Research Article

A comparative evaluation of the fracture resistance of endodontically treated teeth with compromised intra radicular tooth structure using three different post system.

Vaidya Vidya N, Chitnis Deepa P

Department of Prosthetic Dentistry, Maitri College of Dental Sciences and Research Centre, Bhilai, Government Dental College, Mumbai

Abstract:

Intra-radicular loss of tooth structure in endodontically treated teeth poses a challenge. Available methods for treatment are cast post-core, intra-radicular resin reinforcement using composite resin followed by placement of prefabricated metal/fibre post (glass or carbon).This study is an attempt to investigate the validity of treatment of such teeth using above methods and evaluate which post system is best suited for rehabilitation.

Thirtysix endodontically treated anterior teeth were prepared by uniformly removing intra-radicular tooth structure from buccal, lingual, mesial & distal surfaces such that only 0.75mm-1mm remained. Twelve teeth were subsequently restored with cast metal post & core, 12 with intra-radicular resin reinforcement followed by prefabricated titanium post (Luminex post system) & 12 with intra-radicular resin reinforcement followed by glass fibre post (Luscent Anchor post system). Statistical analysis used was t-test. There was no statistically significant difference between the 3 post systems, but it was observed that cast post & cores caused more apical & oblique fractures, rendering the teeth unrestorable. Teeth restored with intra-radicular resin reinforcement & placement of titanium or glass fibre post failed with root fractures limited to the coronal aspect along with dislodgement of post. Intra-radicular resin reinforcement offers advantages like preventing the metal display of the post through the thin dentinal wall, reinforcement of the thin walled teeth & comparable fracture resistance to cast post and core.

Key words: Intra-radicular resin reinforcement, cast post & core, titanium post, glass-fibre post, smooth light transmitting plastic post.

Introduction:

Increased emphasis on the maintenance and preservation of natural dentition combined with an increase in the predictability and effectiveness of endodontic therapy, has made their post endodontic restoration a great challenge. Endodontics & Prosthodontics go hand in hand to retain pulpless, badly broken down teeth that would have been otherwise deemed fit for extraction & thereby reinstating them as a functional member of the masticatory system. Pulpless teeth frequently remain intact after endodontic treatment with conservative access preparation. However, if the remaining tooth structure is thin and fragile, fracture of such teeth is not uncommon (Caputo & Standle, 1976; Hunter et al, 1989; Saupe et al, 1996; Tjan &Whang 1985; Trabert et al, 1978; Trope & Ray, 1992). For years, posts have been thought to be providing reinforcement to pulpless teeth against fracture, though, recent workers have strongly contradicted this statement emphasizing the role of posts more as means of providing retention for the core (Caputo & Standle, 1976; Deutsch et al, 1983; Sapone & Lorencki, 1981; Sokol, 1984; Sorenson & Mortinoff, 1984). Cast posts and cores have been favoured to provide coronoradicular stabilization in varied clinical conditions (Morgano & Milot, 1993; Perel & Muroff, 1972; Sheets, 1970). Recently with the advancement of their physical & mechanical properties there has been an increase in the use of adhesive technology (Freedman et al, 1994; Godder et al, 1994; Lui, 1992; Morgano & Milot, 1993). Luminex post system and Luscent Anchor post system have been introduced for intra-radicular resin reinforcement, wherein a smooth light transmitting plastic post (used in Luminex post system) and a glass fibre post (used in Luscent Anchor System) is used for polymerization of light cure composite which is placed intra-radicularly to resurface the fragile radicular walls with composite & there by reinforce them.

The present study was under taken to evaluate & compare under controlled laboratory conditions the fracture resistance of teeth with compromised intra-radicular tooth structure restored with cast post & core, Luminex post system and Luscent Anchor post system respectively.

Materials and Method:

Thirtysix freshly extracted central incisors which were stored in normal saline from the time of extraction to the time of final testing, were randomly divided into 3 groups:-

Corresponding Author: Dr. Vidya Vaidya, C-16, C.H.P.L. Dream Homes, Model Town, Bhilai - 491023
Phone No.: 9893180345
E-mail : chiukli@yahoo.com

Group A:Teeth to be restored with cast post & core.

Group B:Teeth to be restored with intra-radicular resin reinforcement using smooth light transmitting post followed by placement of Luminex titanium post and composite core.

Group C:Teeth to be restored with intra-radicular resin reinforcement using smooth light transmitting post followed by placement of Luscent Anchor glass fibre post & composite core.

Post space preparation:

Access cavity for endodontic therapy was established in a conventional manner. Teeth were instrumented upto a size of no. 45 (international standardization organization size). The canals were obturated by lateral condensation. After endodontic treatment of all the teeth they were sectioned till 15mm of total length remained. Gutta-percha was then removed from each canal until 4mm of root canal filling material remained at the apex.

To simulate extensive clinical damage the canal space of each root was further prepared by routing out the internal dentin surface using motor driven Pessos reamers, leaving the test specimens with 11mm dowel space length within the canal and a residual dentinal wall thickness of 0.75 to 1.00 mm at cemento-enamel junction. Each residual root was measured on buccal, palatal and proximal aspects at 2.50, 5.00 and 7.00 mm below the occlusal surface for uniformity in thickness (0.75-1.00mm). Fig I. A no: 5 classic post system reamer (Dentatus, USA) was then used to produce a positive seat centered in the apical 2.00 mm of each 11mm dowel space. A counter bevel was given to all specimens coronally to provide a ferrule to the teeth such that the crown margins would be placed on sound tooth structure and apical to tooth core interface (Saupe et al, 1996).

Cast metal post & core were fabricated for 12 teeth of group A in nickel chromium alloy (Durabond) & cemented with self cure adhesive resin, Hi-X post cement (Bisco Inc., Schaumburg).

For the resin reinforced group, 12 teeth grouped under group B & C were prepared similar to group A till the last step, except for the placement of the type of post.

Teeth in group B & C were readied as follows: Unietch 32% phosphoric acid gel (Bisco Inc Schaumburg) was used to etch the intra-radicular dentin for 15 seconds & rinsed with water for 30 seconds & dried. The application & curing of bonding agent(5th generation one step bonding agent- Bisco, Inc., Schaumburg) was followed by injection of Aeliteflo™ low-modulus flowable composite (Bisco Inc., Schaumburg) into the canal. A no: 6 smooth light transmitting plastic post (SLTP) of the Luminex post system (Dentatus, USA), was inserted & centered in to the positive seat of the dowel space till predetermined length of 11mm indicated by rubber stop. The post was cut such that only 3-4mm of post projected out of the tooth. The resin was cured for 60 seconds with the post inside & for 20 second after removal of the post. To further reduce the lumen of the canal, a no: 5 (SLTP) was inserted after injecting the flowable composite inside the tooth. This step ensures to resurface the voids if any & to reduce the canal lumen to desired diameters of 1.05mm.

This was followed by luting of no. 5 titanium (Dentatus, USA) post in group B & 1.6 mm diameter of glass fibre post of the Luscent Anchor post system (Dentatus, USA), in group C, using Hi-X self cure resin cement (Bisco Inc., Schaumburg). A core of 5mm height was built up on the group B & C teeth with Biscore TM dual cure core build-up material (Bisco Inc., Schaumburg) and finally were finished & polished (Fig. II & Fig. III).

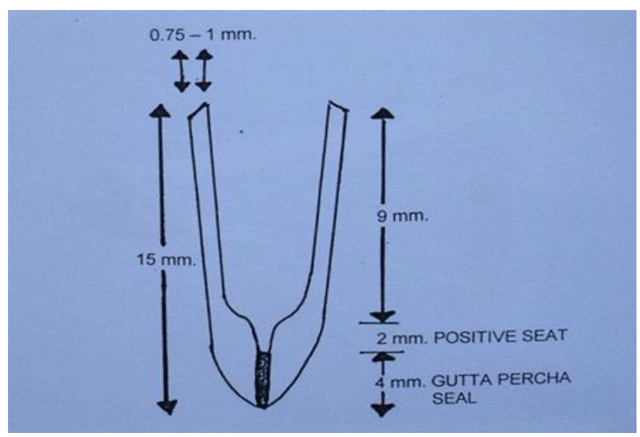

Fig. I: schematic representation of the desired tooth preparation for a structurally weakened design.

All 36 teeth were then given cast coping made with nickel chromium alloy (Durabond) which were cemented with zinc phosphate cement (Powers, 2002). The copings were given an indention on the palatal side at 130° to the long axis of the tooth, 1mm away from the incisal edge to facilitate proper placement of the pointer tip of loading machine (Fig. IV). Sample teeth were then mounted in acrylic block,shaped as equilateral triangles of 60°, such that the long axis was

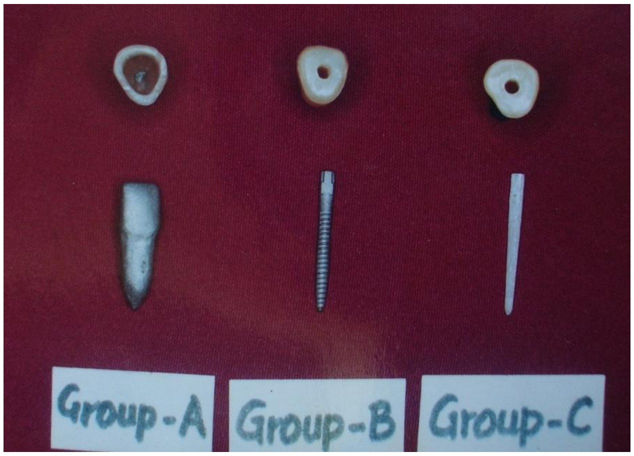

Fig. II: Canal width and post diameter of group B and C after IRR as compared to Group A which was to receive cast post and core.

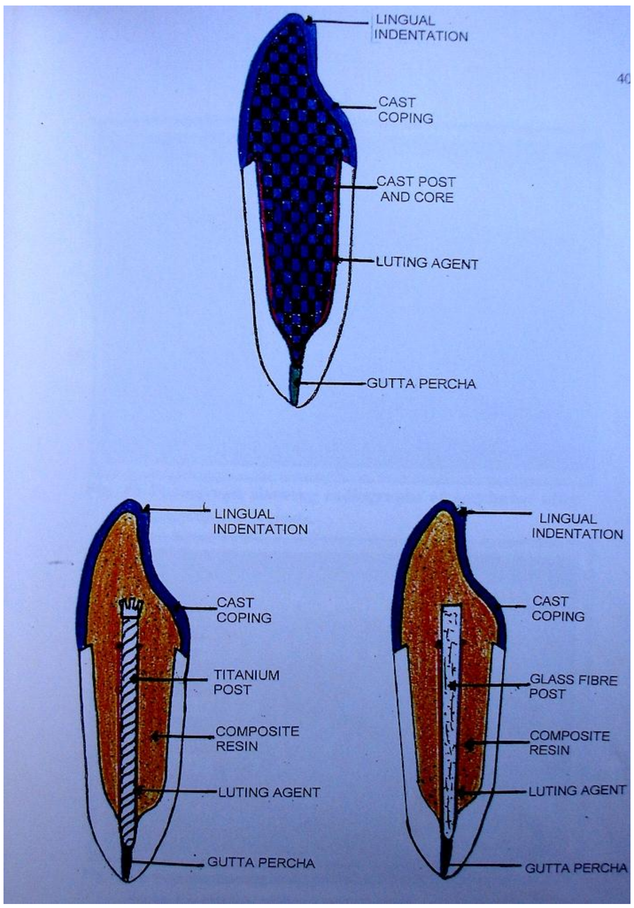

Fig. III: Schematic representation of the specimen following cementation of the post systems in their respective groups.

perpendicular to the inclined surface with their lingual surface facing upwards. This placed the pointer in the lingual indentation of the coping and angle of 130° between the long axis of the tooth & the pointer of the loading jig was formed (Deutsch et al, 1985; Guzy & Nicholls, 1979; King & Setchell, 1990; Stern & Hirschfield, 1973) (Fig. V). The samples were tested on a universal testing machine Instron, which was set at a cross head speed of 5mm/min.

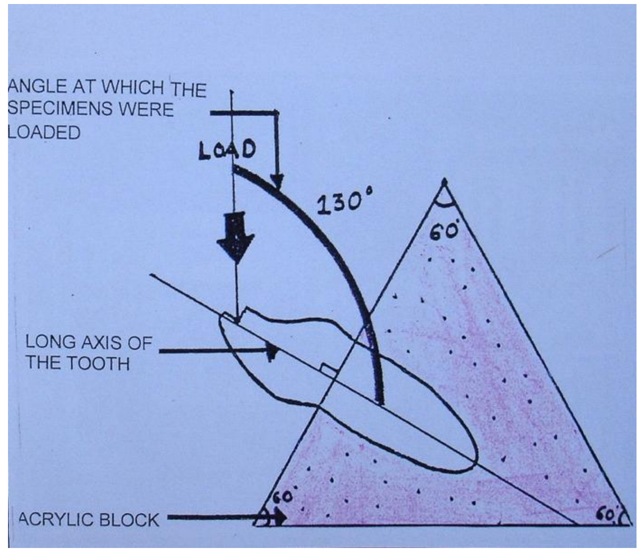

Fig. IV: Schematic representation of a mounted specimen prior to testing.

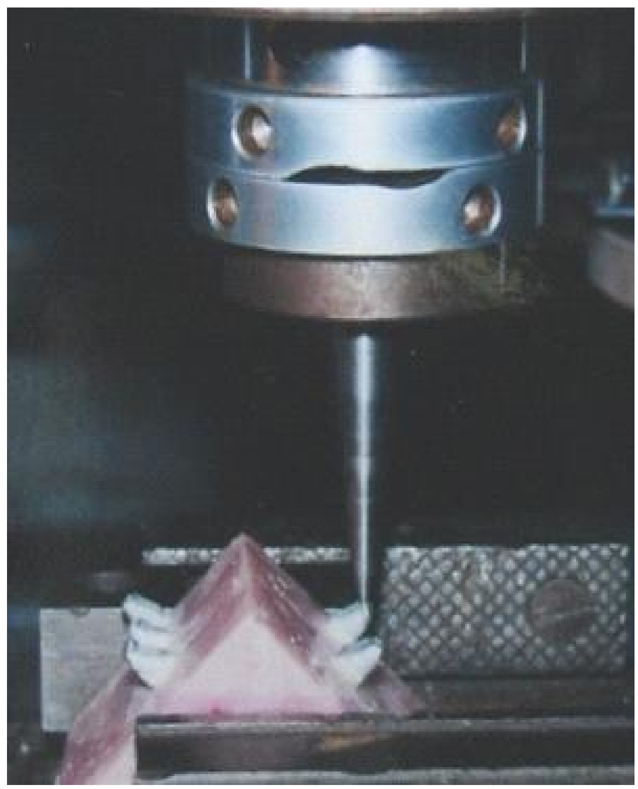

Fig.V: Testing of the samples on the Instron machine.

Result :

The results were compared by using t-test and it was found that there was no statistically significant difference between the fracture resistance of teeth in group A, B &C. However, when the mode of failure was compared, the fractures occurring in teeth with cast posts and core (Group A) were more extensive in vertical and oblique in direction, rendering the teeth non restorable and necessitating extraction. None of the teeth restored with intra-radicular resin reinforcement and placement of titanium or glass fibre post failed with extensive root fractures (Group B&C). The fractures in these two groups were at the dentin-core interface, with a few posts fracturing along with a part of dentin core interface (Fig. VI).

The mean failure load observed was

a) Cast post & core (group A): 0.7758 KN
b) Intra-radicular resin reinforcement with Luminex post & composite core (group B) : 0.6483 KN
c) Intra-radicular resin reinforcement with Luscent Anchor post& composite core (group C): 0.7083KN

Difference in the mean failure load observed between group A, B & C is depicted in Table I.

Table I: Comparative evaluation of differences between means.

COMPARISON	DIFFERENCE OF MEANS
1) Cast post and core *vs* Intra-radicular resin reinforcement and Luminex titanium post.	0.7758-0.6483=0.1275
2) Cast post and core *vs* Intra-radicular resin reinforcement and Luscent anchor glass fibre post	0.7758-0.7083=0.0675
3)Intra-radicular resin reinforcement and Luminex titanium post vs Intra-radicular resin reinforcement and Luscent Anchor glass fibre post	0.7083-0.6483=0.0600

NS :Non significant:p>0.05 (by t-test)

Fig. VII: Mean fracture resistance in (KN).

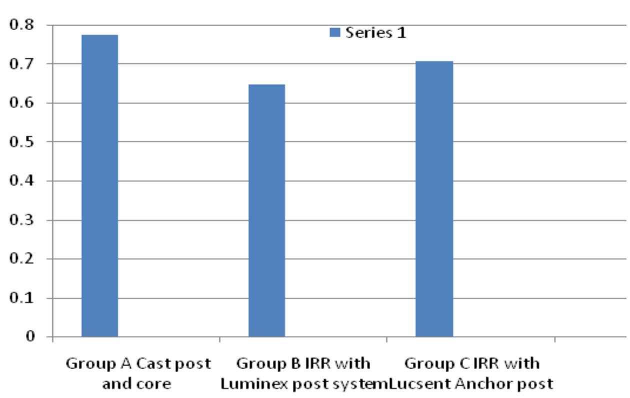

Fig.VI: Mode of fracture of posts in Group A, Group B and Group C (Fom right to left).

Discussion:

Preservation of existing tooth structure while restoring the tooth is mandatory. An ideal post should provide retention & resistance to displacement of core coupled with esthetics. A post is no longer associated with the reinforcement of endodontically treated tooth (Caputo & Standle, 1976; Hunter et al, 1989; Saupe et al, 1996; Tjan & Whang, 1985; Trope & Ray, 1992). An over-enlarged post space, either created by operator or as an outcome of dental disease, is at a risk of fracture during insertion, cementation of post or subsequent function. Internal stresses are greater as post diameter increases, resulting in reduced thickness of the remaining dentinal wall. Thus, the fracture resistance of the root is directly related to the amount of remaining tooth structure. Cast post & cores were advocated in compromised radicular tooth structure cases as they were thought to require less instrumentation. Enhanced fracture resistance was believed to be present as it is a one body, post & core restoration with a ferrule effect (Lui, 1992; Morgano & Milot, 1993; Perel & Muroff, 1972). But it has some inherent disadvantages like

a) arduous fabrication,
b) more number of sittings,
c) dependence on skill of the laboratory technician,
d) tapered shape causing high stress concentrations,
e) high modulus of elasticity, which has a potential to concentrate and transfer stresses applied to the surrounding tooth structure
f) more vertical/oblique root fractures rendering the teeth deemed for extraction.

Standlee et al (1972), Henry (1977), Mattison et al (1984) have shown that tapered posts produced high stress concentrations when cemented and loaded, thereby causing more fractures than parallel-sided posts. Morgano & Milot (1993) reported a high rate of failure of cast post and cores as compared to alternative systems of corono-radicular stabilization. In the present study, results are consistent with the studies of Chan & Byrant (1982). Sorensen & Martinoff (1984) have reported high incidence of root fractures in teeth treated with tapered cast posts and cores. Teeth with Intra-radicular resin reinforcement & placement of glass or titanium post showed no failures or extensive root fracture. The fractures, in both the groups were at dentin-core interface, a few fracturing along with a part of dentin-core interface. The replacement and reinforcement of intra-radicular tooth structure with a material like composite, whose modulus of elasticity is compatible with that of dentin has shown to be a far better treatment option, as compared to cast post and cores. The results are contrary to the results achieved by Saupe et al (1996) who compared fracture resistance of cast post and cores to intra-radicular resin reinforced teeth with Luminex post and cores.They concluded that the fracture resistance was higher in the later group. However, their study had a limitation that the cores were directly loaded as compared to their clinical counterparts.

Furthermore, material property of the post has been shown to affect the stress distribution, which is more favourable when two substances of equivalent or near about similar modulus of elasticity approximate each other. Thus considering that the modulus of elasticity of dentin is 20G pa, a glass fibre post (modulus of elasticity 40Gpa), would be the best post material. Ceramic post (69 Gpa), titanium post (120 Gpa) and Carbon fibre post (120 Gpa) would also be good post materials as compared to base metal alloy post (200 Gpa) or a Steel post (210 Gpa) with respect to stress distribution (Powers, 2002; Martelli, 2000).

Clinical significance:

Intra-radicular Resin (IRR) reinforcement promises to be a viable treatment alternative to cast post and core in treatment of endodontically treated teeth with thin dentinal walls, with following advantages:

a) single sitting procedure.
b) total control of the dentist over the procedure.
c) facility to provide a smaller diameter post.
d) esthetic restoration by masking the metal display of the post through the thin dentinal walls by the intervening thick core of composite.
e) fracture resistance of the titanium or glass fibre post after IRR comparable to cast post and core.

Conclusion:

Following are the conclusions of the study:

1) No statistically significant difference was observed in the resistance to fracture between teeth restored with cast post and core and either groups of intra-radicular resin reinforcement followed by placement of Luminex titanium post or Luscent anchor post.
2) The groups of intra-radicular resin reinforcement showed failure at the post/core interface, sometimes showing fracture of the core along with some part of the tooth-core interface. No radicular fractures were seen, thereby making the teeth more amenable to retreatment.
3) A cast post and core can cause areas of stress concentration making the endodontically treated tooth susceptible to vertical & oblique direction fracture, deeming the tooth non-restorable.
4) Luminex and Luscent Anchor post Systems that utilize placement of composite resin to replace the lost intra-radicular tooth structure prior to the placement of metallic and glass fibre post respectively, have the potential to reinforce teeth.

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