"COMPARATIVE EVALUATION OF FRACTURE RESISTANCE OF ENDODONTICALY TREATED ROOTS WITH VARIOUS POST N CORE SYSTEMS: AN *IN-VITRO* STUDY"

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In

PROSTHODONTICS, CROWN & BRIDGE AND IMPLANTOLOGY

By

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Under the guidance of

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BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES, LUCKNOW

(Faculty of Babu Banarasi Das University)

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I hereby declare that this dissertation entitled **" COMPARATIVE EVALUATION OF FRACTURE RESISTANCE OF ENDODONTICALLY TREATED ROOTS WITH VARIOUS POST N CORE SYSTEMS: AN *IN-VITRO* STUDY "** is a bonafide and genuine research work carried out by me under the guidance of ***Dr. Sulabh Kumar*** **,** Senior Lecturer, Department of Prosthodontics, Crown & Bridge and Implantology, Babu Banarasi Das College of Dental Sciences, Babu Banarasi Das University, Lucknow, Uttar Pradesh.

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CONTENTS

LIST OF TABLES

ABSTRACT

Background: The present era of dental practice today is witnessing a huge paradigm shift in their emphasis on esthetics. Metal post n core are compromised with altered asthetics. With growing popularity of all ceramic restorations tooth coloured post n core are needed to compensate for their metallic non esthetic counterparts.

Aim: To determine and to compare the fracture resistance of endodontically treated teeth when restored with cast metal, fibrereinforced composite,zirconia and lithium di silicate posts.

Material method: Forty extracted maxillary central incisors were collected and were subjected to root canal treatment and obturated with gutta-percha. All teeth were decoronated and mounted in acrylic blocks. The teeth were equally divided in four groups: (a)cast metal,(b)Fibrereinforced composite post n core, (c)Prefabricated zirconia post with composite core and (d)Lithium di silicate post n core. Post space was prepared and particular post was cemented in post space. Core build was done and teeth were prepared with a circumferential shoulder including a 1 to 2 mm ferrule; all restored with complete-coverage crowns. Compressive load was applied on the palatal aspect at an angle 130 degree to the long axis using instron universal testing machine. The force at fracture was measured in newton. Data were tabulated and analysed statistically using analysis of variance and t tests (SPSS version 21, IBM)

Result: Zirconia post had good fracture resistance (258.87 Mpa) when compared with cast metal (246.99 Mpa), Fibrereinforced composite (220.09 Mpa) and Lithium di silicate (208.31 Mpa)

Conclusion: Zirconia posts with composite cores might be recommended as a cosmetic alternative to cast posts and core in the anterior region. Avoid using Lithium di silicate post in one piece.

Keywords: Esthetic post, Zircoina post, Lithium di silicate post.

Crowns are frequently used to repair endodontically treated teeth with insufficient dental structure. In teeth with hard tissue loss resulting from trauma posts are needed for providing retention to the core material.[1,3,9,14]

The most dangerous type of failure in post-restored teeth is a radicular fracture. To avoid this, a post with a modulus of elasticity close to that of dentin aids in the uniform distribution of occlusal stress.[3,8,12] The choice of an appropriate restoration in this situation is goverened by strength and esthetics.

The present era of dental practise today is witnessing a huge paradigm shift in their emphasis on esthetics. Today's patients not only expect us to provide them with healthy teeth, healthy periodontium and an undisturbed neuromuscular function, many of them also desire an aesthetic teeth profile as well.[1,4,7,10,14]

It is important that the dentist takes note of these expectations that the patient has and try to fulfil these expectations within limits.

In clinical practise when a patient presents with a severely broken down teeth, a coronoradicular post is required for the longevity of restorations. Earlier, metal ceramic posts were commonly employed because of their long term success. These metal post and core restorations are associated with compromised esthetics when an all ceramic restoration is planned. Metal posts and core may alter the appearance of cervical area through the thin gingival tissue. Additionally, certain corrosive products may also deposit in the gingival tissues and may further cause root discoloration.

With the growing popularity of anterior all-ceramic restorations for aesthetic reasons, tooth-colored posts and cores are needed that are as excellent as, if not better than, their metallic non-esthetic counterparts.[7]

The goal of this research was to examine the fracture resistance of flared roots repaired with various tooth-colored aesthetic post and core systems.

The metal free posts are of two types based on the composition: composite and ceramic posts.

Composite materials: made up of carbon or silica fibres encased in a polymer resin matrix, commonly an epoxy resin. For direct posts, a polyethylene polymer (Ribbond) has recently been employed.

An important reason for the success of these restoration can be attributed to their biomimetic behaviour. Due to their greater similarity in elastic properties to dentine these posts allow for a uniform stress distribution to the tooth and surrounding tissues thus yielding a protective effect against root fracture.[3,6]

Ceramic materials: The proven ability of ceramic materials to mimic the appearance of tooth structure has been combined with improvements in strength and durability. The use of all ceramic posts is limited to situations where cast metal posts would have otherwise been indicated.[6,7]

The major advantage of these all ceramic post systems is their colour i.e aesthetics. The colour of which will be dependent on the internal shade of restoration that will be similar to the optical properties of the natural teeth. Even at the cervical regions it will aid in providing a certain depth to the cervical root areas.[3]

This study is hence planned to compare the fracture resistance of central incisor root with various post and core systems i.e

with cast metal, prefabricated fibrereinforced composite, prefabricated zirconia and Lithium Di Sillicate (Emax pressable).

AIM

To determine and to compare the fracture resistance of endodontically treated roots when restored with various post n core systems: Cast metal post n core , Zirconia post n core, all ceramic post n core, Fibre reinforced composite post n core.

OBJECTIVES

To determine the fracture resistance of roots with Cast metal post n core.

To determine the fracture resistance of roots with Zirconia post n core.

To determine the facture resistance of roots with Fibre reiforced composite post n core.

To determine the fracture resistance of roots with Lithium di silicate post n core.

To compare and analyse the fracture resistance of roots with various post n core systems.

Dentists are usually presented with a restorative challenge when confronted with an endodontically treated tooth complicated by loss of coronal tooth structure. The post provides retention for the core which replaces the lost coronal tooth structure and helps to retain the restoration.

Harris (1871)[40] recommended a post or "pivot" to retain an artificial crown in a root with an extirpated pulp, although endodontic techniques were crude at that time.

Silverstein W.H. (1964)[41] had given importance to restoration of teeth after endodontic treatment by cast gold post and core; otherwise crown might fracture under the masticatory forces. He preferred post and cores because post core restores the integrity of the pulpless tooth as a single- unit, rendering it independence from the veneer which covered it.

Colley IT. *et al.* (1968)[42] used extracted teeth and investigated the retentive properties of dowels of various diameters and lengths and revealed that vertical resistance to displacement (i.e. retention) is in direct proportion to length, diameter and surface roughness of the dowel.

Angmar-Mansson. *et al.* (1969)[43] concluded that accumulation of corrosive products formed as a result of difference in potentials of metals used for post and core material exerts pressure on the inside of the root leading to fracture. So one should never use differnt materials for the post, core and crown.

Dawson PE. (1970)[44] stated that metal posts should be preferred in the non-vital teeth. Using self-threading pins for retaining restorative material tent to cause dentinal crazing or crazing in teeth.

Kantorowicz G.F. (1970)[45] recommended that the post should be atleast as long as the length of the crown being restored but if that is not possible then post should extend to within 5 mm of radiographic apex.

Standlee J.P. *et al.* (1972)[46] compared the 3 types of posts regarding design, insertion, length and ability to transmit forces to supporting structures using photoelastic stress analysis. They found that tapered posts acts as a wedge and creates high stress concentrations that result in root fracture and stress concentration decreases with increased post length.

Weine, F.S. (1972)[47] concluded that short posts increase the possibility of root fracture whereas the long post distributes the stress throughout the root that it contacts which is well surrounded by bone.

Stern, N. and Hirschfeld, Z. (1973)[48] showed that dowel diameter should be one third the diameter of the root.

Hanson, E.C. and Caputo, A.A. (1974)[49] conducted an experiment in which different cements i.e. Zine phosphate, polycarboxylate, ethyl cynoacrylate and dowel diameters were tested. Their results showed no differences between the three cements used according to retention values.

Caputo, A.A. and Standlee, J.P. (1976)[50] proposed that atleast 1mm of sound dentin should be maintained around the entire circumference of the post space. Also, a sufficient buccal dentin wall must be conserved in maxillary anterior teeth because it functions as a fulcrum toward horizontallydirected force.

Hock D. (1976) suggested that the strenght of a tooth is directly to the bulk of the dentin structure and excessive removal of tooth structure may lead to increased stress.

Therefore every attempt should be made to conserve remaining tooth structure to prevent fractures.

Johnson, J. et al. (1976) found that a change to a parallel sided serrated dowel post increased the retention4½ times over that of a tapering sided post. They also found that increase in post length or diameter yielded only a 30% to 40% increase in retention.

Rud & Omnell (1976) studied teeth with vertical / oblique root fractures and found that 72% of the fractures were because of prolonged electrolytic reaction between dissimilar post and core metals, the products of this reaction deposited in the root canal, induced volumetric changes and caused root fracture.

Dale, Moser *et al.* (1977) concluded that the semiprecious metals produced accurate and well- fitted dowels needing minimal adjustment and being harder then type III Gold alloy, would be ideal for casting dowels and cores.

Henry P.J. (1977) through photoelastic study of six post and core designs found that the parallal post design distributed stress more evenly while the tapered post showed localized high stress concentrations.

Lovdahl & Nicholls (1977) measured resistance to a stress applied lingually at an angle of 130 degrees to the long axis of the tooth. Under the test conditions, maxillary central incisors with natural crowns demonstrated greater strength then teeth treated with either a cast dowel and core or pin-retained amalgam cores.

Johnson and Sakamura (1978) found parallel -sided dowels to resist tensile forces 4.5 times greater then the tapered dowels and increasing the length of the dowel from 7 or 9 mm to 11 mm increased retention by 24% to 30%.

Trabert, K.C., *et al.* (1978) found that teeth with 1.25 mm diameter steel dowels were less prone to fracture than either untreated control teeth or teeth reinforced with dowels larger than 1.75 mm. Endodontically treated teeth with parallel sided stainless steel posts showed significantly higher resistance to fracture.

Guzy and Nicholls (1979) applied forces at 130^{o} to 59 intact endodontically treated teeth with and without kerr Endo-Post reinforcement and compared. Fifty-eight teeth fractured below the cementoenamel junction. Teeth without post fractured through the middle and coronal one third of the root. Teeth with post fractured through the body of the post. They concluded that there is no statistically significant difference in reinforcement by cementing a tapered dowel into a sound endodontically treated tooth.

Chan & Bryant (1982) discovered that freshly extracted mandibular premolars with cast gold post and cores under compressive loads failed by displacement and root fracture in comparison to the Parapost and amalgam or composite resin specimen which demonstrated fracture of the core but exhibited fewer post-core dislogements and root fracture. Cast gold dowel and cores demonstrated a singnificantly lower mean failure load than amalgam or composite resin cores with a cemented Parapost.

Mattison, G.D. (1982) showed through the photoelastic stress analysis that the diameter of a post with a core affected the magnitude of stress and stress generally increases with increase in post diameter & vertical load.

DeSort *.et al.* (1983) claimed that, from a retentive standpoint, the parallel sided posts have a greater retention than the tapering sided posts but, because they are placed within a tapering root, they require more fitness on placement. Also the length of the

posts is important, since it is directly proportional to the amount of support offered by the post and its resistance to root fracture.

Deutsch, A.S., *et al.* (1983) stated that tapered post exhibit a wedging effect and produce the highest shoulder stress concentration. The post design has a definite effect on the distribution of stress. Sharp angles should be avoided at the occlusal shoulder because they concentrate functional stresses.

Goerig, Mueninghoff (1983) stated that the cast post and cores possess superior adaptation to the root canal as they were customized for each canal. They also recommended that the post and core and possibly the crown should be fabricated of the same metal and recommended that post preparation should only minimally alter the internal anatomy of the canal.

Assif, D., Bleicher, S. (1986) examined the thickness of a composite luting agent for serrated endodontic posts and concluded that adaptation to the canal did not affect the retention.

Brown and Mitchem (1987) determined the retentive strength of seven combination of posts (Para post , Brassler and Flexi post), cementing agents(Zine phosphate and glass ionomer and two resin cements) , and canal treatments in recently extracted human anterior teeth . The Flexi post displayed twice the retention as compared to other systems evaluated.

Eissman and Radke (1987) in the post-endodontic restoration recommended a cast restoration that extended at least 2 mm apical to the junction of the core and the remaining tooth structure and suggested that encirclement of the root, with this ferrule

effect would protect the pulpless tooth against fracture by counteracting spreading forces genereted by the post.

Donna A B .*et al.* (1990) compared the stress distribution during insertion and function of three prefabricated posts with various designs by using the criteria of post length and diameter. During compressive loading flexible posts displayed significantly higher shoulder stresses along the coronal surface of the post's length than Para posts. Apical stresses were similar for Flexi-Post, Para-Post, and Para-Post Plus posts during compressive loading.

Burgess JO, *et al.* (1992) studied the resistance to tensile, compression and torsional forces provided by four post systems (an experimental, Para post, Flexi post and V-lock). The tensile load required in pulling the experimental post and resin was significantly less than the load required to remove the threaded posts. Flexible prefabricted-Posts provided the greatest resistance to torsion and tensile loading. The compressive load required to fracture the core over the V-Lock post was significantly greater than the other post systems.

Cohen. *et al.* (1992) compared the retention of posts for various diameters of three prefabricated post systems with that of the previously reported No. 1 and No. 2 Flexi-Post systems. The retention of 1.3 mm posts from most to least retentive was Flexi-Post (zine phosphate)>Filpost (zinc phosphate)>Filpost (resin)>Brasseler (zinc phosphate)> Unity (resin). The retention of 1.6 mm posts from most to least was Flexi-Post (zinc phosphate)>Filpost (zinc phosphate)>Brasseler (zinc phosphate) Unity (resin)>Filpost (resin).

Mendoza D.B.*et al.* (1994) compared the ability of three resinous cements and a glass ionomer cement to retain preformed posts in the root canals of extracted

endodontically treated maxillary canines. They found that resinous cements vary in their case of manipulation and in their ability to retain endodontic posts. Glass ionomer cement was equally or more retentive than the two brands of resinous cement used.

Annika Torbjorner, *et al.* (1995) compared custom cast and parallel sided serrated posts with respect to type of failure and failure rate. The failure rate was 15% for tapered posts and 8 % for Para-post posts. A higher success rate was recorded for parallel sided serrated posts compared with custom cast posts regarding both the total failure rate and severity of failure. **Leary JM, Holmer DC, Johnston WT (1995)** evaluated the retention of post and cores using various cements such as resin composite luting cement with and without Gluma dentin bond, Zinc phosphate cement, and Glass ionomer cement. According to them, Gluma appeared to enhance the bond at the post/tooth interface, resulting in decreased variability and increased strength.

Loney, Moulding, Ritsco (1995) studied the effect of load angulation on fracture resistance of teeth restored with cast post and cores and crowns and found significant differences in the fracture resistance of post-restored teeth as a result of load angle. They found that mean failure loads were increased as load angle approached parallelism to the long-axis of the teeth.

Holmes DC., *et al.* (1996) did a finite element analysis to study the influence of various post dimensions on stress distribution in dentin of an endodontically treated tooth restored with cast post and cores. They found that the greatest compressive and tensile stresses in dentin lingual (compression) o facial (tension) root surface were on the coronal third of the root. Minor alterations in post dimensions had minimal effect

on the distribution of compressive and tensile stresses in dentin. The greatest shear stresses in dentin occurred adjacent to the post in the facio-lingual section at approximately stresses occurred when the length of the post was reduced.

Potashnick Steven R (1996) found that post-retained restorations are a practical and reliable treatment option. Cast tapered posts, when made correctly will provide a reliable foundation for post retained restorations. The cast tapered post is a versatile, universally adaptable method of achieving retention for all types of post-retained restorations.

Purton and Payne (1996) in a study of the fracture resistance of teeth restored with carbon fiber posts and stainless steel posts reported that tooth fracture were uncommon and that the most frequent site of failure was the post and core interface.

Morgano SM. (1996) found that a custom cast post is the most effective means of conserving tooth structure when a post is required to retain a core for an artificial tooth. Atleast 4-5 mm of apical guttapercha must be maintained. Also that the prognosis is improved if the width of the post does not exceed one half the width of the root and that the cemented artificial crown extends apical to the core to provide 1.5 to 2 mm ferrule.

Mendoza DB , Eakle WS (1997) evaluated the retention of posts cemented with various dentinal bonding agents and concluded that C&B Metabond cement was most retentive , no difference was found between ketac-cem and Panacea cements and All Bond 2 cement was least retentive of all cements.

Ulter JN, *et al.* (1997) evaluated retention of prefabricated metal posts cemented with resin cement and zinc phosphate cement and found that posts cemented with resin cement had higher tensile strength.

Brett I Cohen *et al.* (1998) compared retentive values of three posts (Flexi-Post, AccessPost, and ParaPost) cemented with five cements (Flexi-Flow, zinc phosphate, Advance, Duet, and Ketac-Cem) plus a control group that consisted of a Flexi-Post No. 2 dowel without cement. The Flexi-Post dowel demonstrated higher mean retention than AccessPost or ParaPost dowel; AccessPost dowel was higher than ParaPost dowel. Flexi-Flow cement had the highest overall mean retention followed, in decreasing order, by zinc phosphate, Advance, Ketac-Cem, and Duet cements.

Duncan JP, Pameijer CH (1998) compared the retention of parallel sided titanium posts cemented with six luting agents. There was no significant difference between Ketac-Cem cement, Resinomer, with one step system and zinc phosphate cement.

Love RM, Purton DG (1998) compared the retention of serrated root canal posts cemented with glass ionomer cements (Hybrid). The results concluded that performance of resin modified glass ionomer cements was significantly below that of other cements used in their study.

Martinez-Insua, A., *et al.* (1998) compared the fracture resistances of pulpless teeth restored with a cast post and core or carbon-fiber post with a composite core. They found that significantly higher fracture threshold values were obtained in the cast-post and core group. The teeth restored with cast posts showed fracture of the tooth, at loads rarely occurring clinically. The teeth restored with carbon fiber post and composite core showed failure of the post/core interface before the fracture of the tooth occurred.

Purton DG, Chandler NP and Love RM (1998) tested the rigidity and the retention of parallel root canal posts. A serrated, stainless steel post was used as the control. They concluded that stainless steel; serrated posts were superior to the two newer types in terms of rigidity and retention into roots.

Cohen B.I. *et al* (1999) compared the retention and photoelastic stress patterns from two loading conditions, vertical (133 2 N, 30 pounds) and oblique at a 26o angle (133 2 N, 30 pounds) for two prefabricated post systems (Flexi-Post and C-Post). According to them, the symmetric even stresses and statistically higher retentive strength for Flexi-Post are more favorable than the asymmetric, uneven stresses and retatively low retentive strength for the C-Post.

Stockton LW (1999) formulated, through the literature search that for most clinical situations, a passive parallel-sided post will, in the hands of the average practitioner, allow the dentist to successfully restore most endodontically treated teeth.

Cohen BI, *et al.* (2000) compared retention of an active post system (Flexi-Flange), a metal passive prefabricated post system (ParaPost), a passive prefabricated burnoutpost system (ExactaCast) with and without grooved dentin walls, and a zirconium oxide ceramic post design (Cerapost). The Flexi-Flange with Flexi-Flow Natural cement obtained the highest retentive value.

Mitchell CA (2000) published criteria for selection of materials for post cementation . They concluded that for posts with adequate mechanical retention zinc phosphate is a good choice. Posts with compromised mechanical retention, benefit can be derived by using resin modified glass ionomer cement. Composite resin cements should be reserved for rare case with inadequate mechanical retention.

Resentritt, *et al.* (2000) carried out a comparative study of fracture strength of metallic and tooth-colored posts and cores. They found that posts with composite cores had a higher fracture strength than all ceramic and gold alloy systems. The failure of metal systems was marked by loosening and pulling out of the post in contrast to ceramic posts which fractured.

Hew YS; *et al.* (2001) compared the rigidity, retention within the root canals of extracted teeth and ability to retain composite resin cores with titanium core foundation. The dowel systems were lesser retentive with the resin core material than with the titanium control. Resin dowel systems were more retentive in the root than the ceramic dowel but were similar to the titanium control.

Newman M P *et al* (2003) compared the effect of 3 fibre-reinforced composite post systems (FibreKor, Luscent anchors and Ribbond posts) with stainless steel posts (ParaPost) on the fracture resistance and mode of failure of endodontically treated teeth and thus concluded that the load to failure of the composite posts were lesser than the stainless steel posts.

Coelho Santos *et al* (2004) determined the influence of different types of posts on the fracture resistance of a resin composite core using tensile strength test. The use of the posts did not result in reinforcement of resin composite core when diametral tensile force was applied. When used with the core material, Light-Post, Dentorama Post, and FiberKor resulted in the highest diametral tensile strength values, whereas Para-Post resulted in the lowest values.

Aksoy G, *et al* (2005) evaluated the retention between a prefabricated dowel (Gold Plated Anchorage Post) and 3 different core materials (amalgam, light-polymerized resin composite, and glass ionomer) with and without a dual-polymerized adhesive

resin luting agent. They concluded that the dowel-head retention of the GIC was significantly weaker than the dowel-head retention for amalgam and resin composite, whether bonded or not. The adhesive resin luting agent tested appeared to have a significant strengthening effect on the dowel-head retention of the core materials.

Ertugrul H Z *et al* (2005) investigated the retention of the dowel, luting agents and tooth complex while appluing different luting agents to cast metal dowel under vertical tensile loading and concluded that zinc phosphate cement can provide superior retention for cast metal dowels retative to the phosphate-methacrylate resin luting agent with or without the silane coating techniques.

Goto Y *et al* (2005) compared the fatigue resistance of 3 dowel and core system and concluded that a stronger union between crowns and endodontically compromised teeth may be achieved by using resin-bonded fibre-reinforced dowels and composite cores, rether than conventional cast dowel and cores.

Clarisse C.H.Ng *et al* (2006) investigated the fracture resistance of restored endodontically treated teeth when residual axial tooth structure was limited to one half the circumference of the crown preparation. They concluded that the location of the remaining coronal tooth structure may affect their fracture resistance.

Faruk Taner Dilmenerb *et al* (2006) compared the fracture resistances of 3 recently introduced esthetic post-and-core systems with a cast metal post and core using a clinically related test method. They concluded that the cast metal post/core and zirconia post/ceramic core foundations were found to be more fracture resistant than the zirconia post/composite-resin core and stainless steel post/composite-resin core foundations. Aside from its desirable esthetic properties, the zirconia post/ ceramic core combination demonstrated high resistance to fracture.

Gu X M *et al* (2006) evaluated the fracture resistance of crown-restored incisors with different post-and-core systems and luting cements and suggested that fibre post s can be recommended as an alternative to cast and prefabricated metallic posts and composite resin cement cannot significantly improve fracture resistance of metallic post and crown- restored incisors.

Giuseppe Varvara *et al* (2007) concluded that the custom-made cast post and core has the highest catastrophic failure potential, although fracture occurs above the normal masticatory range; therefore, it is recommended for use when little or no residual dentin remains. Alternatively, when at least 2 mm of residual height of dentin exists, the carbon fiber post system restoration may be more suitable, since it demonstrated only a slightly lower fracture resistance than the custom-made cast post and core, but with a more favorable failure potential.

Luiz Ricardo Menani *et al* (2008) concluded that Titanium alloy cast posts and cores demonstrated mean retentive values similar to those obtained with cast gold-alloy posts and cores when cemented with either zinc phosphate cement or resin cement. It was concluded that there was no advantage to use the resin cement when compared with zinc phosphate cement.

11.**4. Eligibility Criteria**

Inclusion criteria

1. Teeth with intact cervical and root region

Exclusion Criteria

1. Teeth having incompletely formed root(open apex)
2. Teeth having root fracture
3. Teeth having extreme canal curvature
4. Teeth having root resorption

11.6 Materials and equipment used in the study with specifications and company

For sample preparation:

1. Micromotor (NSK Japan)
2. Diamond disc (0.25 mm thick)
3. Formalin 10%

For Root canal preparation:-

1. Endo access bur & Endo Z bur (Dentsply Maillefer, Switzerland)
2. K files (Dentsply Maillefer, Switzerland)
3. Gutta Purcha (Dentsply)
4. 0.9% w/v Saline (Eurolife, India)
5.

Post space preparation and core build up

1. Peeso reamer (Dentsply Serona)
2. Universal bonding agent (Ivoclar, Germany)
3. Etchant (3M)
4. Dual cure luting agent (Multilink N, Ivoclar Germany)

For tooth preparation and impression

Tooth preparation burs (SHOFU, JAPAN)

Rubber base impression material (Ivoclar, Germany)

11.5 Sampling Method

The present study was conducted in the Department of Prosthodontics, B.B.D.C.O.D.S, Lucknow and CIPET Lucknow to study the comparative evaluation of fracture resistance using different post n core system on an instron universal testing machine.

Total 20 extracted maxillary incisors were collected for in vitro study and stored in normal saline. Root canal treatment, followed by the obturation was carried out on each tooth.

The teeth were randomly assigned into four experimental groups with five in each group

Group A: Custom cast post n core

Group B: Fibre reinforced composite post with composite core

Group C: Prefabricated zirconia post with composite core

Group D: Lithium disillicate post n core.

The samples were decoronated at cemento-enamel junction using fine grite diamond disc and endodontic treatment was carried out in all the specimens using Protaper rotary file system with the crown down technique. 5.25% sodium hypochlorite was used to irrigate the canals after each file. Teeth were prepared apically ISO size 25, and canals were dried with paperpoints . Teeth were obturated with gutta percha cones using lateral condensation.

Post space were prepared by removing the gutta-percha with peeso-reamer files leaving 3 mm of gutta-percha apically.

In Group A:

Custom cast post and core

Direct inlay pattern of post and core was prepared. The pattern was then casted with cast metal. The post space was treated with chelating agent (Glyde Germany), and subsequently irrigated with 5.25% sodium hypochlorite to remove the smear layer. The post and core were cemented with dual cure adhesive cement

In Group B:

Fibre reinforced composite post and composite core

Prefabricated Fibre posts were cut to the desired length.

Each post area was cleaned for 30 seconds with 5 mL normal saline and dried with paper tips. The post space was etched for 15 seconds with 37 percent phosphoric acid (Total etch Ivoclar Vivadent), washed for 15 seconds with distilled water, and dried with paper points.

A microbrush was used to apply the bonding compound, which was then cured for 20 seconds.

Lentulospiral was used to apply the dual cure resin cement, and the post was then placed.

In Group C:

Zirconia (Prefabricated) post and composite core

Prefabricated posts were cut to the necessary length. Each post area was cleaned for 30 seconds with 5 mL normal saline and dried with paper tips. The post space was etched for 15 seconds with 37 percent phosphoric acid (Total etch Ivoclar Vivadent), washed for 15 seconds with distilled water, and dried with paper points. Bonding agent were applied with microbrush & cured for 20 sec.

The Dual cure resin cement were applied with lentulospiral and post were then placed into the canal & excess material was removed and light cured for 40 seconds.

In Group D:

Lithium Di Sillicate (emax pressible) posts and core

Direct inlay pattern of post and core were prepared and casted with ceramic ingots. The casted lithium di silicate post and core were then finished and polished with heatless stones.

Each post area was cleaned for 30 seconds with 5 mL normal saline and dried with paper tips. The post space was etched for 15 seconds with 37 percent phosphoric acid (Total etch Ivoclar Vivadent), washed for 15 seconds with distilled water, and dried with paper points.

A microbrush was used to apply the bonding compound, which was then cured for 20 seconds.

Lentulospiral was used to apply the dual cure resin cement, and the posts were then placed.

All preparations were finished with 1mm butt shoulder preparations and a wall convergence of approximately 6 degrees. The finish line of each preparation followed by the CEJ.

Each specimen were scanned through cad cam scanner and wax crowns were then designed for central incisor and then milling was done through milling machine.

The wax crown were then casted in cast metal alloy. And every crown were the finished and polished and luted to the specimens with GIC luting.

Root surfaces of all the teeth were coveredup with Teflon tape to a depth 2mm below the facial cementoenamel junction to produce a -2.2to -2.0mm layer approximately equal to the average thickness of the periodontal ligament.

All specimens were mounted on the acrylic block.

A specially made device was made that allowed loading of the tooth at the middle point of palatal side of the incisal edge 130° to the long axis.

All the specimens were subjected to the compressive force at 1 mm diameter at an angle of 130° to long axis of the tooth using Instron Universal Testing Machine. The force at fracture was measured in Newton. Data were tabulated and statistically analyzed using analysis of variance and t-tests (SPSS version 21, IBM.

DATA ANALYSIS

The data was entered in microsoft excel format and was analysed using SPSS version 21(IBM SPSS Corp. Ltd. Armonk, N.Y). Summarized data was presented using Tables and Graphs. Descriptive data was reported for each variable. Descriptive statistics such as mean and standard deviation for continuous variables was calculated. Shapiro Wilk test was used to check the normality of the data. As the data was found to be normally distributed bivariate analyses was performed using One way ANOVA followed by tukeys test for post hoc comparison. Level of statistical significance was set at p-value less than 0.05

ANALYSIS OF VARIANCE

Analysis of variance (ANOVA) is used when we compare more than two groups simultaneously. The purpose of one-way ANOVA is to find out whether data from several groups have a common mean. That is, to determine whether the groups are actually different in the measured characteristic. One way ANOVA is a simple special case of the linear model. For more than two independent groups, simple parametric ANOVA is used when variables under consideration follows Continuous exercise group distribution and groups variances are homogeneous otherwise non parametric alternative Kruskal-Wallis (H) ANOVA by ranks is used. The one way ANOVA form of the model is

$Y_{ij} = \alpha_{.j} + \varepsilon_{ij}$

where:

- Y_{ij} is a matrix of observations in which each column represents a different group.
- $\alpha_{.j}$ is a matrix whose columns are the group means (the "dot j" notation means that α applies to all rows of the j^{th} column i.e. the value α_{ij} is the same for all i).
- ε_{ij} is a matrix of random disturbances.

The model posits that the columns of Y are a constant plus a random disturbance. We want to know if the constants are all the same.

Assumptions are:

a) Response variable must be normally distributed (or approximately normally distributed).
b) Samples are independent.
c) Variances of populations are equal.
d) The sample is a simple random sample (SRS).

Two-way anova is used when we have one measurement variable and two nominal variables, and each value of one nominal variable is found in combination with each value of the other nominal variable. It tests three null hypotheses: that the means of the measurement variable are equal for different values of the first nominal variable; that the means are equal for different values of the second nominal variable; and that there is no interaction (the effects of one nominal variable don't depend on the value of the other nominal variable). When we have a quantitative continuous outcome and two categorical explanatory variables, we may consider two kinds of relationship between two categorical variables, In this relationship we can distinguish effect of one factor from that of the other factor. This type of model is called a **main effect model** or **no interaction** model.

Tukey Multiple Comparison Test

After performing ANOVA, Tukey HSD (honestly significant difference) post hoc test is generally used to calculate differences between group means as

$$q = \frac{\bar{X}_1 - \bar{X}_2}{SE}$$

where,

$$SE = \sqrt{\frac{S^2}{2}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$$

S^2 is the error mean square from the analysis of variance and n_1 and n_2 are number of data in group 1 and 2 respectively.

Statistical significance

Level of significance "p" is level of significance signifies as below:

$p > 0.05$ Not significant (ns)

$p \leq 0.05$ significant (*)

Results

Table 1 shows Groupwise comparison of mean fracture strength. Mean fracture strength was found to be 225.22±15.35 in Group A, 201.75±13.06 in Group B, 234.55±35.20 in Group C and 166.05±28.54 in Group D.

	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
Group A-Custom cast post n core (control group)	225.2260	15.35100	4.85441	214.2446	236.2074	203.56	246.99
Group B-Fibre reinforced composite post with composite core	201.7500	13.06852	4.13263	192.4013	211.0987	182.76	220.09
Group C-Prefabricated Zirconia post with composite core	234.5560	35.20963	11.13426	209.3686	259.7434	137.63	258.87
Group D-Lithium Di Sillicate post n core (Emax pressible)	166.0520	28.54376	9.02633	145.6330	186.4710	122.22	208.31

Table 1: Groupwise comparison of mean fracture strength

Figure 1: Groupwise comparison of mean fracture strength

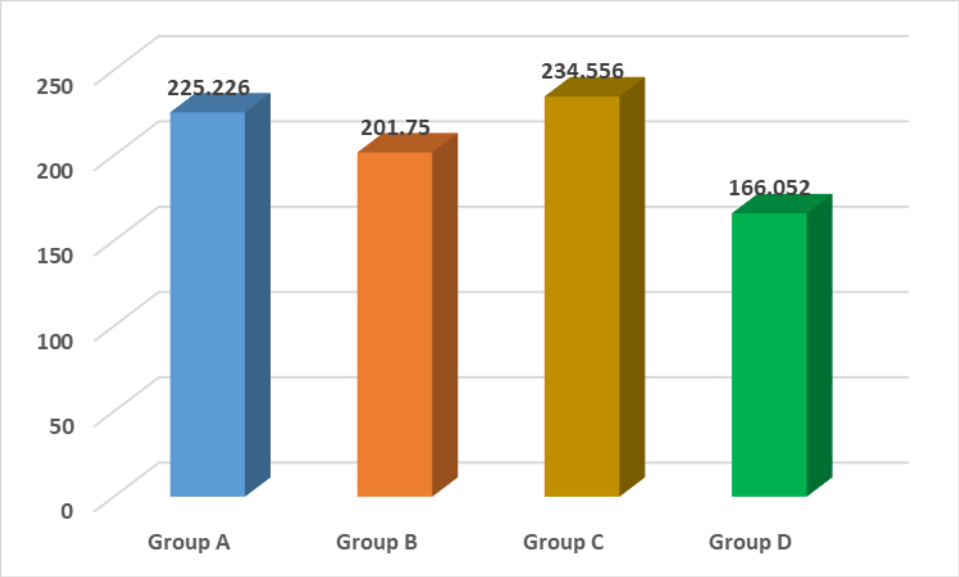

Table 2 shows One way Analysis of variance. Overall significant difference was seen in the fracture strength of four study groups when compared using One way ANOVA as $p<0.05$.

	Sum of Squares	Df	Mean Square	F	P value .
Between Groups	27957.782	3	9319.261	15.148	.0001*
Within Groups	22148.131	36	615.226		
Total	50105.913	39			

Table 2: One way Analysis of variance

Groups	Mean Difference	Std. Error	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
Group A vs B	23.47600	11.09257	.167	-6.3988	53.3508
Group A vs C	-9.33000	11.09257	.835	-39.2048	20.5448
Group A vs D	59.17400*	11.09257	.0001*	29.2992	89.0488
Group B vs C	-32.80600*	11.09257	.027*	-62.6808	-2.9312
Group B vs D	35.69800*	11.09257	.014*	5.8232	65.5728
Group C vs D	68.50400*	11.09257	.0001*	38.6292	98.3788

Table 3 shows Post hoc pairwise comparison using Tukey's test. Mena fracture strength was found to be significantly less in Group D as compared to GroupA, B and C. when comparison was made between Group B and Group C, fracture resistance was found to be significantly lesser in Group B. rest all the pairs failed to reach the level of statistical significance as p >0.05.

Table 3: Post hoc pairwise comparison using Tukey's test

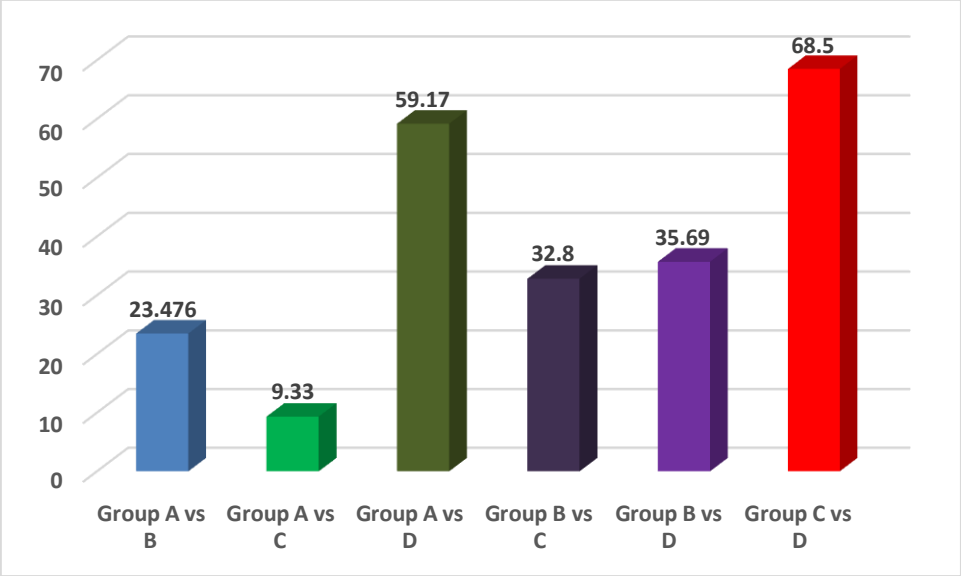

Figure 3: Post hoc pairwise comparison using Tukey's test

Endodontically treated teeth with inadequate coronal structure can be expected to be last in the oral cavity based on the final restoration. Hence, it is a vital step to determine the success of post n core in endodontically treated tooth with inadequated tooth structure[1].

The results from the above study has shown prefabricated zirconia posts to be most resistant to fracture when compared to Lithium di silicate post n core showing least resistance to fracture with Fibre reinforced composite post n core showing second least resistance to fracture; whereas cast metal post n core core showing second most resistance to fracture which was taken as control group under tangential loading using an instron universal testing machine.

Because of their superior physical properties cast metal post-core have a long history of successful use[5]. The high modulous of elasticity i.e stiffness, on the other hand, might induce stress concentrations in the surrounding radicular dentin, which can lead to root fractures[3,8,12].

Furthermore, as the desire for more attractive biocompatible restorations grows, tooth-colored, translucent, metal-free post-core systems have been developed. To meet the demand, prefabricated zirconia ceramic post systems were designed.

Many in vitro research on zirconia posts have been published in the last ten years as a result of the widespread interest in and use of zirconia post systems.[1,2,3,14]

The goal was to provide details on zirconia post retention, fracture resistance, microleakage, light transmission, aesthetic benefits, and radiodensity.

The overall survival rates recorded in the present study are similar to those reported by Butz et al [32] (cast post and core, 81%; titanium or zirconia posts/composite cores, 93.8%; zirconia posts/ceramic cores, 100%) and by Strub et al36 (zirconia posts/composite cores, 80%, zirconia posts/ceramic cores, 100%) but larger than those reported by Mannocci et al13 (zirconia posts/composite cores, approximately 45%).

This result may be because of the fact that zirconia posts has the highest modulus of elasticity among the post types tested. Higher modulus of elasticity results in less bending of the post/core unit under load, because of which less stress is exerted on the tooth.[3,1,14]

The zirconia/composite combination (Group C) offered the additional advantage of improved esthetics due to its white color[4]. The type of failure recorded in Fibrereinforced post n composite core (Groups B) resembled the pattern found in a study that tested fiber reinforced composite posts. Composite fibre posts have a modulus of elasticity closer to dentin and lower than that of zirconia. The maximum fracture strength of fibre posts and cores has been reported as significantly lower than of cast posts and cores, but most fractures in the former are repairable[1].

Group D Lithium Di Sillicate (emax pressable) was kept in the research because of its advantage that the material can be pressed to 0.5 mm thick and still have a flexural strength of 500 MPa[7,8,13].

Additionally, chemical bonding to the tooth will be improved. This is critical in situations where mechanical retention is restricted. However, when compared to other groups, it demonstrated the least resistance to fracture[2,7].

It's probably owing to its low tensile strength; the material is fine when compressive pressures are applied, but it can't withstand tensile stresses and hence fractures[7,8].

Because of changes in research design, fracture strength values from other studies are not comparable to the results of this study.

In this and previous investigations, human teeth have been effectively used for in vitro testing of post restorations.Because all teeth were prepared at an abutment height of 5 mm above the CEJ's most incisal position, the final tooth lengths were slightly variable.

Variations in post lengths arose from the post hole preparation stopping 3 mm from the apex. Anatomical variance and hand preparation caused specimen discrepancies, which mimicked clinical reality. To guarantee uniformity in the current investigation, all specimens were restored and tested with full-coverage crowns.

The practise of placing a crown during endodontic restoration testing has been questioned, as it may hide the effects of various buildup procedures. If the margins ring a sound dentin collar, a crown does provide a ferrule effect and a distinct load distribution when placed over a core accumulation [3,4,34]. However, assessing post-n core preparations without a crown would be more difficult.

If 50% or more of the coronal portion of the clinical crown is lost, direct core restorations with either cast metal or zirconia posts are appropriate. With regard to strength, cast posts and cores offer no advantage over prefabricated zirconia post n composite core.

The fracture strengths found in this investigation appear to be similar to or somewhat greater than those found in prior studies of a similar type.

Another restriction is that minor variations in post lengths may have altered the fracture strength test findings.

The resulting post lengths and initial lengths of the teeth used varied within 1 mm. Other investigations involving a chewing simulation or fatigue loading of post-and-core restorations have yielded significant outcomes. Clinical trials are necessary to substantiate the results of these investigations as well as the present in vitro study.

Significant differences in fracture strength were found among the four test groups.

As a result, the following conclusions can be drawn:

1. Zirconia posts with composite cores might be recommended as a cosmetic alternative to cast posts and cores in the anterior region.

2. Avoid using all ceramic post and core in one piece.

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Dr. Lakshmi Bala
Professor and Head Biochemistry and
Member-Secretary, Institutional Ethics Committee

Communication of the Decision of the VIIth Institutional Ethics Sub-Committee

IEC Code: 41 **BBDCODS/01/2019**

Title of the Project: Comparative Evaluation of Fracture Resistance of Endodontically Treated Roots With Various Post and Core Systems: An *In Vitro* Study.

Principal Investigator: Dr. Chetna Awasthi **Department:** Prosthodontics and Crown & Bridge

Name and Address of the Institution: BBD College of Dental Sciences Lucknow.

Type of Submission: New, MDS Project Protocol

Dear Dr. Chetna Awasthi,

The Institutional Ethics Sub-Committee meeting comprising following four members was held on 10th January 2019.

1.	Dr. Lakshmi Bala Member Secretary	Prof. and Head, Department of Biochemistry, BBDCODS, Lucknow
2.	Dr. Amrit Tandan Member	Prof. & Head, Department of Prosthodontics and Crown & Bridge, BBDCODS, Lucknow
3.	Dr. Rana Pratap Maurya Member	Reader, Department of Orthodontics & Dentofacial Orthopedics, BBDCODS, Lucknow
4.	Dr. Sumalatha M.N. Member	Reader, Department of Oral Medicine & Radiology, BBDCODS, Lucknow

The committee reviewed and discussed your submitted documents of the current MDS Project Protocol in the meeting.
The comments were communicated to PI thereafter it was revised.

Decisions: The committee approved the above protocol from ethics point of view.

Lakshmi Bala
21/01/19

(Dr. Lakshmi Bala)
Member-Secretary
IEC

Member-Secretary
Institutional Ethic Committee
BBD College of Dental Sciences
BBD University
Faizabad Road, Lucknow-226028

Forwarded by:

(Dr. B. Rajkumar)
Principal
BBDCODS

PRINCIPAL
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BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES
(FACULTY OF BBD UNIVERSITY), LUCKNOW

INSTITUTIONAL RESEARCH COMMITTEE APPROVAL

The project titled **"Comparative Evaluation of Fracture Resistance of Endodontically Treated Roots With Various Post and Core Systems: An *In Vitro* Study."** submitted by **Dr Chetna Awasthi** Post graduate student from the **Department of Prosthodontics and Crown & Bridge** as part of MDS Curriculum for the academic year 2018-2021 with the accompanying proforma was reviewed by the Institutional Research Committee present on **26th November 2018** at BBDCODS.

The Committee has granted approval on the scientific content of the project. The proposal may now be reviewed by the Institutional Ethics Committee for granting ethical approval.

Prof. Vandana A Pant
Co-Chairperson

Prof. B. Rajkumar
Chairperson

Curiginal

Document Information

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Sources included in the report

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J	**The effect of post length and core material on root fracture with respect to different post materials** URL: 41a89607-3e72-422e-af08-b1d5334c93d4 Fetched: 3/12/2019 10:51:54 PM	1

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