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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.

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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

Contributors

1. Dr. Lalit Kumar
   M.D.S
   Senior Assistant Professor,
   Department Of Prosthodontics
   Dr. Harvansh Singh Judge Institute of Dental Sciences and Hospital,
   Panjab University, Chandigarh, India
2. Dr Bhupinder Pal
   M.D.S
   Department of Dentistry
   Shah Satnam Ji Speciality Hospitals Sirsa

3. DR Prashant Pujari
   M.D.S
   Reader
   Department of Orthodontics
   Pacific Dental College Udaipur

Corresponding Author:

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

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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).

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

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

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)**.

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).

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.

Canal length was established using # 15 K file. Working length was kept 1 mm short of the apical end. Biomechanical preparation of the teeth was done with K-files from # 15 to #60 using conventional technique. Frequent recapitulation was done to maintain patency of the canal and prevent it from getting clogged. Finally after proper biomechanical preparation, the canal was 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).

2.3 Preparation of Post Space:

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

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.

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 build-up.

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

2.6 Mounting the samples:

Petroleum jelly was applied on the inner surface of the split mould **(Figure-2)** for easy separation of 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.

2.7 Testing of the samples for fracture resistance:

The acrylic block with the samples were placed on the Zwick machine **(Figure-4)** for 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.

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**.

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

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 as listed in **Table-4**. Fracture patterns were either horizontal, oblique, some involving the core, some involving the post and tooth structure, some with debonding of post and core and some with a combination of above types. However an attempt is made to classify these fractures into two groups as shown in **Table -5 and 6**. They are –

1. Restorable or Salvageable Fractures -

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

2. Non-Restorable or Non-Salvageable Fractures –

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

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

All the samples were sectioned with an air rotor 2 mm coronal to cemento-enamel junction, and a finish line of 1.5 mm deep chamfer was prepared all around the samples. A ferrule of 2 mm was prepared for all the samples (Yue LH, Xing ZY. 2003; Pereira JF, Ornelas F, Conti PCR, Valle AL. 2006; Akkayan B. 2004; Tan PLB et al. 2005). This was done to simulate the natural conditions, as teeth which have fractured in the cervical one-third with insufficient coronal tooth structure remaining, have to be restored with post and core so as to give retention to the artificial crown. A finish line of 1.5 mm was given to simulate the preparation for the future 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 similar manner 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 5 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.

Data thus obtained showed that Luxacore gave the highest mean fracture loads with all 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 I-C 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 cemento-enamel 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 non-salvageable 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.

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

CONCLUSION

The study conducted evaluated the fracture resistance of three composite resin core build-up 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,

1. 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 fiber posts then with quartz fiber posts and least with zirconia posts.

3. Ti-core (self-cured composite resin) had the best fracture resistance with quartz fiber posts 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.

5. a) It was observed that maximum number of salvageable fractures occurred with Lumiglass followed by with Ti-core, and least occurred with Luxacore.

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 occurred.

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Table-1

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

			Sub Groups
Group I	Glass Fiber post (Reforpost by Angelus *Dental solutions Brazil*).	A - Luxacore	I-A Glass Fiber post+ Luxacore
		B - Lumiglass	I-B Glass Fiber post + Lumiglass
		C - Ti Core	I-C Glass Fiber post + Ti Core
Group II	Quartz Fiber post (D.T. Light posts by *RTD France*)	A - Luxacore	II-A Quartz Fiber post+ Luxacore
		B - Lumiglass	II-B Quartz Fiber post+ Lumiglass
		C - Ti Core	II-C Quartz Fiber post+ Ti Core
Group III	Zirconia post (Snow light posts by *Danville*)	A - Luxacore	III-A Zirconia post + Luxacore
		B - Lumiglass	III-B Zirconia post + Lumiglass
		C - Ti Core	III-C Zirconia post + Ti Core

TABLE-2

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

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

I-A – Glass fiber + Luxacore　II-A -Quarz fiber + Luxacore　III-A – Zirconia + Luxacore
I-B – Glass Fiber + Lumiglass　II-B- Quartz fiber + Lumiglass　III-B – Zirconia +Lumiglass
I-C -Glass Fiber + Ti-Core　II-C - Quartz fiber + Ti-Core　III-C – Zirconia + Ti-Core

TABLE-3

Mean Failure Loads and Standard Deviation for All the Specimens in Various Groups

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 ± (S.D.)	± 1.4006	± 3.0814	± 3.3845	± 2.8105	± 3.2506	± 1.9118	± 2.2128	± 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

TABLE-4

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

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

Table Value of ‘t’ for 36 degree of freedom t 0.05 = 2.02t 0.001 = 2.436
S.E. D = 2.8828 √1/5 + 1/5 = 1.8231
D 0.05 = 2.028 x 1.831 = 3.7155
D 0.01 = 2.436 x 1.8231 = 44630
Largest difference is between III-A – III-C = 26.010 – 15.498 = 10.512
Smallest difference is between II-A – II-C = 23.115 – 22.715 = 0.400

17 differences are significant at 0.05 level
14 differences are significant at 0.01 level.

Table-5

Shows the number of samples fractured as salvageable or non-salvageable in all the groups with respect to the *core materials* used.

GROUP	Salvagable Fractures		Non-salvagable Fractures	
	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

Table-6

Shows the number of specimens fractured as salvageable or non-salvageable in all the groups with respect to *the posts* used.

GROUP	Salvagable Fractures		Non-salvagable Fractures	
	Nos.	%	Nos.	%
(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

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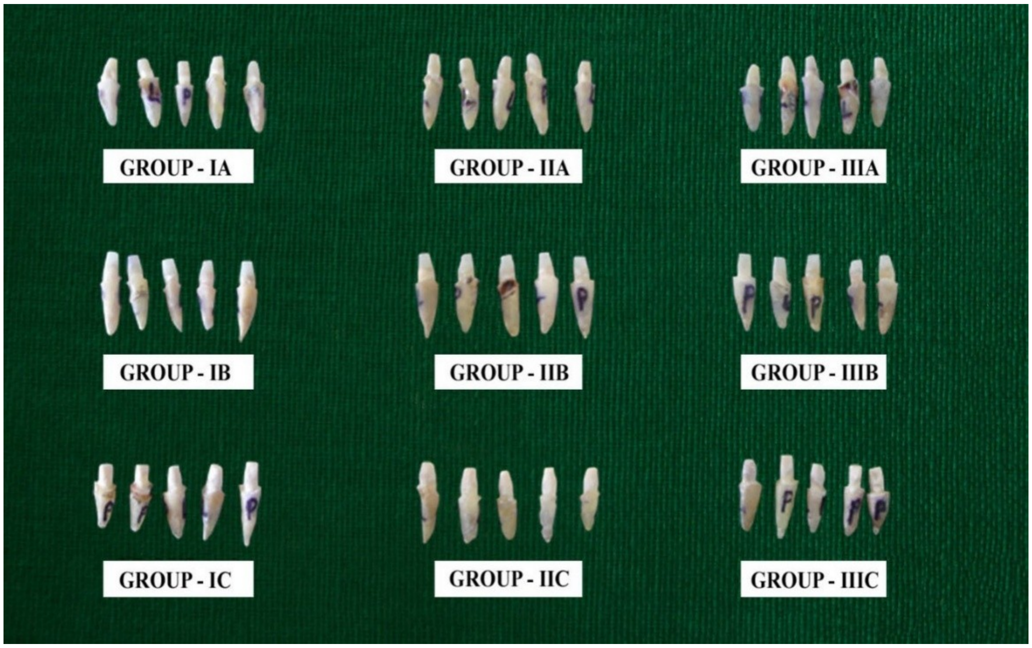
498 **Figures with legends**

499 **Figure 1** Photograph showing samples with core build-ups



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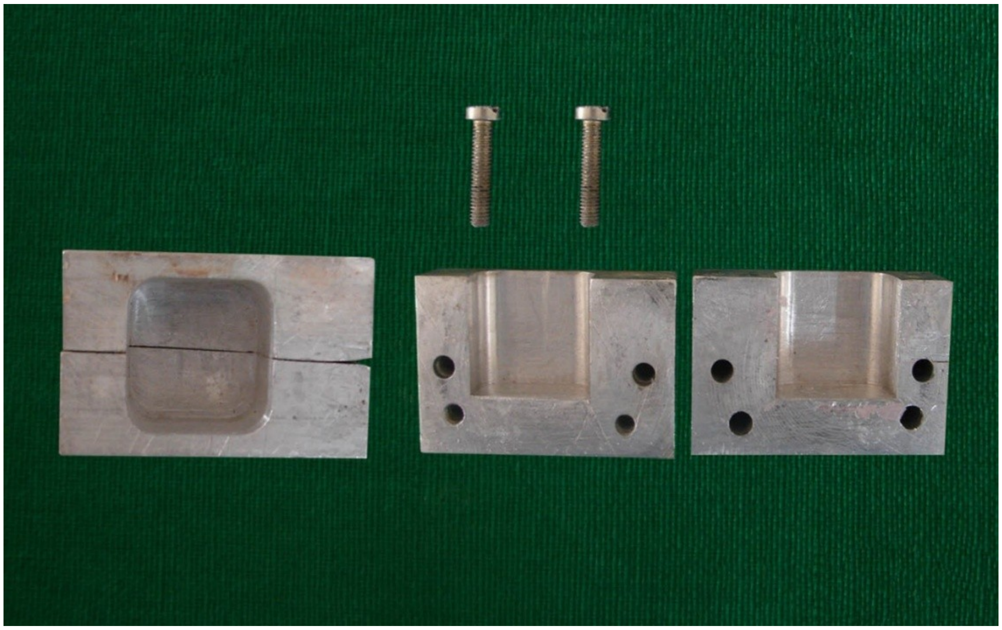
500 **Figure 2** Photograph showing split mould for mounting samples



501 **Figure 3** The acrylic block with the samples

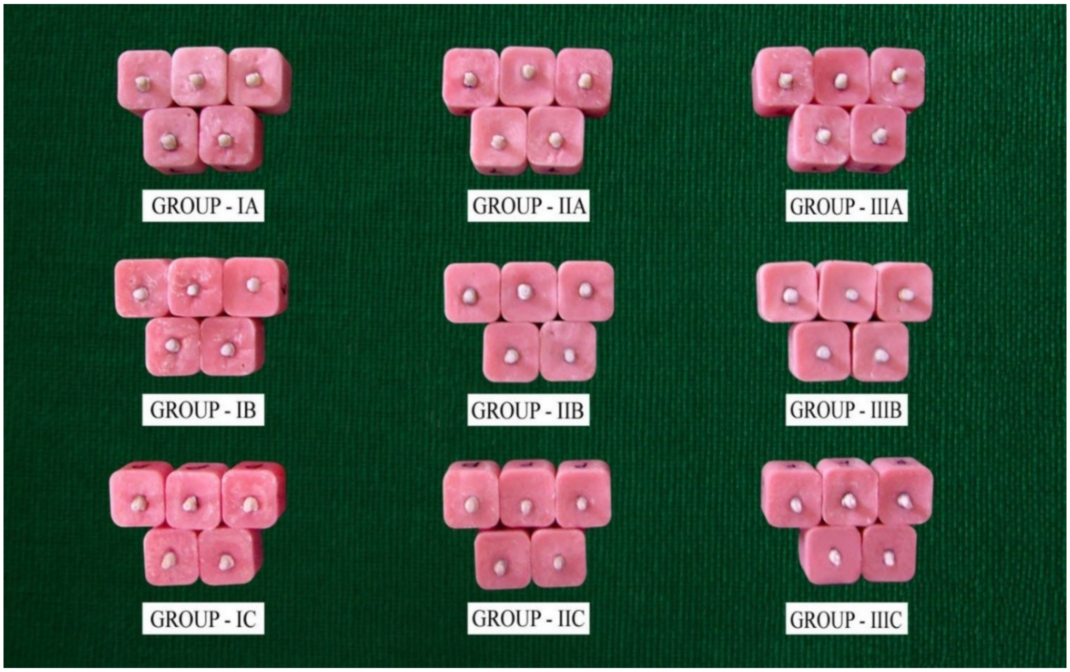
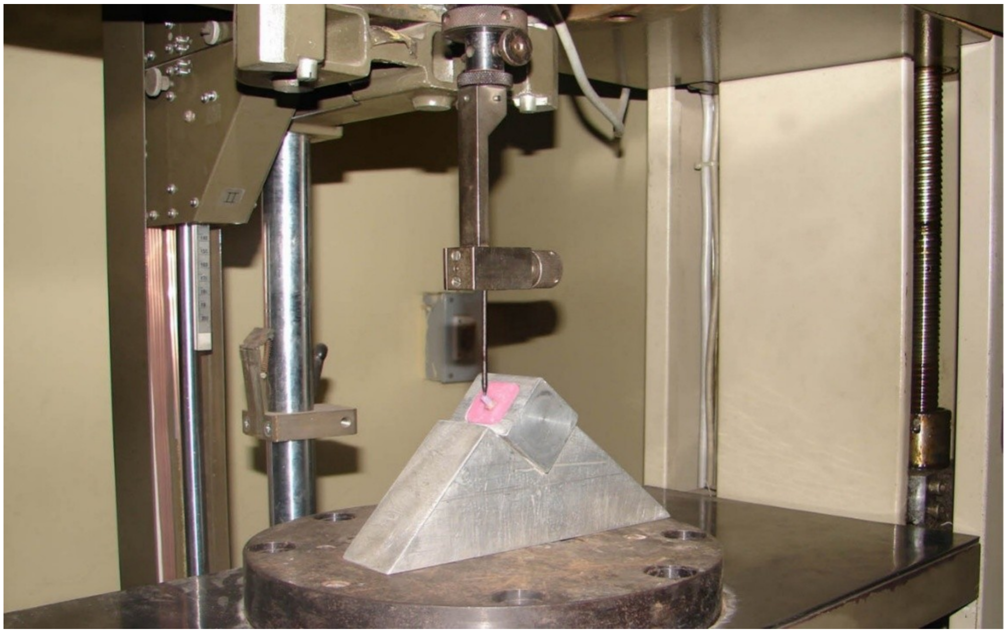
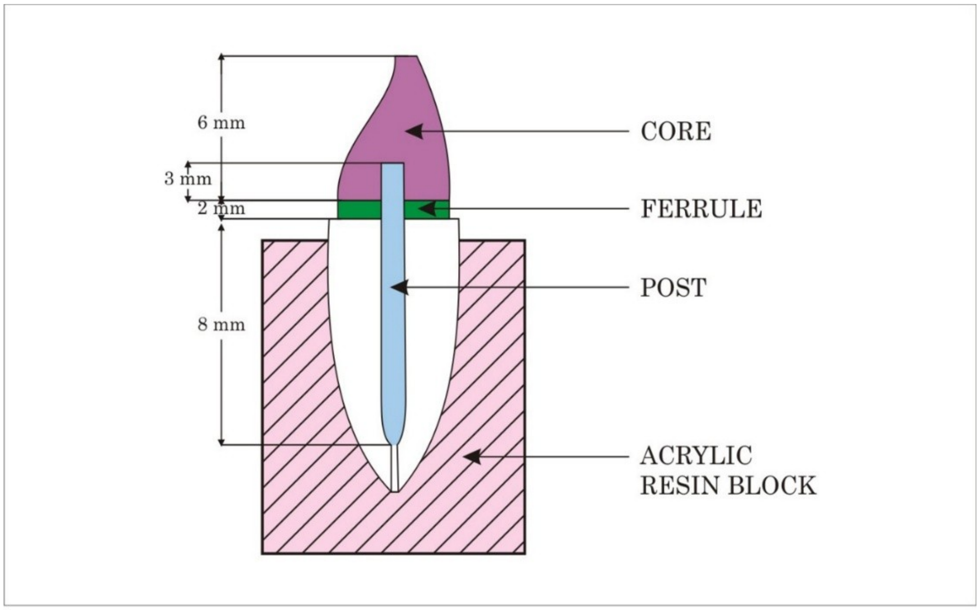


Figure 4 Photograph showing samples positioned at 1300 on the Zwick universal load testing machine



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



505**Figure 6** Photograph showing fractured samples