesting in vitro comparison of fracture resistance of various types of post systems progressing through various simulated clinical stages. They evaluated posts only, posts alone bonded into teeth, posts bonded into teeth with core buildup, and post and core buildup and full crown. For the first two stages, the titanium post was significantly stronger than the other post systems. However, once the core buildup was placed, there was no significant difference in fracture resistance between titanium, cast alloy, carbon fiber or zirconia posts. Only the glass fiber post was consistently weaker throughout all four stages of the study. The most important finding of this study was that placement of a crown with a 1 mm ferrule distributed the stresses so as to render even the weakest post system not significantly different from three of the other post systems. This confirms earlier work by Hoag and Dwyer[52] and Gelfand et al. [53] showing that the placement of a crown negated many of the effects of dowel placement, length, shape or material used. Crown placement is the great equalizer. Any study evaluating factors in restoration of endodontically treated teeth must have crowns cemented over the post or core in order to realistically represent the clinical situation. Sorensen & Engelman [7], and Assif et al. [5] in static load to failure tests and Libman and Nicholls [8], and Isidor, Br ø ndrum, Ravnholt [9] with fatigue tests demonstrated the importance of the ferrule extension under a crown.

The primary reason clinicians offer for utilizing the new post and core systems is for esthetics. A white and opaque post is supposed to lighten the tooth structure or avoid the dark shadowing of a metal post. Perhaps the clinician should consider using one of the more opaque all-ceramic crown systems such as In-Ceram alumina (Vita Zahnfabrik, Bad Sackingen,Germany), Procera All Ceram(Nobel Biocare, Goteborg, Sweden) or the new zirconia systems that will mask out the dark underlying substrate. Andersson et al. [54] demonstrated that even with a densely sintered alumina substructure only 0.6 mm thick it could sufficiently block out black and white dies.

The present study tested the post strength in a dry environment. Torbjornerðet al. [12] revealed that water storage reduced the strength and stiffness of carbon fiber posts (Composipost) by approximately 65%. The deleterious effects of saliva could reduce the strength and stiffness of the carbon fiber posts to such a level as to cause breakdown of the cement and or core material and subsequent disintegration of the restorative complex.

For research on restoration of endodontically treated teeth, single static load to failure can be criticized for not representing the clinical mode of fatigue loading with subcritical loads in a moist oral environment. Fatigue testing in an aqueous environment would better demonstrate the differences in elastic moduli of post and core materials as well the deleterious effects of moisture on the bond of buildup materials to tooth structure and stability of the core material.

Further research is needed to ascertain whether a high or low elastic modulus post and core better distribute occlusal forces to the remaining tooth structure and extend clinical longevity. Cyclic fatigue tests appear to be the standard for measuring and predicting clinical performance in the adversarial oral environment.

A material with high strength and modulus of elasticity is desired so that the material can be fashioned into minimal dimensions in order to maximize the remaining tooth structure. A low elastic modulus core material in the thin dimensions characteristic of an anterior tooth would have poorer long-term resistance to fatigue loading that occurs during normal function in the stomatognathic system. The carbon fiber post had a bend strength similar to the zirconia post and exceeded that of the titanium post.

When moderate amounts of coronal tooth structure are to be replaced by a post and core on an anterior tooth a prefabricated post and high strength, high elastic modulus core may be suitable. When the higher stress situation exists with only a minimal ferrule extension remaining a cast post and core or zirconia post and pressed core are desirable. The diameter of the post should be minimized so as to maximize remaining tooth structure. Root structure should not be removed to accommodate a large diameter post. This may preclude the use of many of the large diameter esthetic prefabricated post systems. Further research is needed to discern the relative importance of strength versus elastic modulus of core materials as well as post materials to clinical longevity.

CONCLUSIONS

1. Several of the composite resin core materials, Clearfil Photo Core and Luxacore had flexural strengths approaching amalgam.
2. Despite that these composite resins had strengths of about 90% of amalgam, the modulus of elasticity of these same materials was only about 15% of that of amalgam.
3. The heat pressed glass ceramic core had a high elastic modulus but a relatively low flexural strength approximating that of the lower strength composite resin core materials.
4. The stainless steel, zirconia and carbon fiber post (C-Post) exhibited high bending strengths.
5. The glass fiber posts displayed bending strengths that were approximately half of the higher strength posts.

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