A peer-reviewed version of this preprint was published in PeerJ on 24 February 2015.

<u>View the peer-reviewed version</u> (peerj.com/articles/795), which is the preferred citable publication unless you specifically need to cite this preprint.

Kumar L, Pal B, Pujari P. 2015. An assessment of fracture resistance of three composite resin core build-up materials on three prefabricated non-metallic posts, cemented in endodontically treated teeth: an *in vitro* study. PeerJ 3:e795 <u>https://doi.org/10.7717/peerj.795</u>

An assessment of fracture resistance of three composite resin core build-up materials on three prefabricated non-metallic posts, cemented in endodontically treated teeth - An in vitro study

Lalit Kumar, Bhupinder Pal, Prashant Pujari

Endodontically treated teeth with excessive loss of tooth structure would require to be restored with post and core to enhance the strength and durability of the tooth and to achieve retention for the restoration. The non-metallic posts have of a superior esthetic quality. Various core materials can be used to build-up cores on the posts placed in endodontically treated teeth. The core materials would show variation in their bonding with the non-metallic posts and the remaining tooth structure. They will also have an effect on the strength and resistance to fracture of the remaining tooth structure. **Aims:** The aim of the study was to assess the fracture resistance of three composite resin core build-up materials on three prefabricated non-metallic posts, cemented in extracted endodontically treated teeth. Material and methods: Forty five freshly extracted maxillary central incisors of approximately of the same size and shape were selected for the study. Student's unpaired 't' test was also used to analyse and compare each group with the other groups individually, and decide whether their comparisons were statistically significant. **Results:** Luxacore showed the highest fracture resistance among the three core build-up materials with all the three posts systems. Ti-core had intermediate values of fracture resistance and Lumiglass had least values of fracture resistance.

1 An Assessment Of Fracture Resistance Of Three Composite Resin Core Build-Up

2 Materials On Three Prefabricated Non-Metallic Posts, Cemented In Endodontically

3 Treated Teeth. -An In-Vitro Study

4 Contributors

5 6	1.	Dr. Lalit Kumar M.D.S
7		Senior Assistant Professor,
8		Department Of Prosthodontics
9		Dr. Harvansh Singh Judge Institute of Dental Sciences and Hospital,
10		Panjab University, Chandigarh, India
11	2.	Dr Bhupinder Pal
12		M.D.S
13		Department of Dentistry
14		Shah Satnam Ji Speciality Hospitals Sirsa
15	3.	DR Prashant Pujari
16		M.D.S
17		Reader
18		Department of Orthodontics
19		Pacific Dental College Udaipur

20 Corresponding Author:

Dr. Lalit Kumar
Dr. Lalit Kumar
House No 222 G/F Sector 37 A
Chandigarh 160036
India
+919914419876
drlalitbida@gmail.com

1. INTRODUCTION

Esthetics demands as well as awareness of patients have increased over the years. Combinations of the new generation materials with improved clinical procedures have opened newer avenues for both the dentist and the patient. Esthetic dentistry has progressed to a point that it can completely predict the need of the patient requirements.

Dental treatment and techniques have evolved from "removing the infected tooth" to "treating the infected tooth." Endodontic therapy has transversed a meandering course, and in the present day scenario a virtually dead tooth is used very effectively to support a restoration and return to function, aesthetics, and psychological comfort for the patient. Special techniques and consideration are needed to restore such mutilated teeth to have a good prognosis (Fernandes AS, Dessai GS, 2001).

The loss of considerable amount of tooth structure makes retention of subsequent restorations more problematic and increases the likelihood of fracture during functional loading. Different clinical techniques have been proposed to solve these problems, and one such technique is the post and core which is being widely used. The basic objective in restoring mutilated teeth with post and core, is the replacement of the missing tooth structure to gain adequate retention for the final restoration (Trabert KC, Cooney JP, 1984)

Technological progress is at its peak. Dentistry and more so Prosthodontics has not been spared by the technological boom. There has been rapid research and development in the different post and core systems and the available instrumentation has been made easier than even before. Foundation restoration as they are known today, form the base for attachments for crowns, bridges and other prosthesis (Morgano SM, Brackett SE, 1999).

49 In the earlier years dowel crowns as they were known were fabricated to restore 50 endodontically treated teeth where a considerable amount of tooth structure was lost. However 51 they were difficult to replace, as they could not be removed easily from the root canal without 52 fracturing the root. With the advances in restoring endodontically treated teeth the post and core 53 system has gained popularity to build the lost tooth structure (Figure-5). The post engaged the 54 radicular dentin to achieve retention and the core replaced the coronal portion of the crown. This 55 could be fabricated in metal as one piece casted restoration or could be a separate post with a core 56 build up.

Various materials for posts have been introduced. To achieve the best results the post material should have physical properties similar to dentin, it should bond to the tooth structure and be biologically compatible (Assif D, et al., 1989; King PA, Setchell DJ, 1990). Posts are made mostly of various corrosion resistant metals, which are rigid and their metallic colour may show through the restoration. The growing demand for esthetic restorations has led to the development of tooth coloured, metal free posts which have elastic moduli comparable to dentin which prevents the tooth from fracture, potentially allowing for retreatment of the tooth and better esthetics (Shetty T, Bhat S, Shetty P, 2005).

Cores are built in any of the metallic or non-metallic materials. In earlier years amalgam was popular, later cements like glass ionomer and modified ionomers were used and now improved high strength composite resins are being used to build cores (Cohen S, Burns RC, 1994).

69 Composite resin core materials are used in conjunction with non-metallic posts in 70 restoring endodontically treated anterior teeth to achieve better esthetics. Thus the prefabricated 71 non-metallic posts with composite resin core built-ups have gained popularity in the recent years. 72 A variety of these systems are available. With this background in mind an in-vitro study was 73 planned to assess and compare the fracture resistance of composite resin core build-up materials 74 with non-metallic posts in extracted endodontically treated teeth.

75

2. MATERIALS & METHOD

45 freshly extracted maxillary central incisors of approximately of the same size and shape were selected for the study. Ethical clearance has been taken from the ethical committee of the institution to use extracted teeth for the purpose of this study. It was observed that they were free of cracks, caries and fracture. Teeth were scaled to remove calculus and hard debris with an ultrasonic scaler. They were then stored in saline until use. The labial and palatal surfaces were marked on the root with a permanent marker.

The 45 central incisors were divided randomly into 3 groups of 15 each depending on the types of non-metallic posts used. Depending on the core build-up material each group was further divided into 3 groups (A, B and C) of 5 samples each. Since there were 3 types of posts and 3 different core materials, there were a total of 9 subgroups having 5 samples each (**Table-1**).

86 2.1 Preparation of Teeth:

All the forty-five samples were sectioned 2 mm coronal to the cemento-enamel junction with a wheel shaped diamond point on an air rotor with water spray. The teeth were prepared using a torpedo shaped diamond point above the cemento-enamel junction in such a way, to achieve a 2mm ferrule (Yue LH, Xing ZY,2003; Akkayan B. 2004; Pereira JF et al. 2006) and a 1.5mm deep chamfer finish margin (Akkayan B, Gulmez T, 2002).

92 2.2 Endodontic Treatment of Selected Teeth:

Access opening of all 45 teeth was done with a round diamond point No.4 (Mani, Japan) at a high speed with water spray. At # 15 K-file was introduced into the canal to achieve patency of the canal. Pulp was extirpated with a barbed broach and constant irrigation with 5% sodium hypochlorite.

97 Canal length was established using # 15 K file. Working length was kept 1 mm short of the 98 apical end. Biomechanical preparation of the teeth was done with K-files from # 15 to #60 using 99 conventional technique. Frequent recapitulation was done to maintain patency of the canal and 100 prevent it from getting clogged. Finally after proper biomechanical preparation, the canal was 101 irrigated with distilled water and stored back in saline till obturation was done.

For obturation, each of the teeth were removed from saline, and the canal was dried with paper points. The canals of all the teeth were obturated using the same standardized process. The gutta-percha at the canal orifice was sealed with a hot burnisher, samples were stored in saline (Akkayan B, Gulmez T, 2002).

106 2.3 Preparation of Post Space:

107 The samples were removed from saline. A silicone stopper was attached to the universal 108 drill, which was used to remove the gutta-percha and prepare the post space to a depth of 10mm 109 apical to the coronal dentin. The subsequent drills supplied by the manufacturer were used to 110 further prepare the post space to obtain the desired length and diameter for the specific posts. The 111 canal was irrigated with saline to remove debris.

The glass fiber posts selected were checked for their fit and length in the prepared canal.To get a total length of 13mm of the post with 10mm in the tooth (8mm below the cemento-

enamel junction and 2mm ferrule) and 3mm above the prepared coronal dentin, (Sirimani S, Riis
DN, Morgano SM. 1999) the posts were cut 13mm from its apical end to get the required
dimensions.An intra-oral periapical radiograph was taken to check the position of the post in the
canal.

118 2.4 Etching, Bonding Silanation and Cementation

As instructed by the manufacturer silane was applied to the glass fiber post with a brush and air dried for 1 min. Quartz fiber post did not required to be silanated. Zirconia posts were pre-silanated, but had to be cleaned with alcohol to remove any surface impurities. The post space and the exposed part of the coronal dentin was etched and primed for 10 seconds with Clearfil SE, then dried and Clearfil SE bonding agent was applied, after that it was exposed to a light blast of air to obtain a thin layer of bonding agent, which was then light cured for 20 seconds. All the 45 posts were bonded with Clearfil SE (Cohen BI. et at 1999).

RelyX ARC resin cement was used to cement the posts in the canals. Equal amounts of base and catalyst of RelyX ARC resin cement was mixed on a mixing pad and the canal as well as the post is coated with it. The posts were placed in the canal and held under digital pressure, and light cured for 20 seconds.

All the posts in various groups were cemented in the similar manner.

131 **2.5** Composite core build up:

A preformed core former was selected for each of the samples of the teeth for the core build-up with the respective core build-up materials. The core formers were modified at the gingival end to achieve the standard dimension of the core. Luxacore (DMG Dental Avenue India) is a dual cured core build-up material.

Equal amount of base and catalyst was premixed and dispensed from the syringe into the core former. The core former with the core build-up material was placed on the post and prepared tooth surface. It was light cured for 40sec. The core formers were held in position for 5minutes for complete polymerization to occur because it is a dual cured composite resin. In the similar manner all the core build-ups were carried out for the 15 samples using Luxacore for core buildup.

Lumiglass (RTD France by Prime Dental India) is a light cured composite resin core build-up
material. Ti-core (Essential Dental Systems U.S.A.) is a self-cured composite resin. It does not

130

144 required to be light cured. In the similar manner all the core build-ups were carried out as 145 mentioned above for the 15 samples using Ti-core and Lumiglass for core build up (Figure-1).

146 **2.6 Mounting the samples:**

Petroleum jelly was applied on the inner surface of the split mould (Figure-2) for easy separationof the acrylic block from the mould.

A split mould was used to mount the teeth in autopolymerising acrylic resin. The teeth were mounted perpendicular to the base of the mould and embedded in the autopolymerising acrylic resin so that the cervical finish line was just above the autopolymerising acrylic resin (Figure 3). All the teeth were mounted in a similar manner.

153 2.7 Testing of the samples for fracture resistance:

154 The acrylic block with the samples were placed on the Zwick machine (Figure-4) for 155 testing of the fracture resistance.

For positioning the samples on the Zwick machine a customized mounting fixture was fabricated into which the acrylic blocks fitted perfectly. The fixture also helps to position the samples in such a way that the load could be directed at 130° to the long axis of the tooth (Akkayan B, Gulmez T, 2002).

Each of the sample blocks were fixed to the base of the Zwick machine using the fixture and the tip of the plunger was made to contact the notch on the palatal surface of the core build up. The samples were loaded at a crosshead speed of 0.5mm/min (Fraga RC et al, 1998) until there was a visible or audible sign of failure in the post and core. The site at which the fracture **(Figure-6)** took place was evaluated and the results tabulated. Observations thus obtained were statistically analysed.

166

3. RESULTS And DISSUCTION

The study was carried out to assess the fracture resistance of various composite resin core build-up materials with three prefabricated non-metallic posts cemented in extracted endodontically treated teeth. The 45 specimens were loaded in the Zwick machine at an angle of 130° to the long axis of the tooth. Load was applied till there was an audible or visible sign of fracture. The load at that instance was recorded as the peak load that the tooth can sustain before fracture. This was recorded for all the specimens and is listed in **Table-2**.

173 These observations were statistically analysed to comparatively evaluate the values 174 obtained. The analysis of variance ANOVA test was applied using F distribution. It is suitable for 175 testing the significance of difference between two or more specimens simultaneously. Since 176 significant F does not give us which means differ significantly, hence we had to proceed to test 177 separate differences by permutation and combinations through student 't' test. The analysis of 178 variance is based on a separation of the variance of all observation into parts, each of which 179 measured variability attributable to some specific source such as internal variation of the 180 specimen or one specimen from the other.

181 Student's unpaired't' test was also used to analyse and compare each group with the other 182 groups individually, and decide whether their comparisons were statistically significant as listed 183 in **Table-4**. Fracture patterns were either horizontal, oblique, some involving the core, some 184 involving the post and tooth structure, some with debonding of post and core and some with a 185 combination of above types. However an attempt is made to classify these fractures into two 186 groups as shown in **Table -5 and 6**. They are –

1. Restorable or Salvageable Fractures -

188 Fractures that have occurred above the CEJ, or oblique fractures that cross below the CEJ189 with sum amount of coronal dentin, and the oblique fracture ends in the cervical 1/3rd of the root.

190 2. Non-Restorable or Non-Salvageable Fractures –

191 Fractures occurring below the CEJ with no coronal tooth structure remaining.

192 The longevity and the success of the endodontically treated teeth depends on the 193 procedure with which it is restored. It has been observed that pulpless teeth are more brittle than 194 vital teeth and anterior teeth are more prone to oblique forces resulting in horizontal and vertical 195 fractures usually in the cervical third (Mclean JW, Gasser O. 1985). If there is a conservative 196 access opening, no carious breakdown or fracture of tooth structure and no evidence of internal or 197 external root resorption, the tooth can survive the brunt of masticatory load (Gutmann J.L. 1992). 198 When there is excessive loss of tooth structure, retention for the artificial crown is required. This 199 can be achieved by using a post and core (Morgano SM, Brackett SE. 1999). However, it should 200 not adversely affect the load bearing capacity of the tooth. It has been indicated that the 201 structural integrity of the tooth depends on the quality and quantity of dentin and its anatomic 202 form (Gutmann J.L. 1992). When the tooth is endodontically treated both these factors are

187

affected, hence they may not perform their function to their fullest extent as a vital tooth. Thus,
an extra-coronal restoration would be required to restore the weakened tooth. The remaining
tooth structure might not be adequate to retain a crown and thus, a post and core is indicated. A
large number of post and core systems are available with their advantages and disadvantages.
Conflicting results regarding the reinforcement of the tooth due to placement of post exists
making it more difficult to choose a particular system (Assif D, Gorfil C. 1994).

The cast post and core has been widely used in restorations, but however its stiffness has always increased the risk of stress concentration and tooth fracture.¹⁸ Custom cast post would also compromise esthetics as a grey tint of the metal may show through the thin root walls. This esthetic concern has led to the development of esthetic posts made from reinforced resins or ceramics which can overcome the esthetic deficiency of the metal posts.

A prefabricated metal posts could be used with composite resin core build-up with a ceramo-metal crown over it which may aid in masking the metallic colour of the post. The ceramo-metal crown will allow the clinician to use any of the post and core systems. The type of crown material will affect the post selection (Fernandes AS, Shetty S, Coutinho I. 2003). All ceramic crowns are translucent and allow metal to show through. With the advent of metal free dentistry and to achieve optimum esthetics, tooth coloured non-metallic post like glass fiber, quartz fiber, zirconia, ceramic have become popular. They can be used with various composite resin core build-up materials.

There are various core materials used in the past like amalgam, glass ionomer cement, modified glass ionomer and composite resin. Prepared composite resins cores have better strength than prepared glass ionomer cement cores (Stober T, Rammelsberg P. 2005) and prepared amalgam cores.

A variety of self-cured, light cured and dual cured composite resin core build-up materials
are used in conjunction with non-metallic posts for an esthetic restoration (Standlee JP, Caputo
AA, Hanson EL. 1978; Dilmener FT, Sipahi C, Dalkiz M. 2006).

In this study 45 human maxillary central incisors were selected. The selection of intact natural central incisors seems to represent the best possible option to simulate clinical situation for endodontically treated teeth. Previous studies have reported their use for research of various post systems (Akkayan B, Gulmez T. 2002; Fraga RC et al. 1998; Sirimani S, Riis DN, Morgano SM. 1999; Raygot CG, Chai J, Jameson L. 2001). An attempt was made to choose teeth of similar root length and diameter with the help of the digital vernier calliper. The mean size of roots was 15.41 + 1.18 mm in length and 6.29 + 0.45 mm in mesio-distal width at cementoenamel junction.

237 All the samples were sectioned with an air rotor 2 mm coronal to cemento-enamel 238 junction, and a finish line of 1.5 mm deep chamfer was prepared all around the samples. A ferrule 239 of 2 mm was prepared for all the samples (Yue LH, Xing ZY. 2003; Pereira JF, Ornelas F, Conti 240 PCR, Valle AL. 2006; Akkayan B. 2004; Tan PLB et al. 2005). This was done to simulate the 241 natural conditions, as teeth which have fractured in the cervical one-third with insufficient 242 coronal tooth structure remaining, have to be restored with post and core so as to give retention to 243 the artificial crown. A finish line of 1.5 mm was given to simulate the preparation for the future 244 extra-coronal restoration (Sirimani S, Riis DN, Morgano SM. 1999).

All the teeth were endodontically treated by conventional technique. Obturation was done with gutta-percha with a non-eugenol based root canal sealer. The effect that eugenol can have on the bonding of resin cement or composite resin core build-up material is debatable. Eugenol is shown to inhibit polymerization of composite resin (Dilts WE, et al. 1986). Hence, a eugenol free root canal sealer was used in the study.

The recommended diameter of posts used for restoring maxillary central incisors is between 0.9 to 1.4 mm.² Glass fiber has a diameter of 1.1 mm, Quartz fiber 1.2 mm and Zirconia 1.2 mm have been used which are within the above mentioned range.

The length of the post below the cemento-enamel junction for maxillary central incisor is 8.3 mm according to Shillingburg HT, et al. in 1982. But for the ease of measurement in this study the posts were embedded to a depth of 8mm below the cemento-enamel junction. The post head was exposed 3mm above the ferrule for retention of the core buildup (Sirimani S, Riis DN, Morgano SM. 1999).

The teeth were divided randomly into 3 groups (Figure 4). In Group I, glass fiber posts were cemented in the canal. Firstly the glass fiber post were silanated according to the Manufacturer's instructions. It was observed surface conditioning of the posts increased the micro-tensile bond strength of dual cure core material to glass and quartz fiber post (Aksornmuang J, et al. 2004). Clearfil SE bonding agent was applied to the post and canal was etched and bonded and the post was cemented with resin cement RelyX ARC. Bonding agent was applied to the post as well as the tooth to enhance the bonding between the post and the remaining tooth structure to composite resin core build-up material.

Group II consisted of quartz fiber post which were cemented in the canal in the similarmanner but did not required to be silanated.

Group III consisted of Zirconia post which were pre-silanated by the manufacturer and they were also cemented in the similar manner.

From a variety of composite resin core materials available today, three materials were selected which were widely used. Luxacore, Lumiglass and Ti-core were the three composite resin core materials chosen, which have different modes of curing.

Composite resin core build-up materials have been widely used owing to their high
compressive strength, good adhesive properties, low modulus of elasticity, and economically
affordable (Piwowarczyk A et al. 2002; Cohen BI et al. 1996).

Each group of teeth (I, II, III) were further subdivided into three groups randomly having teeth each on which core build-ups were done using the three core build-up materials namely Luxacore(Group A), Lumiglass (Group B) and Ti-core (Group C). The core build-up was done using core formers to standardize the dimensions.

The core build-ups were modified with an air rotor to give the shape of a prepared tooth so as to simulate clinical conditions. The height of the core from the cemento-enamel junction was 8 mm (Brandal JL, Nicholls JI, Harrington GW, 1987). It was observed that the incisal edge of lower teeth contacted the palatal surface of the maxillary central incisor 1mm below the incisal edge of the core (Dilmener FT, Sipahi C and Dalkiz M, 2006). Thus, this point was standardized for load application by preparing a notch on the palatal surface of the core 1mm below the incisal edge. These samples were mounted on acrylic blocks.

The load was applied on the palatal aspect at an angle of 130° to the long axis of the tooth. This was because the lower anteriors contacted the palatal surface of the upper anteriors at an angle of 130° to the long axis of the maxillary central incisor. Guzy and Nicholl's reported that for incisors, a loading angle of 130° was chosen to
simulate a contact angle in Class I occlusion between maxillary and mandibular anterior teeth
(Guzy GE, Nicholls JI,1979).

Crowns were not used in this study (Dilmener FT, Sipahi C and Dalkiz M, 2006; Burke FJT et al 2000; Cohen BI, et al. 1997). It was observed that if the post and core combination has a good fracture resistance, the addition of a crown would enhance the fracture resistance of the tooth and it will be able to withstand greater forces (Kern SB, Fraunhofer JR, Mueninghoff A, 1984) In this manner the probable altering of parameters, such as material structure, shape, length, and thickness, by crown restorations was avoided.

Load was applied by a Zwick universal load testing machine at a crosshead speed of 0.5 mm/min (Fraga RC et al. 1998). Failure threshold was defined as a point at which the sample could no longer withstand load and fracture of material, tooth or root occurred. From the observation obtained statistical analysis was performed.

304 Data thus obtained showed that Luxacore gave the highest mean fracture loads with all305 the three posts used.

With Luxacore the mean fracture loads were Group I-A 25.220+1.4006, Group II-A
23.115+ 3.0814, Group III-A 26.010+ 3.3845.

Lumiglass showed lowest mean failure loads with various posts systems Group I-B
23.614+2.8105, Group II-B 19.896+3.2506, Group III-B 16.873+ 1.9118.

Ti-core showed intermediate values between Luxacore and lumiglass they were Group IC 22.163+2.2128, Group II-C 22.715+ 3.6613, Group III-C 15.498+ 3.3860.

The highest failure load was observed in a combination of zirconia post with Luxacore and lowest was observed in zirconia posts with lumiglass core build-up material. This is because zirconia is a much stronger post material than glass fiber and quartz fiber posts thus giving higher failure loads.

It was also observed that Luxacore provided only 73.33% salvageable fractures, whereas Lumiglass which is the weakest provided highest of 86.67% of salvageable fractures, and Ti-core provided 80% of salvageable fractures. Thus, the weaker the composite resin core build-up material, the earlier it will fracture at a lower load which would protect the tooth from fracturing (Kern SB, Fraunhofer JR, Mueninghoff A, 1984) and thus a restoration can be done again. Glass fiber posts showed highest percentage of salvageable fractures of 93.33%, while
Quartz fiber and zirconia posts both showed lower percentage of salvageable fractures values of
73.33% each.

Teeth which fractured above the cemento-enamel junction or just below the cementoenamel junction in the coronal 1/3rd of the root with some amount of coronal dentin remaining were considered salvageable fractures (Akkayan B. 2004; Sidoli GE, King PA, Setchell DJ. 1997; Heydecke G et al. 2002; Toksavul S et al. 2005). There were non-salvageable fractures in zirconia posts due to their high moduli of elasticity due to which greater stresses were transmitted to the tooth causing its fracture (Akkayan B, Gulmez T. 2002).

Thus, Lumiglass has lowest fracture resistance than Ti-core and Luxacore, but produced maximum salvageable fractures, as the core would fracture before the tooth could fracture and failure would occur in the core rather than the tooth.

Glass fiber posts produced maximum number of salvageable fractures. This might be related to the fact that its moduli of elasticity is very close to dentin preventing transmission of undue stresses to the tooth.

Luxacore with zirconia and glass fiber posts have a failure load greater than the biting force. But however these teeth would receive restoration, which would further enhance the fracture resistance (Akkayan B and Gulmez T 2002).

The results of the above study are in consistence with results obtained by Akkayan B and Gulmez T (2002). They concluded that there were more salvageable fractures in glass fiber posts than zirconia posts.

According to the study by Fraga RC, ety al. (1998) concluded that there were more nonsalvageable fractures in cast post and core rather than metal posts with composite cores. They also concluded that the reason composite resin core build-ups are preferred because they will fracture at a lower load than what is required to fracture the tooth.

In earlier studies by Fokkinga WA, Kreulen CM, Vallittu P, Crugers NH (2004) showed
that fiber reinforced posts had more failures than metal posts but they were more salvageable
failures, whereas metal posts showed non- salvageable failures.

Composite resin core build up materials are less stiff and more resilient than metallic cores, thus transmitting lesser stresses to the tooth. Yaman and Thorsteinsson (1992) reported that stiffer core materials increases cervical stresses and reduces apical stresses.

352 It was observed from the present study and the work done by other workers, (Akkayan B, Gulmez T. 2002; Ravgot CG, Chai J, Jameson L. 2001; Heydecke G, et al. 2002) that a lot of 353 354 importance and emphasis is given to the strength of the posts, core and the restoration placed over 355 them. But going through literature, the load at which fracture of the teeth, post or core takes place 356 is at a much higher load than that actually occurring during mastication. It may be subjected to 357 higher load during a blow or trauma, which would lead to the fracture of the natural tooth. 358 Therefore, the selection of the post and core should be done on the basis of tooth structure loss, 359 type of restoration placed after the build-up and the occlusion it will be subjected to.

360

CONCLUSION

The study conducted evaluated the fracture resistance of three composite resin core buildup materials when used with three prefabricated posts cemented in extracted endodontically treated teeth. Within the limitation of the in-vitro study, the following conclusions were drawn,

Luxacore (dual cured composite resin) had the best fracture resistance with zirconia posts
 then with glass fiber posts and least with quartz fiber posts.

2. Lumiglass (light cured composite resin) had the best fracture resistance with glass fiberposts then with quartz fiber posts and least with zirconia posts.

368 3. Ti-core (self-cured composite resin) had the best fracture resistance with quartz fiber posts369 then with glass fiber posts and least with zirconia posts.

4. Luxacore showed the highest fracture resistance among the three core build-up materials
with all the three post systems followed by Ti-core and the least values were observed with
lumiglass.

Fracture resistance of Luxacore was best with zirconia post, lumiglass was best with Glass fiber posts and Ti-core was best with Quartz fiber posts. The highest failure load was observed in a combination of zirconia post with Luxacore and lowest was observed in zirconia posts with lumiglass core build-up material. 377 5. a) It was observed that maximum number of salvageable fractures occurred with Lumiglass followed by with Ti-core, and least occurred with Luxacore. 378

379 b) It was observed that maximum number of salvageable fractures occurred with glass fiber post, while with both quartz fiber and zirconia posts same number of salvageable fractures 380 381 occurred.

References:

	302		
S	383	1.	Akkayan B, Gulmez T. 2002. Resistance to fracture of endodontically treated teeth
rint	384 385	2.	restored with different post systems. <i>J Prosthet Dent</i> 87:431-7. Akkayan B. 2004. An in vitro study evaluating the effect of ferrule length on fracture
	386		resistance of endodontically treated teeth restored with fiber reinforced and zirconia
D	387 388	3.	dowel systems. <i>J Prosthet Dent</i> 92:155-62. Aksornmuang J, Foxton RM, Nakajima M, Tagami J. 2004. Microtensile bond strength of
	389 390	4.	a dual cure resin core material to glass and quartz fiber posts. <i>J Dent</i> 32:443-50. Assif D, Gorfil C. 1994. Biomechanical consideration in restoring endodontically treated
66	391 392	5.	teeth. J Prosthet Dent. 71:565-7. Assif D, Oren D, Marshak DL, Aviv I. 1989. Photoelastic analysis of stress transfer by
	393		endodontically treated teeth to the supporting structure using different restorative
	394 395	6.	techniques. J Prosthet Dent. 61:535-43. Brandal JL, Nicholls JI, Harrington GW. 1987. A comparison of three restorative
	396 397	7.	techniques for endodontically treated anterior teeth. <i>J Prosthet Dent.</i> 58:161-5. Burke FJT, Shaglouf AG, Combe EC, Wilson NHF. 2000. Fracture resistance of five pin
	398		retained core build-up materials on teeth with and without extracoronal preparation.
	399 400	8.	Opera Dent. 25:388-94. Cohen BI, Pagnillo MK, Condos S, Deutsch AS. 1996. Four different core materials
	401		measured for fracture strength in combination with five different designs of Endodontic

posts. J Prosthet Dent. 76:487-95.

382

402

403 Cohen BI, Pagnillo MK., Newman I, Musikant BL, Deutsch AS. 1997. Cyclic fatigue 9. 404 testing of five Endodontic post designs supported by four core materials. J Prosthet Dent. 405 78:458-64.

406 Cohen BI., Pagnillo MK, Newman I, Musikant BL., Deutsch AS. 1999. Effects of three 10. 407 bonding systems on the torsional resistance of titanium reinforced composite cores

408 supported by two post designs. J Prosthet Dent. 84:678-83.

Cohen S, Burns RC. 1994. Pathwavs of the Pulp. 6th ed. The C.V. Mosby & Co, 604-632. 409 11.

410 12. Dilmener FT, Sipahi C and Dalkiz M. 2006. Resistance of three new esthetic post and core systems to compressive loading. J Prosthet Dent. 95:130-6. 411 412 Dilts WE, Miller RC, Miranda FJ, Duncanson MG. 1986. Effect of zinc oxide-eugenol of 13. 413 shear bond strengths of selected core/cement combinations. J Prosthet Dent. 55(2):206-8. 414 14. Fernandes AS, Dessai GS. 2001. Factors affecting the fracture resistance of post-core 415 reconstructed teeth: a review. Int J Prosthodont 14:355-63. 416 Fernandes AS, Shetty S, Coutinho I. 2003. Factors determining post selection: A literature 15. 417 review. J Prosthet Dent. 90:556-62. 418 16. Fokkinga WA, Kreulen CM, Vallittu P, Crugers NH. 2004. A structure analysis of in vitro 419 failure loads and failure modes of fiber, metal and ceramic post and core systems. Int J 420 Prosthodont 17:476-82. 421 Fraga RC, Chaves BT, Mello GSB, Siqueira JF. 1998. Fracture resistance of 17. 422 endodontically treated roots after restoration. J of Oral Rehab. 25:809-13. 423 Gutmann J.L. 1992. The dentin-root complex: Anatomic and biologic considerations in 18. 424 restoring endodontically treated teeth. J Prosthet Dent. 67:458-67. 425 Guzy GE, Nicholls JI. 1979. In vitro comparison of intact endodontically treated teeth 19. 426 with and without endo-post reinforcement. J Prosthet Dent. 42:39-43. 427 Heydecke G, Burtz F, Hussein A, Strub JR. 2002. Fracture strength after dynamic loading 20. 428 of endodontically treated teeth restored with different post and core systems. J Prosthet 429 Dent. 87:438-45. 430 Kern SB, Fraunhofer JR, Mueninghoff A. 1984. An in vitro comparison of two dowel 21. 431 and core techniques for endodontically treated molars. J Prosthet Dent. 51:509-14. 432 22. King PA, Setchell DJ. 1990. An in vitro evaluation of a prototype CFRC prefabricated 433 post developed for the restoration of pulpless teeth. J Oral Rehab. 17:599-609. 434 23. Mclean JW, Gasser O. 1985. Glass cermet cements. J Dent Res. 5:333-43. 435 24. Morgano SM, Brackett SE. 1999. Foundation restorations in fixed prosthodontics: Current 436 knowledge and future needs. J Prosthet Dent. 82:643-54. 437 25. Pereira JF, Ornelas F, Conti PCR, Valle AL. 2006. Effect of a crown ferrule on the fracture 438 resistance of endodontically treated teeth restored with prefabricated posts. J Prosthet 439 Dent. 95:50-4. 440 26. Piwowarczyk A, Otti P, Lauer HL, Buchler A. 2002. Laboratory strength of glass ionomer cement, compomers and resin composites. J Prosthet Dent. 11:86-91. 441 442 27. Raygot CG, Chai J, Jameson L. 2001. Fracture resistance and primary failure mode of 443 endodontically treated teeth restored with a carbon fiber reinforced resin post system in 444 vitro. Int J Prosthodont. 14:141-5. 445 Shetty T, Bhat S, Shetty P. July 2005. Aesthetic post materials A review article. JIPS. 28. 446 5:122-5.

- 447 29. Shillingburg HT, Kessler JC, Wilson EL. 1982. Root dimensions and dowel size. Calif Dent Assoc J 10:43-9. 448 449 30. Sidoli GE, King PA, Setchell DJ. 1997. An in vitro evaluation of a carbon fiber based 450 post and core system. J Prosthet Dent. 78:5-9. 451 Sirimani S, Riis DN, Morgano SM. 1999. An in vitro study of the fracture resistance and 31. 452 the incidence of vertical root fractures of pulpless teeth restored with six post and core 453 systems. J Prosthet Dent. 84:262-9. 454 32. Standlee JP, Caputo AA, Hanson EL. 1978. Retention of Endodontic dowels: Effects of 455 cement dowel length, diameter and design. J Prosthet Dent. 39:401-5. 456 Stober T, Rammelsberg P. 2005. The failure rate of adhesively retained composite core 33. 457 build-ups in comparison with metal added glass ionomer core build ups. J Dent 33:27-32. 458 Tan PLB, Aquilino SA, Gratton DG, Stanford CM, Tan SC, Johnson WT, Dawson D. 34. 459 2005. In vitro fracture resistance of endodontically treated central incisors with varying 460 ferrule heights and configurations. J Prosthet Dent. 93:331-6. 461 35. Toksavul S, Toman M, Uyulgan, Schmage P, Nergiz I. 2005. Effect of luting agent and 462 reconstruction techniques on the fracture resistance of prefabricated post systems. J of 463 Oral Rehab. 32:433-440. 464 36. Torbjorner A, Karlsson S, Odman PA. 1995. Survival rate and failure characteristics for 465 two post designs. J Prosthet Dent 73:439-44. 466 Trabert KC, Cooney JP. 1984. The endodontically treated tooth. Dent Clin North Am 37. 467 28:923-51. Yue LH, Xing ZY. 2003. Effect of post-core design and ferrule on fracture resistance of 468 38. 469 endodontically treated maxillary central incisors. J Prosthet Dent. 89:368-73.
- 470

471

Table showing 45 teeth divided randomly into 3 Groups of 15 Each

Table-1

			Sub Groups		
	Glass Fiber post	A - Luxacore	I-A Glass Fiber post+ Luxacore		
Group	(Pafarnast by Angelus	B - Lumiglass	I-B Glass Fiber post + Lumiglass		
I	(Relotpost by Aligerus	C Ti Coro	I.C. Class Eiber post + Ti Core		
	Dental solutions Brazil).	C - ITCOle	1-C Glass Floer post + 11 Core		
	Quartz Fiber post	A - Luxacore	II-A Quartz Fiber post+ Luxacore		
Group	(DT Light posts by	B - Lumiglass	II-B Quartz Fiber post+ Lumiglass		
II	(D.I. Light posts by	C Ti Coro	II C. Quertz Eiher negt Ti Core		
	RTD France)	C - ITCOle	II-C Quartz Fiber post+ II Core		
	Zirconia post	A - Luxacore	III-A Zirconia post + Luxacore		
Group	(Snow light posts by	B - Lumiglass	III-B Zirconia post + Lumiglass		
III	(Show light posts by	C Ti Coro	III C. Ziraania post + Ti Cara		
	Danville)		III-C Zitcoina post + II Cole		

4	7	3	

Failure Loads for All the Specimens in Various Groups

Group Specimen	I-A	II-A	III-A	I-B	II-B	III-B	I-C	II-C	III-C
1.	24.051	20.656	28.259	24.816	17.866	19.236	19.055	19.497	19.595
2.	26.981	20.134	22.548	27.916	18.233	15.265	24.310	22.320	18.264
3.	26.051	23.897	22.238	22.434	22.614	15.035	22.222	20.950	11.264
4.	25.424	23.038	29.531	22.124	16.603	18.529	21.047	21.830	14.317
5.	23.593	27.851	27.476	20.780	24.072	16.299	24.180	28.977	14.048

474 (Values mentioned above are in kilograms and indicate peak failure loads failure loads)

475 I-A – Glass fiber + Luxacore 476 I-B – Glass Fiber + Lumiglass II-B- Quartz fiber + Lumiglass 477 I-C -Glass Fiber + Ti-Core

II-A -Quarz fiber + Luxacore II-C - Quartz fiber + Ti-Core

III-A – Zirconia + Luxacore III-B - Zirconia +Lumiglass III-C – Zirconia + Ti-Core

TABLE-3 479 Mean Failure Loads and Standard Deviation for All the Specimens in Various Groups

48	0									
	Group INDICES	I-A	II-A	III-A	I-B	II-B	III-B	I-C	II-C	III-C
	SAMPLE SIZE	5	5	5	5	5	5	5	5	5
	MEAN	25.220	23.115	26.010	23.614	19.896	16.873	22.163	22.715	15.498
	STANDARD DEVIATION <u>+</u> (S.D.)	<u>+</u> 1.4006	<u>+</u> 3.0814	<u>+</u> 3.3845	<u>+</u> 2.8105	± 3.2506	<u>+</u> 1.9118	± 2.2128	<u>+</u> 3.6613	± 3.3860
	RANGE	23.593- 26.981	20.134- 27.851	22.238- 29.531	20.780- 27.916	16.603- 24.072	15.035- 19.236	19.055- 24.310	19.497- 28.977	11.264- 19595

481 **TABLE-4** 482 Mean Difference Between Pairs Of Groups With Its Significance Using Students 't' Test

	I-A	II-A	III-A	I-B	II-B	III-B	I-C	II-C	III-C
I-A	-	2.105	0.790	1.606	5.324	8.347	3.050	2.505	9.722
		NS	NS	NS	**	**	NS	NS	**
II-A	-	-	2.895	0.497	3.219	6.242	0.952	0.400	7.617
			NS	NS	NS	**	NS	NS	**
III-A	-	-	-	2.396	6.114	9.137	3.847	3.295	10.512
				NS	**	**	*	NS	**
I-B	-	-	-	-	3.718	6.741	1.001	0.899	8.116
					*	**	NS	NS	**
II-B	-	-	-	-	-	3.023	2.267	2.819	4.398
						NS	NS	NS	*
III-B	-	-	-	-	-	-	5.290	5.842	1.375
							**	**	NS
I-C	-	-	-	-	-	-	-	0.552	6.665
								NS	**
II-C	-	-	-	-	-	-	-	-	7.217
									**
III-C	-	-	-	-	-	-	-	-	-

483 N.S.-Non Significant P > 0.05 * - Significant P < 0.05 ** - Significant P < 0.001

484 Table Value of 't' for 36 degree of freedom t 0.05 = 2.02t 0.001 = 2.436

485 S.E. D = $2.8828 \sqrt{1/5} + 1/5 = 1.8231$

486 D 0.05 = 2.028 x 1.831 = 3.7155

487 $D \ 0.01 = 2.436 \ x \ 1.8231 = 44630$

488 Largest difference is between III-A – III-C = 26.010 - 15.498 = 10.512

489 Smallest difference is between II-A - II-C = 23.115 - 22.715 = 0.400

490 17 differences are significant at 0.05 level

491 14 differences are significant at 0.01 level.

492

Table-5

493 Shows the number of samples fractured as salvageable or non-salvageable in all the groups

494

with respect to the core materials used.

CDOUD	Salvagab	le Fractures	Non-salvagable Fractures		
GROUP	Nos.	%	Nos.	%	
I-A	4	26.67	1	6.66	
II-A	3	20.00	2	13.33	
III-A	4	26.67	1	6.66	
TOTAL:	11	73.33	4	26.66	
I-B	5	33.33	-	-	

II-B	5	33.33	-	-
III-B	3	20	2	13.33
TOTAL:	13	86.66	2	13.33
I-C	5	33.33	-	-
II-C	3	20.00	2	13.33
III-C	4	26.67	1	6.66
TOTAL:	12	80	3	20
GRAND TOTAL :	36	80	9	20

495	Table-6
496	Shows the number of specimens fractured as salvageable or non-salvageable in all the
497	groups with respect to the posts used.

	Salvagable	Fractures	Non-salvagable Fractures		
GROUP	Nos.	%	Nos.	0/0	
(I)A	4	26.67	1	6.67	
(I)B	5	33.33	-	-	
(I)C	5	33.33	-	-	
TOTAL :(15=100%)	14	93.33	1	6.67	
(II)A	3	20	2	13.33	
(II)B	5	33.33	-	-	
(II)C	3	20	2	13.33	
TOTAL: (15=100%)	11	73.33	4	26.67	
(III)A	4	26.67	1	6.67	
(III)B	3	20	2	13.33	
(III)C	4	26.67	1	6.67	
TOTAL: (15=100%)	11	73.33	4	26.67	
GRAND TOTAL (45=100%)	36	80.0	9	20.0	

498

Figures with legends

499 Figure 1 Photograph showing samples with core build-ups





501 Figure 3 The acrylic block with the samples



502 Figure 4 Photograph showing samples positioned at 1300 on the Zwick universal load testing503 machine





504Figure 5 Photograph showing dimensional representation of post and core foundation

505Figure 6 Photograph showing fractured samples

