COMPARATIVE EVALUATION OF FRACTURE RESISTANCE OF VARIOUS PREFABRICATED POST AND CORE SYSTEM USING DIFFERENT LUTING AGENTS: AN IN VITRO STUDY

Thesis submitted in partial fulfillment of the requirements for degree of

MASTER OF DENTAL SURGERY

In the subject of

CONSERVATIVE DENTISTRY AND ENDODONTICS

DEPARTMENT OF CONSERVATIVE DENTISTRY & ENDODONTICS

BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES,

LUCKNOW, UTTAR PRADESH- 227105

BABU BANARASI DAS UNIVERSITY, LUCKNOW

BATCH- 2018- 2021

Dr. ANAMIKA KUMARI

Enrolment No-11803220557

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled "**COMPARATIVE EVALUATION OF FRACTURE RESISTANCE OF VARIOUS PREFABRICATED POST AND CORE SYSTEM USING DIFFERENT LUTING AGENTS : AN IN VITRO STUDY**" is a bonafide and genuine research work carried out by me under the guidance of **Dr. B. RAJKUMAR, PROFESSOR AND HEAD**, Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Sciences, Babu Banarasi Das University, Lucknow, Uttar Pradesh.

Anamika Kumari

Date: 7/7/2021

Place: BBDCODS Lucknow

Signature of the candidate

Dr. ANAMIKA KUMARI

DEPARTMENT OF CONSERVATIVE DENTISTRY AND ENDODONTICS

BABU BANARSI DAS COLLEGE OF DENTAL SCIENCES,
LUCKNOW, UTTAR PRADESH-227105

CERTIFICATE

This is to certify that the dissertation **entitled "COMPARATIVE EVALUATION OF FRACTURE RESISTANCE OF VARIOUS PREFABRICATED POST AND CORE SYSTEM USING DIFFERENT LUTING AGENTS: AN IN VITRO STUDY"** has been undertaken by the candidate **Dr. ANAMIKA KUMARI** , herself in this department. The candidate fulfils all the conditions necessary for the submission of this thesis.

Recommendation of Head of Department

Dr. B. Rajkumar, MDS
Professor & Head
Department of Conservative Dentistry and Endodontics
Babu Banarsi Das College of Dental Sciences.
BBDU, Lucknow (U.P.)

CERTIFICATE

This is to certify that the dissertation entitled **“**COMPARATIVE EVALUATION OF FRACTURE RESISTANCE OF VARIOUS PREFABRICATED POST AND CORE SYSTEM USING DIFFERENT LUTING AGENTS: AN IN VITRO STUDY**”** is an original bonafide research work done by **Dr. ANAMIKA KUMARI ,** in partial fulfilment of the requirement for the degree of **MASTER OF DENTAL SURGERY (M.D.S)** in the speciality of **CONSERVATIVE DENTISTRY AND ENDODONTICS** under our supervision.

GUIDE

Dr. B. Rajkumar , MDS

Professor & Head

Department of Conservative Dentistry and Endodontics
Babu Banarsi Das College of Dental Sciences,
BBDU, Lucknow (U.P.)

CO-GUIDE

Dr.Rita Gupta
Senior Lecturer

Department of Conservative Dentistry and Endodontics
Babu Banarsi Das College of Dental Sciences,
BBDU, Lucknow (U.P.)

ENDORSEMENT BY THE HEAD OF INSTITUTION

BABU BANARSI DAS COLLEGE OF DENTAL SCIENCES
LUCKNOW, UTTAR PRADESH-227405

CERTIFICATE

This is to certify that the dissertation entitled "COMPARATIVE EVALUATION OF FRACTURE RESISTANCE OF VARIOUS PREFABRICATED POST AND CORE SYSTEM USING WITH DIFFERENT LUTING AGENTS: AN IN VITRO STUDY" has been undertaken by the candidate **Dr. ANAMIKA KUMARI**, under direct supervision and guidance of **Dr. B. RAJKUMAR**, Professor & Head of the Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Sciences, Babu Banarasi Das University, Lucknow, Uttar Pradesh

Dr. B. Rajkumar

PRINCIPAL

Babu Banarsi Das College of Dental Sciences BBDU, Lucknow (U.P.)

COPYRIGHT

Anamika Kumari

Date: 7/7/2021

Place: BBDCODS Lucknow

Signature of the candidate

Dr. ANAMIKA KUMARI

ACKNOWLEDGEMENT

First of all, I would like to thank Almighty of God for this blessing and for all the achievements in my life.

My heart is filled with overwhelming emotions, as I put my pen down on completion of this thesis. The journey was long with ups and down and all along I had wonderful mentors to show me the way It is difficult to express gratitude in words, as words can"t express true feeling. It is proud privilege and I feel greatly hounoured to undertake the golden opportunity to acknowledge all of those who helped me and contribute to the completion of thesis.

I bow my head in respect before God, the Almighty, for the endless shower of his blessings which always give me strength and courage to overcome anything and everything. He has always stood by me throughout my life and this thesis is no exception.

It is with a deep sense of gratitude and reverence that I express my sincere thanks to the guiding light and pillar of strength, my guide **, Dr. B . Rajkumar , Professor and Head Of Department** of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental sciences Lucknow whose invaluable guidance, suggestions, innovative idea, patience, versatile knowledge and vigilant supervision proved indispensably beneficial in carrying out this task satisfactorily. He always encouraged me to finish the work on time. Without his generous supervision at every step this work could not be completed.

It is a profound sense of gratitude that I express my thankfulness to ***Dr. Vishesh Gupta, MDS, Reader, Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Sciences, Lucknow,*** *who has been a constant source of inspiration and encouragement to me. for his constant support, caring attitude and advice that has helped me to carry out this work, his vast knowledge and ability to achieve excellence has proved to be very valuable throughout.*

I would like to express my gratitude to ***Dr. Akanksha Bhatt, Ph.D, MDS, Reader, Babu Banarasi Das College of Dental Sciences, Lucknow*** *for extending all cooperation* *everlasting guidance, constant help and advice when need arose, for being there when I needed her help.*

I would like to extend my sincere thanks to ***Dr. Tanu Tewari, MDS, Reader, Babu Banarasi Das College of Dental Sciences, Lucknow*** *for all the much needed constructive criticism, along with the ingenious suggestions to overcome them.*

I'm extremely grateful to ***Dr. Sandeep Dubey, MDS, Reader, Babu Banarasi Das College of Dental Sciences, Lucknow*** *for the invaluable suggestions & unparalleled knowledge in this very topic of my dissertation.*

I am truly grateful to ***Dr. Palak Singh, Dr. Jaya Singh & Dr. Pragya Paliwal, MDS, Senior Lecturer, Babu Banarasi Das College of Dental Sciences, Lucknow*** *for their unwavering help & support in the completion of my dissertation, not just as a teacher, but also as a senior & friend throughout my PG life.*

My sincere thanks to ***Dr. Rita Gupta & Dr. Tarun Saxena, MDS, Senior Lecturer, Babu Banarasi Das College of Dental Sciences, Lucknow*** *for their valuable inputs and encouragement.*

With deep sense of gratitude, I acknowledge my revered teacher ***Dr. Amit Nigam, Lecturer, Babu Banarasi Das College of Dental Sciences, Lucknow*** *for his encouragement and guiding wisdom which many a times supported my sagging spirits.*

Very special thanks to our beloved teacher ***Dr. Lalit Chandra Boruah,*** *who laid the very foundation of our post-graduate life in our department.*

A very special acknowledgement with a deep sense of gratitude that I express my feelings, thanks for always encouraging me and always standing by me as a pillar of strength *in difficult situations* ***My Husband Dr. Anand Shankar, My beloved parents and My in-laws, My Brother in law Dr. Gautam and My Daughter Shanaya shree ,.***

I would like to thank my colleagues ***Dr. Dibyajit Sur, Dr. Vandana Shukla, Dr. Ruchi Gupta, Dr.Karishma Rao & Dr.Sankalp nigam*** *for their valuable suggestions and support.*

I wish my sincere thanks to my super seniors, ***Dr. Manish Singh, Dr. Apurva Biyani, Dr. Harsh Mishra & Dr. Mariyam Mirza;*** *& my seniors* ***Dr. Shruthi Mary Sunil, Dr. Swikriti***

Agarwal, Dr. Garima Singh, Dr. Gitanjali Singh & Dr. Apurva Sharma *who have been a great source of inspiration and encouragement to me*

I would like to thank my juniors, ***Dr. Rahul Sharma, Dr. Prachi Mishra, Dr. Chris Cherian Geogi, Dr. Divya, Dr. Aarushi Shekhar, Dr. Ananya Jain, Dr. Aishwarya Sudha, Dr. Atul Krishnan, Dr. Laxmi Pandey, Dr. Richu Raju, Dr. Ricku Matthew & Dr. Rimjhim Singh*** *for all their help & support.*

. I wish to thank my special friends who have been my motivators and support ***Akash kumar , Dr swati pandey ,pranay pankaj ,pranav pankaj and Raj Aryan****.*

I would like to acknowledge the support of the non-teaching staff of our department- ***Mr. Parshuram, Mr. Vaibhav, Mrs. Anita, Mr. Arun, Mr. Surendra, Mr.Ramsagar, Mr. Mithlesh & Mr. Mukesh****. I would also like to acknowledge college management staff-* ***Dr. Anup, Mrs. Priyanka, Mrs.Succhi, Mr. Santosh, Mr. Girish.***

I beg forgiveness from those, whose names I have inadvertently missed but they should find solace that their knowledge has been extended to others by way of this thesis.

Above all I bow my head in gratitude to the almighty and ever loving ***GOD*** *for bestowing his blessings on me, & rest my work on his feet.*

OM NAMAH SHIVAAY

Dr. Anamika kumari

CONTENTS

GROUP OF TABLE

LIST OF GRAPH

LIST OF FIGURE

LIST OF ANNEXURE

LSIT OF ABBREVIATION

S.NO.	Abbreviation	Full form
1.	CEJ	Cemento enamel junction
2.	GIC	Glass ionomer cement
3.	Mm	Millimeters
4.	<	Less than
5.	>	Greater than
6.	N	Number of Samples
7.	RPM	Rotations per minute
8.	N	Newton
9.	FRC	Fibre reinforced composite
10.	Wt%	Weight percentage
11.	Cm	Centimeter
12.	NaOCI	Sodium Hypochlorite
13.	EDTA	Ethylene diaminetetra acetic acid
14.	SD	Standard deviation
15.	∑	Sigma

ABSTRACT

Aim: The aim of the study is to comparative evaluate the fracture resistance of various prefabricated post system using with different luting agents.

Methodology: A total of 70 human maxillary incisors extracted teeth were collected. Samples were decoronated at the level of CEJ to obtain a root length of 11+1mm. Cleaning and shaping of the samples were performed using Rotary Protaper Gold files till F3 size, followed by obturation of the root canals. The samples were then divided in to 7 groups (n=10) according to the fiber posts and luting cements used. Group 1(control group), Group2 (carbon fibre Post with resin cement), Group 3 (carbon fibre Post with GIC), Group 4 (glass fibre Post with resin cement), Group 5(Glass fibre Post with GIC), Group 6 (Zirconia fibre Post with resin cement), Group 7 (Zirconia fibre Post with GIC). Post space preparation was done and posts were luted with the respective dual cure resin cement. For fracture resistance test core build up was done with direct composite and light cured. The Fracture resistance tests were performed on each group using universal testing machine at a cross head speed of 1.5 mm/min. Failure modes were also evaluated.

Results: The mean fracture resistance of Group4 was the highest followed by Group 6,Group 2,Group 5, Group 7,Group3 and Group1,the least (Group1<Group 3 < Group7 <Group 5<Group 2<Group 6<Group4).The fracture resistance of Group4 was the highest and significantly ($P < 0.001$) higher than all groups, thus may considered as the best fibre post among studied post system.

Conclusion: The highest fracture resistance was observed with glass fibre post (Everstick post) luted with dual core resin cement.

Keywords: Carbon fibre post, glass fibre post, zirconia fibre post, luting cement , fracture resistance.

INTRODUCTION

The goal of post endodontic restoration to provide optimal oral health, esthetic and function. Restoration of that teeth is accomplished by using post and core to prevent further destruction .post and core is often recommended to enhance retention of the crowns.[1]

The restoration of endodontically treated teeth is challenging as these teeth loses significant part of the tooth structure due to trauma, caries, and Access cavity preparation.

Due to loss of moisture supplied by dentin, failure of restoration, Esthetic considerations or a developmental dental anomaly which makes the tooth week.

The choice of restoration of endodontically treated teeth with Composite or amalgam restoration, Crown (metal or ceramic), Inlay, onlay, Post and core restoration .The choice of restoring endodontically treated teeth is guided by esthstics and strength.[2]

The development of tooth coloured posts has improved the esthetics of teeth restored with post and cores .Zirconium dioxide and glass fibre reinforced composite resins in particular are the foundation of many modern post and core concepts.

Post and core should provide the patient a long lasting restoration with adequate function . Subsequent tooth preparations greately simplified if the tooth is built up to an ideal contour . Because the core becomes an integeral part of the structure of the tooth ,it should provide strength to resist intraoral compressive and tensile forces.

The choice of the post is dependent on External configuration and morphology of root surface diameter (Root length , tooth anatomy , root width , canal configuration ,amount of coronal tooth structure) , geometrical configuration of dowel (post length , post diameter ,post design, post position in the dental arch) & Luting material and luting method used to fabricate these systems.[3]

The cast post and core technique has been advocated as the gold standared restoration for decades . because it has a long history of clinical success.[1]Developed in the 1930 to replace the one piece post crowns . This procedure requires casting a post and core as a separate component from the crown . Advantages of cast post are custom fit to the root configuration. They are adaptable to large irregularly shaped canals and orifices .It can be adapted to be used with prefabricated plastic patterns . But the traditional cast post and core technique is more time consuming and Frequently involves greater laboratory and material costs , temporization between appointments is more difficult .[1]

The prefabricated posts can be metallic and non metallic post system or stiff and flexible .[2]
Introduction of the prefabricated metallic post systems they are rigid , lack bonding ability

and different Modulus of elasticity from the tooth structure ,which induced stress and result in fracture of root therefore ,fibre reinforced composite post have been preferred choice.The prefabricated posts aesthetic post system such as fibre reinforced and zirconia ceramic posts have improved the results significantly . [4]

The prefabricated posts Compared with the cast post and core technique , the use of prefabricated post systems with direct core build-ups is less invasive ,less time consuming and can simplify the restoration procedure.

Fibre reinforced composite (FRC) posts are widely used in endodontically treated teeth due to their superior mechanical properties compare to cast posts and are claimed to prevent vertical tooth fractures under chewing loads.[5]

The FRC post contain a high percentage of continuing reinforcing fibres embedded in a polymer matrix of epoxy resins or other polymers with a high degree of conversion and highly cross linked structure[1].

The prefabricated FRC posts are made of carbon, glass & quartz fibre/ zirconia. The biomechanical properties of these posts have been reported to be close to those of dentin.[4]

Recently , several new types of post material have been introduced, including carbon fibre ,glass fibre , zirconia fibre etc.

Glass fibre-supported resin dowel systems were introduced in 1992. The dowels. are composed of unidirectional glass fibre embedded in a resin matrix that strengthen the dowel without compromising the modulus of elasticity [2]. Glass fibre and zirconia ceramics increase the transmission of light within gingival tissue and underlying root , enhancing the esthetics.[5]

Another advantage of glass fibre is that they distribute stress over a broad surface area, increasing the load threshold at which the dowels begins to show evidence of microfractures. Fibre-reinforced dowels are reported to reduce the risk of tooth fracture and display higher survival rates than teeth restored with zirconia dowels. Glass fibre reinforced posts also have the advantage of easy removal if endodontic re – treatment is required .[5]

Zirconium dioxide and glass fibre reinforced composite resins, in particular , are the foundation of many modern post and core concepts.

Zirconia posts were first introduced by Meyenberg et al .(1995) Post are made from fine grained tetragonal zirconium polycrystals. who reported that the flexural strengths (900-1200 MPa) of these post was comparable to that of cast gold or titanium .and that is possible to have the same post dimension as high gold alloys or titanium.[4]

Zirconia is a widely used material because of its good chemical stability, high mechanical strength , high toughness and a Youngs modulus similar to that of stainless steel alloy .Apart from its favourable chemical and physical properties ,it has the esthetic advantage of having a colour similar to that of natural teeth .The high elastic modulus of elasticity of zirconia posts at 200 GPa causes stress to be transferred to the less rigid dentin , thereby resulting in root fracture.[4]

Carbon fibre posts were introduced by Duret et al in 1996 based on the carbon fibre reinforcement principle.Carbon fibre post consist of bundle of stretched carbon fibers embedded into an epoxy matrix. This was the first non-metallic post introduced to the dentistry .[6]

Carbon fibre has certain properties that make it potentially useful in dentistry. It is biocompatible ,corrosion –resistant ,and strong. Most reports of the potentials uses of carbon fibre in dentistry are limited to the reinforcement of existing restorative materials and as possible post material.

The carbon fibre post is reported to have a modulus of elasticity that is nearly identical to that of dentine, so that it causes less tooth stress and hence , fewer root fracture . By comparison,the modulous of elasticity for stainless steel and titanium are roughly 20and ten times greater than dentin respectively . Post with high modulus of elasticity do not flex with the tooth under loading ,and are empirically believed to cause root fracture.[7]

The use of carbon fibre posts , preformed metallic posts, and/or custom-cast metallic casts in the anterior region has been reported to result in unsatisfactory aesthetics. As a result , aesthetic fibre post have become more popular .They are also well accepted because of their favourable physical properties and biocompatibility.[7]

The quality of cement is important role for post retention. Although there is no consensus in the literature as to the better of one cement to the other. These are many luting agent such as zinc phosphate, polycarboxylate, Glass ionomer cement ,Resin modified glass ionomer cement & resin cement.[7] The effect of type of cement on the retention of post & on fracture resistance of endodontically treated teeth has been investigated extensively.[1]

Zinc phosphate cement It has been used for decades to cement and has a long history of success.The primary disadvantages of this cement are solubility in oral fluids, especially in the presence of acids , and lack of true adhesion and has no anticriogenic properties [8]. Polycarboxylate cement These are also soluble in oral fluid , but they can chemically bond to dentin . Polycarboxylate cements undergo plastic deformation after cyclic loading which is a major disadvantage.

Glass ionomer cement adhere to tooth structure by chemical bonding .The chemical reaction is ionic and occurs between the carboxyl ions of polyacrylic acid and the calcium in tooth structure . [8] Primary disadvantage of conventional glass ionomer cement is its setting reaction. This cement does not reach its maximal strength for many days. Therefore , any recontouring of the core on the day of cementation of the post can potentially disturb the set of the cement and weaken the immture cement.

Resin modified glass ionomer cement They are stronger than conventional glass ionomer cements , they contain hydrophilic resin that slowly imbibe water , causing the cement film to gradually expand [8]. This expansion would fracture crown relatively soon after cementation.

Resin cement They are essentially insoluble in oral fluids and possess high compressive strengths. Glass ionomer and zinc phosphate cements are commonly used for metallic post cementation. Resin luting systems are generally recommended to cement fibre an zirconia ceramic posts. composite resin cement systems with their effective bonding , flexibility and cushing effect of the cement layer , contribute to uniform stress distribution between the post and the dentinal wall .[9]

In addition , they also absorb micromovement of an artificial crown resulting from occlusal forces ,more effectively than conventional brittle cements and hence, the failure of cementation , damage of post , core and root dentin might be prevented. Resin cement has been found to significantly increase retention of posts & fracture resistance of tooth compared with other cements.

Hence the purpose of this study is to evaluate the fracture resistance of prefabricated carbon fibre post, prefabricated glass fibre post & prefabricated zirconia fibre posts cemented with various luting agents such as resin cement & GIass ionomer cement using a universal testing machine which operates in In vitro conditions.

Fracture resistance of a material is the ability of a material to resist crack propagation and may more accurately determine the likelihood of fracture of a restoration in clinical practice . It can be measured using static load test with material testing machine / Universal testing machine .

A universal testing machine also known as universal tester , materials testing machine or materials test frame is used to test the tensile strength and compressive strength of materials.

In this study ,three types of post have been used to restore endodontically treated teeth namely, carbon fibre post(Angelus), glass fibre post (GC) and zirconia post (Densply).

AIM AND OBJECTIVES

AIM

The aim of the study is to comparative evaluate the fracture resistance Of various prefabricated post system using with different luting agents.

OBJECTIVES

1. To evaluate the fracture resistance of prefabricated carbon fibre post with resin cement
2. To evaluate the fracture resistance of prefabricated carbon fibre post with Glass ionomer cement
3. To evaluate the fracture resistance of prefabricated glass fibre post with resin cement
4. To evaluate the fracture resistance of prefabricated glass fibre post with Glass ionomer cement
5. To evaluate the fracture resistance of prefabricated zirconia fibre post with resin cement
6. To evaluate the fracture resistance of prefabricated zirconia fibre post with Glass ionomer cement
7. To compare and evaluate the fracture resistance between the various prefabricated post system using with different luting agents.

REVIEW OF LITERATURE

1. **Colley IT. el.al. (1968)**[10] Compared the retentive properties of dowels of various diameters and lengths and they concluded that vertical resistance to displacement (i.e. retention) is in direct proportion to length, diameter and surface roughness of the dowel.
2. **Angmar-Mansson et. al. (1969)**[11] .; Compared the root fractures due to corrosion and concluded 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.
3. **Dawson PE. (1970)**[12] revealed that metal posts should be preferred in the non-vital teeth. Using self-threading pins for retaining restorative material tend to cause dentinal crazing or crazing in teeth.
4. **Kantorowicz G.F. (1970)**[13] 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.
5. **Standlee J.P. et. al. (1972)**[14] compared the three 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.
6. **Weine, F.S. (1972)**[15] compared the length of post of post endodontic therapy 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.
7. **Hanson, E.C. and Caputo, A.A. (1974)**[16] experiment in different cements i.e. Zinc phosphate, polycarboxylate, ethyl cynoacrylate and dowel diameters were tested. Their results showed no differences between the three cements used according to retention values.
8. **Caputo, A.A. and Standlee, J.P. (1976)**[17] compared the study ,Pins and posts-why, when and how to used and they 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 towards horizontally directed force.
9. **Hock D. (1976)**[18] compared the Impact resistance of posts and cores. And they suggested that the strength of a tooth is directly related to the bulk of 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.

10. **Johnson, J. et. al. (1976)**[19] Evaluation of restoration of endodontically treated posterior teeth .They found that a change to a parallel sided serrated dowel post increased the retention $4^{1/2}$ times over that of tapering sided post. They also found that increase in post length or diameter yielded only a 30% to 40% increase in retention.
11. **Rud & Omnell (1976)**[20] studied of the Root fractures due to corrosion, teeth with vertical/oblique root fractures and they 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.
12. **Henry P.J. (1977)**[21] compared the studied of photoelastic analysis of six type post core restoration designs and they found that the parallel post design distributed stress more evenly while the tapered post showed localized high stress concentration.
13. **Lovdahl & Nicholls (1977)**[22] compared the studied of pin-retained amalgam cores vs cast- gold dowel-cores measured resistance to a load applied lingually at an angle of 130 degrees to the long axis of the tooth. And they founded that under the test can Root fractures due to corrosion conditions, endodontically treated maxillary central incisors with natural crowns demonstrated greater strength than teeth treated with either a cast dowel and core or pin- retained amalgam cores. The prepared teeth in the study were not given coronal coverage and the cores were prepared to approximate normal tooth contour.
14. **Johnson and Sakamura (1978)**[23] comparsion of studied dowel form and tensile force and found parallel- sided dowels to resist tensile forces 4.5 times greater than the tapered dowels and increasing the length of the dowel from 7 or 9 mm increased retention by 24% to 30%.
15. **Guzy and Nicholls (1979)**[24] comparison of intact endodontically treated teeth with and without endo-force reinforcement and they concluded Teeth without post fractured through the middle and coronal 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.
16. **Mattison, G.D. (1982)**[25] Studied of Photoelastic stress analysis of cast-gold endodontic posts and 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.
17. **DeSort et. al. (1983)**[26] Studied of ,The prosthodontics use of endodontically treated

teeth: Theory and biomechanics of post preparation and revealed that, from a retentive standpoint, the parallel sided posts have a greater retention than th, the tapering sided posts but, because they are placed within a tapering root, they require more fineness 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.

18. **Deutsch, A.S., et. al. (1983)**[27] Reviewed the studied of Prefabricated Dowels and they concluded 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.
19. **Assif, D., Bleicher, S. (1986)**[28] examined the thickness of a composite luting agent for serrated endodontic posts and concluded that adaptation to the canal did not affect the retention. Changes of the composite layer thickness up to 500 microns did not decrease determined the retentive strength of seven combination of posts (retention.
20. **Brown and Mitchem (1987)**[29] Para post, Brassler and Flexi post), cementing agents (Zinc phosphate and glass ionomer and two resin cements), and canal treatments in recently extracted human anterior teeth, and they concluded that Flexi post displayed twice the retention as compared to other systems evaluated.
21. **Eissman and Radke (1987)**[30] Compared the studied of 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 generated by the post.
22. **Cohen, et. al. (1992)**[31] compared the retention of posts in the root for various diameters (1.3 mm and 1.6 mm) of three prefabricated post systems (Unity, Filpost, and Brasseler) , and they cocluded that the retention of 1.3 mm posts from most to least was Flexi-Post (zinc 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). The Filpost system achieved higher retention with zinc phosphate cement than it did with resin cement.
23. **Chan FW, et. al. (1993)**[32] compared the retention of prefabricated posts in well-fitting and loose-fitting root canals zinc phosphate cement, polycarboxylate cement, glass ionomer cement or resin cement, and they concluded that Posts cemented with the resin cement were the most difficult to dislodge. Posts cemented into loose-fitting canals

exhibited greater resistance to dislodgement than posts cemented into well-fitting canals irrespective of the type of cements used.

24. **Mendoza D.B et. al. (1994)**[33] 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.
25. **Keyf F, Sahin E (1994)**[34] compared the retention of Flexi-Posts, Para-posts and Brasseler / V lock-posts in root canals using tensile and compressive / shear forces. And they found that There was no difference in retention between the small diameter posts, but the difference between the medium and the large diameter posts, however, was significant. In the medium diameter post group, the Flexi-post was approximately twice as retentive as the other two post-core systems evaluated. The retention difference between the small diameter posts was found to be statistically significant, Flexi-Posts being more retentive than Para-Posts and B/V-Posts.
26. **Leary JM, Holmer DC, Johnston WT (1995)**[35] evaluated the studied of 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.
27. **Holmes DC, et. al. (1996)**[36] analysis to study of 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) or 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.
28. **Potashnick Steven R (1996)**[37] Studied of the restoration of endodontically treated tooth. They 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.
29. **Purton and Payne (1996)**[38] compared the study of the fracture resistance of teeth restored with

carbon fibre posts and stainless steel posts reported that tooth fractures were uncommon and that the most frequent site of failure was the post and core interface.

30. **Morgano SM. (1996)**[39] compared the effect of cementing procedures on retention of prefabricated metal posts and they 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 gutta percha 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.
31. **Ulter JN, et. al. (1997)**[40] 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.
32. **Love RM, Purton DG (1998)**[41] 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.
33. **Martinez-Insua, A., et. al. (1998)**[42] compared the studied of the fracture resistances of pulpless teeth restored with a cast post and core or carbon-fibre 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 fibre post and composite core showed failure of the post/core interface before the fracture of the tooth occurred.
34. **Purton DG, Chadler NP and Love RM (1998)**[43] tested the rigidity and the retention into roots of parallel root canal posts, one a spiral vented titanium post and the other a spiral serrated, hollow stainless steel post. 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.
35. **Cohen B.I. et. al. (1999)**[44] compared the retention and photo-elastic stress patterns from two loading conditions, vertical (133.2 N, 30 pounds) and oblique at a 26° 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 favourable than the asymmetric, uneven stresses and relatively low retentive strength for the C-Post.

36. **Cohen B.I. et. al. (2000)**[45] compared the retention of an active post system (Flexi-Flange), a metal passive pre-fabricated post system (Para Post), a passive prefabricated burnout post system (ExactaCast) with and without grooved dentin walls, and a zirconium oxide ceramic post design (Cerapost). And they concluded that Flexi-Flange with Flexi-Flow Natural cement obtained the highest retentive value of 270.4 lb. The Cerapost cemented with Universal Cement had the lowest retention value of 23.4 lb. The ExactaCast with grooved dentin walls was significantly stronger than the ExactaCast without grooving, the ParaPost, and the Cerapost. The two ExactaCast groups and the ParaPost group had higher retention than the Cerapost group.
37. **Mitchell CA (2000)**[46] 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.
38. **Resentritt, et. al. (2000)**[47] compared the study of fracture strength of metallic and tooth-coloured 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.
39. **Hew YS; et. al. (2001)**[48] compared the rigidity, retention within the root canals of extracted teeth and ability to retain composite resin cores with titanium alloy post (IntegraPost), and stainless steel post (ParaPost). They concluded that the two post types exhibited similar properties in core and root canal retention, however, the IntegraPost was significantly less rigid than the ParaPost.
40. **Akkayan B et. al. (2002)**[49] compared the effect of one Titanium and three esthetic post systems (Quartz fibre, Glass fibre and Zirconia posts) on the fracture resistance and fracture pattern of crowned teeth and concluded that endodontically treated teeth restored with light quartz fibre post were less prone to fracture than teeth restored with any of other 3 post systems tested.
41. **Heydecke G et. al. (2002)**[50] compared the fracture strength of endodontically treated, crowned maxillary incisors with limited ferrule length and different post-and-core systems after fatigue loading. They suggested that Zirconia posts with ceramic cores can be recommended as an alternative to cast posts and cores.
42. **Nergiz I, et. al. (2002)**[51] investigated the effect of length and diameter on the retentive strength of sandblasted tapered prefabricated titanium posts (Erlangen post system). Posts

with constant taper angle but with three different lengths (9, 12, 15 mm) and apical diameters (0.5, 0.9, 1.1 mm) were cemented using Zinc phosphate cement into the prepared and roughened post spaces of 90 intact anterior teeth. They concluded that the retentive strength of the posts is affected proportionally by the length as well as the diameter of the investigated tapered posts. The proportional bonding strength of the posts referring to their surfaces revealed to be constant for all groups. The percentage increase in strength amounted to 100% referring to the length and 60% referring to the diameter. The choice of an adequate post length was found to be more important than the diameter to obtain high retentive strength.

43. **Pontius O, Hutter JW (2002)**[52] evaluated the survival rate and fracture resistance of maxillary central incisors restored with different post and core systems. It was concluded that the preservation of both internal and external tooth structure is of utmost importance when restoring the endodontically treated teeth.
44. **Newman M P et.al (2003)**[53] 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 endodonticcally treated teeth and they concluded that load to failure of the stainless steel posts were significantly stronger than all the composite posts studied.
45. **Ertugrul H Z et.al (2005)**[54] investigated the retention of the dowel, luting agents and tooth complex while applying different luting agents to cast metal dowels under vertical tensile loading and concluded that zinc phosphate cement can provide superior retention for cast metal dowels relative to the phosphate-methacrylate resin luting agent with or without the silane coating tecchniques.
46. **Clarisse C.H.Ng et.al (2006)**[55] 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 restored endodontically treated teeth do not have complete circumferential tooth structure between the core and preparation finish line, the location of the remaining coronal tooth structure may affect their fracture resistance.
47. **Faruk Taner Dilmener et.al (2006)**[56] compared the studied of fracture resistances of three 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.

48. **Gu X M et.al (2006)**[57] evaluated the fracture resistance of crown-restored incisors with different post-and-core systems and luting cements and they suggested that fibre posts 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.
49. **Giuseppe Varvara et.al (2007)**[58] evaluated of fracture resistance and failure mode of internally restored endodontically treated maxillary incisors with differing heights of residual dentin . They concluded that the custom-made cast post and core has the highest catastrophic failure 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 fibre post system 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 favourable failure potential.
50. **Kivanç BH et al (2008)**[59] investigated the fracture strength of three post systems cemented with dual cure composite resin luting cement by using different adhesive systems. They concluded endodontically treated anterior teeth restored with glass fiber posts exhibited higher failure loads than teeth restored with zirconia and titanium posts. Self-etching adhesives are better alternatives to etch-and rinse adhesive systems for luting post systems.
51. **Wang Y Et al (2008)**[60] evaluated influence of C-factor on the microtensile bond strength between fiber posts and resin luting agents. The summarized that the influence of a clinically relevant cavity configuration on the adhesion established by two resin cements on glass fiber posts was not statistically significant.
52. **Dorriz H Et al (2009)**[61] compared the studied of fracture resistance of endodontically treated teeth restored with different post and core systems in combination with complete metal crowns in teeth with no coronal structure. In their study concluded that ,the prefabricated glass fiber post with composite core group showed the most favorable fracture pattern in all test groups.
53. **Poskus LT et al (2010)**[62] assessed the influence of post pattern and resin cement curing mode on the retention of glass fibre posts. They concluded that the retention of glass fibre posts was not affected by post design or surface roughness nor by resin cement-curing mode. The choice of serrated posts and self-cured cements is not related to an improvement in retention.

54. **Bitter K et al (2012)[63]** evaluated the effect of cleaning method, luting agent and preparation procedure on the retention of fibre posts. They concluded that different cleaning methods did not lead to significant differences in root canal cleanliness and did not enhance fibre post retention inside the root canal. However, post space preparation using a Round Bur might be beneficial for improving retention, especially when self-adhesive cements are used.
55. **Vassiliki Nova et al (2013)[64]** evaluated the pull-out bond strength of a fibre-reinforced composite post system luted with self-adhesive resin cements. They concluded that different resin cements influenced the pull-out bond strengths, whereas the cement thickness itself was not responsible for any differences. They also reported that Self-adhesive resin cements can provide an acceptable retention of FRC posts even in case of use with wider post space conditions.
56. **Xiao-jing Li et al (2014)[65]** evaluated the studied ,effect of luting cement and thermomechanical loading on retention of glass fibre posts in root canals. They concluded that Resin-modified Glass ionomer cements have the potential benefit of achieving long-term retention when used for luting glass fibre post to root canal dentine. So It may be recommended for the cementation of glass fibre post in clinics.
57. **Sebnem Begum Turker Et al (2016)[66]** determined the fracture resistance and the mode of fracture of endodontically treated teeth restored with different fiber posts and all-ceramic crowns. They concluded that in terms of optimizing fracture resistance, the fiber post size selection should be done according to the forces applied to the restored teeth.
58. **Neena chandran Et al (2017)[67]** Compared the studied of Fracture resistance of endodontically treated teeth restored with three different post and core system & two different luting agents. They concluded that , teeth restored with glass fibre post showed highest fracture resistance and endodontically treated teeth without post and core system showed that least fracture resistance demonstrating the need to reinforce the tooth.
59. **Ibtisam O .M ALnaqbi , et al (2018)[68]** They compared the studied of Effect of fibre post resin matrix composition on bond strength and they concluded that prefabricated cross-linked post with epoxy-based matrix demonstrated higher bond strength than prefabricated cross- linked post with Bis-GMA based matrix and post with semi-IPN matrix when luted with dimethaacrylate based dual-cured resin cement.
60. **Sonal Maurya, et al (2019)[69]** Compared the studied of Fracture resistance of endodontically treated teeth restored with three different types of fibre reinforced composite post and they concluded that Everstick post provided highest resistance to

fracture than the prefabricated glass fibre post and Ribbond post

MATERIAL AND METHODS

The present study was conducted in the Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Science, Lucknow, in collaboration with Central Institute of Plastic Engineering and Technology ,Lucknow.

Study subject :

Seventy freshly extracted permanent maxillary incisors teeth

ARMAMENTARIUM

Equipments used for preparation of teeth

1. Airotor handpiece , Micromotor & Straight hand piece.(NSK, Japan)
2. Endo access bur (Dentsply , Switzerland)
3. Endo Z bur(Dentsply , Switzerland)
4. Diamond disc Mandril (0.25mm Dynaflex)

Cleaning and shaping:

1. K-Files ISO no 10,15 ,20 (Dentsply Switzerland)
2. Protaper Gold rotary files – (Dentsply Switzerland) .
3. Disposable Syringe [Dispovan India]
4. Mini Endo Block (Dentsply Maillefer, Ballaigues)
5. Sodium HypoChlorite 5.25% (Comdent corporation, Mumbai)
6. PulpDent 17% EDTA (Pulpdent Corporation USA)
7. Saline (Baxter, Tamilnadu, India)
8. Endomotor (X-Smart plus, Dentsply Maillefer Switzerland)

Obturation:

1. ProTaper Gutta – Percha points (Dentsply Maillefer, Ballaigues)
2. AH 26 sealer (dentsply Switzerland)
3. Paper points (Diadent)
4. Pluggers (Dentsply Maillefer, Ballaigues)
5. Lentulo spiral (Dentsply , Switzerland)

6. Spreader (Dentsply Switzerland)
7. GP holding tweezers (API, germany)
8. Blow torch (zhart India)

Equipments used for Preparation of Post Space

1. Peeso reamers (Mani, Japan)
2. Glates Glidden drills (Mani ,Japan)

Materials to be tested (post endodontic restoration)

1. Prefabricated carbon Fibre Post (Angelous Reforpost Brazilian)
2. Prefabricated Everstick glass Fibre Post (GC Australia)
3. Prefabricated zirconia Fibre Post (Densply Switzerland)

Luting Cement:

Flurocore (Dentsply Switzerland)

2 . Glass ionomer cement (Fuji 1GC,japan)

Materials for core buildup

Etchant (Ivoclar , Liechtenstein)

Bonding agents (Ivoclar vivadent bond ,Liechtenstein)

Packable Composite resin (Dentsply Switzerland)

Light cure unit (Dentsply Switzerland)

Com

posite instrument (Dispodent)

Other material used :

1. Vaseline (Hindustan Lever Ltd, India.)
2. Autopolymerising acrylic resin (DPI Rapid Repair Cure , DPI India)
3. Modelling Wax. (Pyrax India)
4. Aquasil LV (dentsply Switzerland)

Equipments used for testing the Specimens

(Universal Testing Machine Unitek – 9450, Fuel Instruments & Eng. Pvt. Ltd. Lucknow)

Fig : 1 Extracted teeth for the preparation of the samples

Fig: 2 Equipment used for preparation of the samples

Fig: 3 Endomotor

Fig 4: Normal Saline, irrigating syringe, sodium hypochloride

Fig: 5 Armamentarium for Obturation

Fig: 6 Armamentarium for core buildup

Fig **7**: Micromotor handpiece with cutting disc.

Fig: 8 Armamentariun for model preparation

Fig: 9 Carbon fibre post

Fig: 10 Glass fibre post

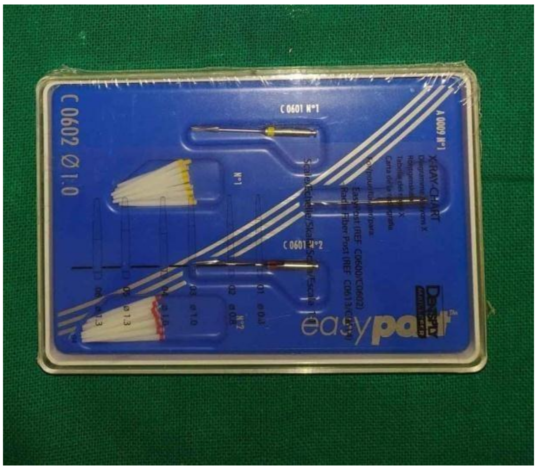


Fig: 11 Zirconia fibre post

Fig:12 Dual cure resin cement

Fig:13 Glass ionomer cement

Sample preparation

A total of Seventy single rooted permanent maxillary incisors were selected according to inclusion and exclusion criteria from the department of oral and maxillofacial surgery, Babu Banarasi Das College of Dental Science, Lucknow & Sterilized in an autoclave at 121 C ,15 psi ,for 15min.

After disinfection the samples were stored in normal saline solution at room temperature till further experiment .

Inclusion criteria:

1 .Completely developed permanent maxillary central and lateral incisors with single straight root canal teeth .

Exclusion Criteria:

- Carious teeth
- Teeth with any crack / Fracture
- Teeth with developmental anomaly.
- Teeth with previously restoration or endodontic treatment .
- Teeth with Root Resorption, calcification.

Preoperative radiographs were taken in the mesiodistal and buccolingual directions to evaluate the inclusion and exclusion criteria .

Methodology

Previously stored teeth were sectioned at the cemento– enamel junction **(Fig: 1)** with diamond disc **(Fig: 7)** under coolant, such that the remaining standard root length of all tested teeth was 16 ± 1 mm.

Endodontic Treatment:

The canal patency was checked and working length was determined with ISO no 10 K- file (Dentsply) **(Fig: 2)**. The file was introduced into the canal until it was visible at the apex and stopper was placed at the coronal reference point i.e.cementoenamel junction. From that length 1mm was subtracting and taken as working length. Hand filling till 20 no k file was used **(Fig: 2)**. The cleaning and shaping of the canals were done by crown down technique using rotary ProTaper gold files system till F3 size **(Fig: 2)**. This file sysem was used at 300 rpm and torque was 312 gcm as mentioned by manfacturer . The canal was irrigated by 3 ml of using 5.25% sodium hypochlorite (NaOCL) **(Fig: 4)** solution between each file used for instrumentation .After instrumentation ,the smear layer was removed by flushing the root canals with 5 ml of 17% EDTA solution and canals was finally rinsed with 10 ml saline with the help of irrigation needle **(Fig: 4)**. Teeth were prepared ISO size 25 apically, and canals were dried with paper points. A sealer (AH Plus) **(Fig: 5)** was placed into the root canal using lentulo spiral. Teeth were obturated with ISO No-25 (6% TAPER) gutta percha cones by lateral / vertical compaction technique . The samples were stored in water at room temperature during the experiment .

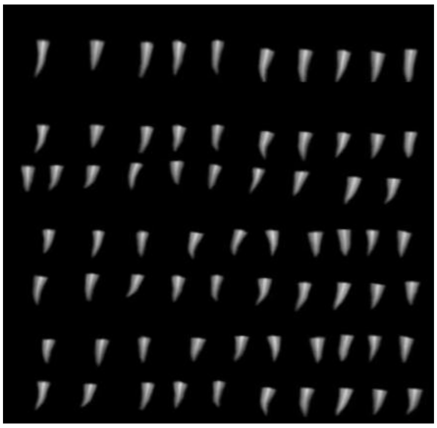


Fig: 14 – Obturated samples

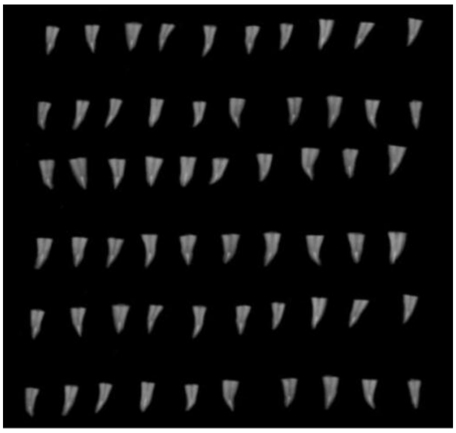


Fig: 15 Specimens after Post Space Preparation

The sample were randomly divided into 7 experimental groups with 10 samples in each experimental group . On the basis of prefabricated post system and luting cements used for post endodontic restoration.

1.GROUP 1- (Control group) root canal treated teeth (10 teeth)

2.GROUP 2- Carbon fibre post with resin cement (10 teeth)

3.GROUP 3- Carbon fibre post with GIC cement(10 teeth)

4.GROUP 4- Glass fibre post with resin cement (10 teeth)

5.GROUP 5- Glass fibre post with GIC cement(10 teeth)

6. GROUP 6- Zirconia fibre post with resin cement (10 teeth)

7.GROUP 7- Zirconia fibre post with GIC cement (10 teeth)

In test group 1 Post was not used in this group.

In test group 2 Carbon fibre post **(Fig: 9)** of 1.0 mm in diameter were used. Root canal were prepared with number 3 Gates Glidden drills & provided by manufacturer (1000 -1200rpm) until the depth of 11mm , keeping 4 to 5mm as an apical seal . The post space preparations was standardised through flaring with peso reamer up to #4 **(Fig: 15)**. Post space preparation was checked with the help of intra oral periapical radiograph .

Position the post to verify its adaptation. Make a mark o the post 2 to 3 mm from the antagonist tooth cut it with a diamond bit at high rotation under cooling.

Cleaned the post with alcohol and dry it. Prior to cementation, post space were rinsed with 5 ml of normal saline for 30 sec & dried with paper points.

Samples luted with dual cure resin cement **(Fig: 9)**, the post space was etched with 37% phosphoric acid (Total etch Ivoclar Vivadent) for 15 sec were used & rinsed with distilled water for 15 sec & dried with paper points. Bonding agent was applied with microbrush & cured for 20 sec.

The resin cement (Flurocore , DMG, America) **(Fig: 12)** was applied with lentulospiral in the root canal space. ,then post were luted with dual core resin cement & Put the post into the canal & excess material is carefully removed.The cement were the light cured for 40 seconds. & wait for the polymerization .

In test group 3 Prefabricated Carbon fibre post **(Fig: 9)** were selected(1.0 mm). Prepared the canal with the Gates Glidden drill number 3 till the depth of 11 mm , keeping 4 to 5 mm as an apical seal . The root canal space preparations were standardised through flaring with peso reamer upto #4. Root surface and post hole conditioned with the 37% phosphoric acid for 10-15 sec . Post was Cleaned with alcohol and dry it. Root canal space were rinsed with 5 ml of normal saline for 30 sec & dried with paper points.

Dispense the powder and liquid of glass ionomer cement on a cooled glass slab and mixing was quickly (30 sec) with the help of plastic spatula ,first increment of cement were incorporated rapidly to produce a homogenous milky consistency by folding motion . consistency of cement was string up to 3-4 cm from slab .

Post was luted with GIC **(Fig: 13)**, the cement was applied with lentulospiral in the canal.

Post was placed & maintained the finger pressure. The excess cement was carefully removed **(Fig: 16) .**

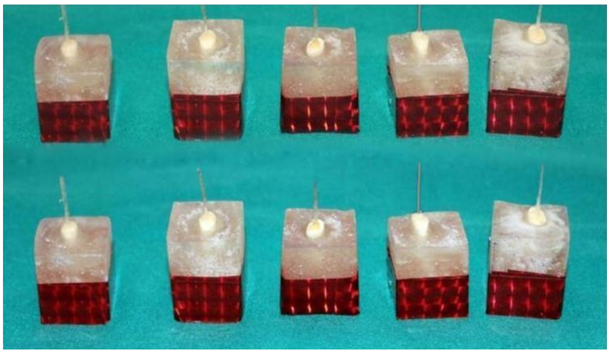


Fig: 16 Sample Preparation with Carbon fibre post

In test group 4 Sample were restored with glass fibre post of 0.9 mm **(Fig: 10)** in diameter which were soft & flexible. Thus , adaptable polymer and resin impregnated unpolymerised glass fibre post .

Root canal were prepared with number 3 drills & provided by manufacturer (1000-1200 rpm) . Posts were cut with scissor to desired length(i.e. with an excess of 4mm to retain the core). Posts were cleaned with alcohol and dry it. Each root canal space were rinsed with 5 ml of normal saline for 30 sec & dried with paper points. The canal walls of post spaces were acid etched with 37% phosphoric acid (Total etch Ivoclar Vivadent) for 15 sec later & rinsed with distilled water for 15 sec & dried with paper points. . The bonding agent was applied with microbrush **(Fig: 6)** and cured for 20 sec .

The surface of the post were pre conditioned with a self etching primer ,then the post were cemented with a resin cement .

The resin cement (Flurocore , DMG, America) **(Fig: 12)** was applied with lentulospiral in the root canal space. ,then post were luted with dual core resin cement & Put the post into the canal & excess material is carefully removed. post is supplied in a pre-polymerised form, post & the cement were light cured for 40 seconds by directing the light perpendicular to the post & wait for the polymerization .

In test group 5 Apical diameters of the posts were kept constant as 0.9 mm. The post spaces were prepared using number 3 drills supplied by the manufacturer. The post space were flared with peso reamer upto #3. The canal were rinced with water & dry it. Post was Cleaned the post with alcohol and dry it. Post space was rinsed with 5 ml of normal saline for 30 sec & dried with paper points. post is supplied in a pre-polymerised form, post were light cured for 40 seconds by directing the light perpendicular to the post & wait for the polymerization .

Post were luted with GIC, the cement was placed in the canal with lentulospiral.

Post were seated & maintained the finger pressure. The excess cement was carefully removed **(Fig: 17)**.

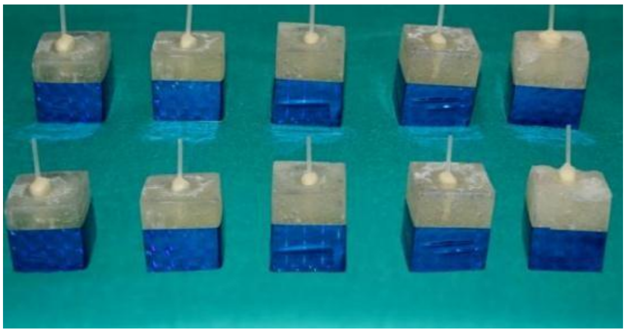


Fig: 17 Sample Preparation with Glass fibre post

In test group 6 Prefabricated zirconia fibre post of 1.0mm **(Fig: 11)** in diameter were used. The root canal were prepared with respective Gates Glidden drills provided by manufacturer (1000- 2000 rpm).The canal space were rinsed with water & dry it . Checked the position in mouth placed a dentin collar of atleast 2 mm around the preparation. Draw the post used a diamond tipped disc. Clean & conditioned the dentin wall with EDTA for 1 minute. Then rinsed the canal with sodium hypochloride then dried with paper points .Then cleaned the post with alcohol dry it . The post as well as the space & access cavity treated with prime bond and self cured .The resin luting cement **(Fig: 12)** applied in the canal using a rotary paste filler. Inserted the post in the canal apply some pressure to ensure maximum adhesion , the cement were light cured for 40 seconds. The excess cement was carefully removed.

In test group 7 Zirconia fibre post of 1.0 mm **(Fig: 11)** in diameter were used. Post space prepared with respective Gates Glidden drills provided by manufacturer (1000 - 2000 rpm).

The Post were sectioned to 13 mm with diamond tipped disc. The root canal space were rinsed with water & dry it .Dentinal wall was Cleaned & conditioned 1 minute with the help of EDTA . Canal were rinsed with sodium hypochloride then dried with paper points. Post was cleaned with alcohol and dry it .

After cleaning of the dentine and post , post were cemented with GIC, according to their manufacturer instruction , the cement was placed in the canal with lentulospiral. Post was placed into the canal space & maintained the finger pressure **(Fig: 18)**.

Fig: 18 Sample Preparation with zirconia fibre post

Evaluation of Fracture Resistance

In all samples for fracture resistance test core build up was done with direct composite and light cured **(Fig: 6)**.

Root surface of all the specimens were dipped into the molten wax to a depth 2 mm below the CEJ to produce a 0.2 -0.3mm layer to simulate the thickness of the periodontal ligament. Teeth were mounted in acrylic resin blocks, size of block 2.5×2.5×2.5cm. Each tooth was removed from the resin block when the first sign of polymerization were observed. Once the resin block was polymerized, the wax spacer was removed from the root surface, self cure acrylic resin **(Fig: 8)** in the custom fabricated metal mould of resin blocks were de -waxed by immersing them in hot water. The light body impression material (aquasil LV, Dentsply) **(Fig: 8)** was mixed and coated over the roots and the teeth were reinserted in the resin blocks , and the impression material was allowed to set ;and trimmed to provide a flat surface. such that 2mm of the root protruding out of the block, the excess material was removed.

Each specimen with the acrylic block were mounted on a universal testing machine **(Fig: 19)**. Middle point of palatal side of the incisal edge 135° to the long axis.

Fig: 19 Fracture resistance test

Fig: 20 Universal Testing Machine

Flow chart of Methodology

Fourty extracted maxillary incisors

↓

Coronal portion were removed leaving 2mm above the CEJ

↓

Endodontic treatment was carried out

↓

Post space

↓

Group division based on post system and luting agents

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Control group	Carbon fibre post (1.0mm) luted with resin cement	Carbon fibre post (1.0 mm) luted with glass ionomer cement .	Glass fibre post (0.9 mm)luted with resin cement	Glass fibre post (0.9mm) luted with glass ionomer cement	Zirconia fibre post 1.0 mm luted with resin cement	Zirconia fibre post 1.0 mm luted with glass ionomer cement.

↓

Failure threshold of all posts was measured in a universal testing machine.

↓

The values were recorded and compared

Statistical analysis

Data were summarised as Mean ± SE (standard error of the mean). Groups were compared by one factor analysis of variance (ANOVA) and the significance of mean difference between (inter) the groups was done by Tukey"s HSD (honestly significant difference) post hoc test after ascertaining normality by Shapiro-Wilk"s test and homogeneity of variance between groups by Levene"s test. Discrete (categorical) data were summarised in number (n) and percentage (%) and groups were compared by chi-square (χ^2) test. A two-tailed (α=2) $P < 0.05$ was considered statistically significant. Analyses were performed on SPSS software (Windows version 22.0).

Results and Observations

The present *in-vitro* study evaluates and compares the fracture resistance of various prefabricated post system using with different luting agents. Total 70 samples were selected and randomized equally into 7 groups (i.e. 10 samples per group) and each group was treated either of 7 different luting agents (Table 1 and Fig. 1). The outcome measures of the study were fracture resistance . The fracture resistance was measured in Newton (N). The objective of the study was to compare the fracture resistance among 7 different groups.

Table 1: Group allocation and distribution of samples in different groups

Treatments (Luting agents)	**Group name**	**Total sample (n=70) (%)**
Control group or root canal treated teeth	Group 1	10 (14.3)
Carbon fibre with resin cement	Group 2	10 (14.3)
Carbon fibre with GIC cement	Group 3	10 (14.3)
Glass fibre post with resin cement	Group 4	10 (14.3)
Glass fibre post with GIC cement	Group 5	10 (14.3)
Zirconia fibre post with resin cement	Group 6	10 (14.3)
Zirconia fibre post with GIC cement	Group 7	10 (14.3)

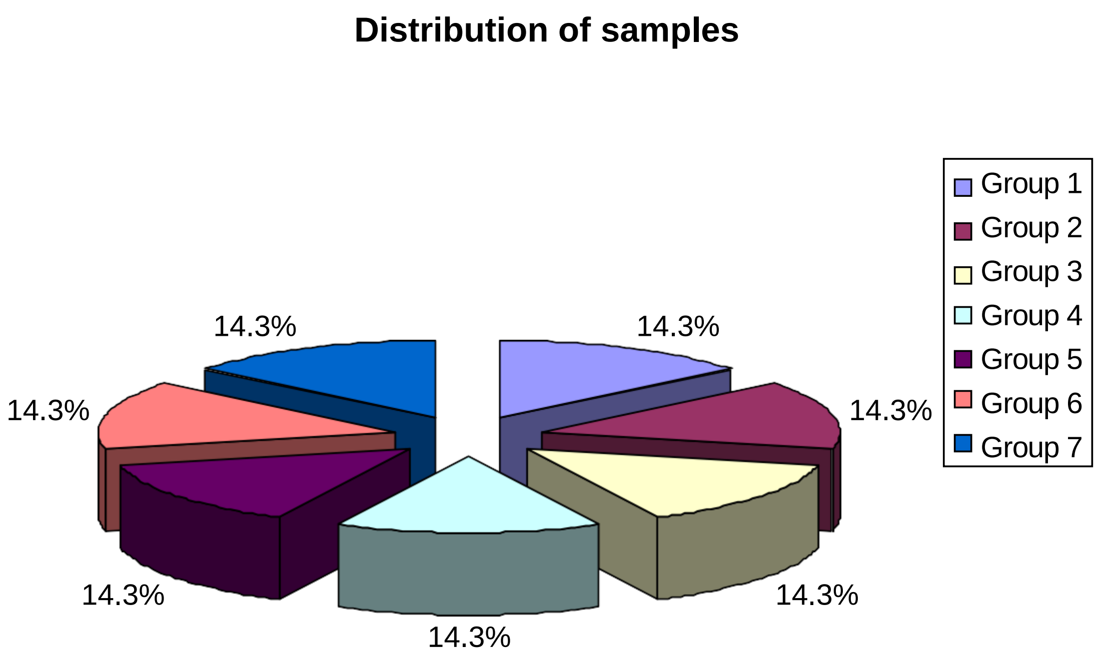


Fig. 1. Pie chart showing distribution of samples in 7 different groups.

Outcome measures

I. Fracture resistance

The fracture resistance (N) of 7 different groups is summarised in Table 2 and also shown in Fig. 2. The mean fracture resistance of Group 4 was the highest followed by Group 6, Group 2, Group 5, Group 7, Group 3 and Group 1, the least (Group 1 < Group 3 < Group 7 < Group 5 < Group 2 < Group 6 < Group 4).

Comparing the mean fracture resistance of 7 different groups, ANOVA showed significantly different fracture resistance among the groups (F=58.86, $P < 0.001$) (Table 2).

Further, comparing the difference in mean fracture resistance between the groups (i.e. pair wise comparison), Tukey test showed significantly ($P < 0.05$ or $P < 0.01$ or $P < 0.001$) different and higher fracture resistance of Group 2, Group 3, Group 4, Group 5, Group 6 and Group 7 as compared to Group 1 (Table 3 and Fig. 3).

Further, the mean fracture resistance of both Group 4 and Group 6 were found significantly ($P < 0.05$ or $P < 0.001$) different and higher whereas Group 3 and Group 7 significantly ($P < 0.01$ or $P < 0.001$) different and lower when compared to Group 2 (Table 3 and Fig. 4). However, it did not differ ($P > 0.05$) between Group 2 and Group 5 i.e. found to be statistically the same.

Similarly, the mean fracture resistance of Group 4, Group 5 and Group 6 were found significantly ($P < 0.01$ or $P < 0.001$) different and higher when compared to Group 3 but it did not differ ($P > 0.05$) between Group 3 and Group 7 i.e. found to be statistically the same (Table 3 and Fig. 5).

In contrast, the mean fracture resistance of Group 5, Group 6 and Group 7 were found significantly ($P < 0.001$) different and lower as compared to Group 4 (Table 3 and Fig. 6).

Conversely, the mean fracture resistance of Group 6 was found significantly ($P < 0.01$) different and higher whereas Group 7 was found significantly ($P < 0.\ 01$) different and lower when compared to Group 5 (Table 3 and Fig. 7).

Further, the mean fracture resistance of Group 7 was found significantly ($P < 0.001$) different lower as compared to Group 6 (Table 3 and Fig. 8).

In conclusion, the fracture resistance of Group 4 was the highest and significantly ($P < 0.001$) higher than all groups, thus may considered as the best post among studied post system.

Table 2: Fracture resistance (N) of 7 different groups

Group	**Fracture resistance (N) (Mean ± SE) (n=10)**	**F value**	**P Value**
Group 1	89.98 ± 5.38	45.97	< 0.001
Group 2	187.17 ± 10.96		
Group 3	128.60 ± 9.99		
Group 4	280.46 ± 7.29		
Group 5	180.19 ± 6.76		
Group 6	228.21 ± 7.79		
Group 7	135.82 ± 9.38		

Fracture resistance of 7 different groups were summarised in Mean ± SE and compared by ANOVA (F value).

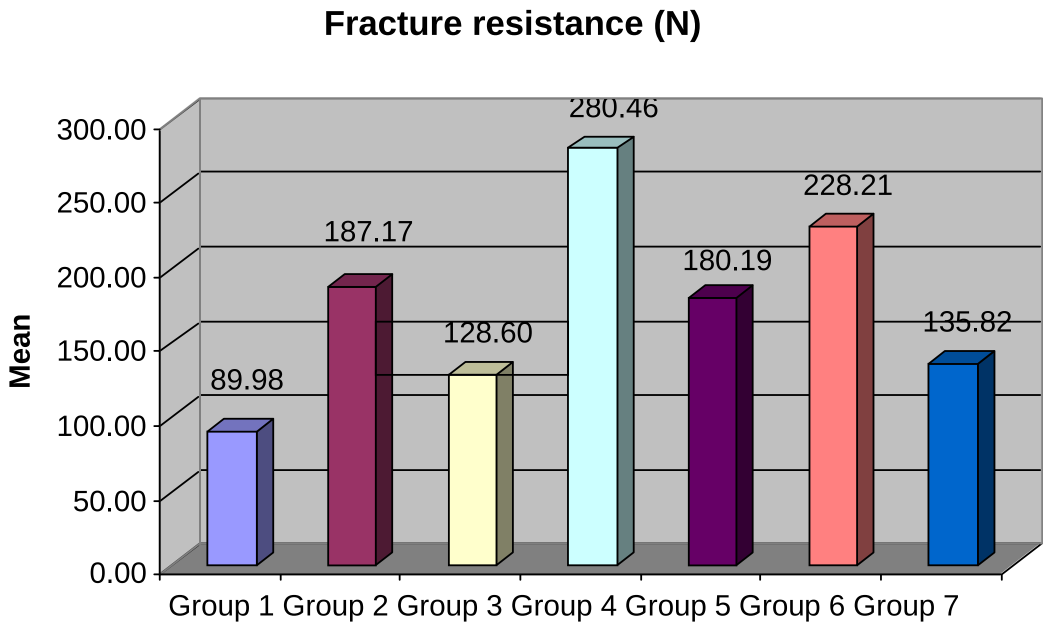
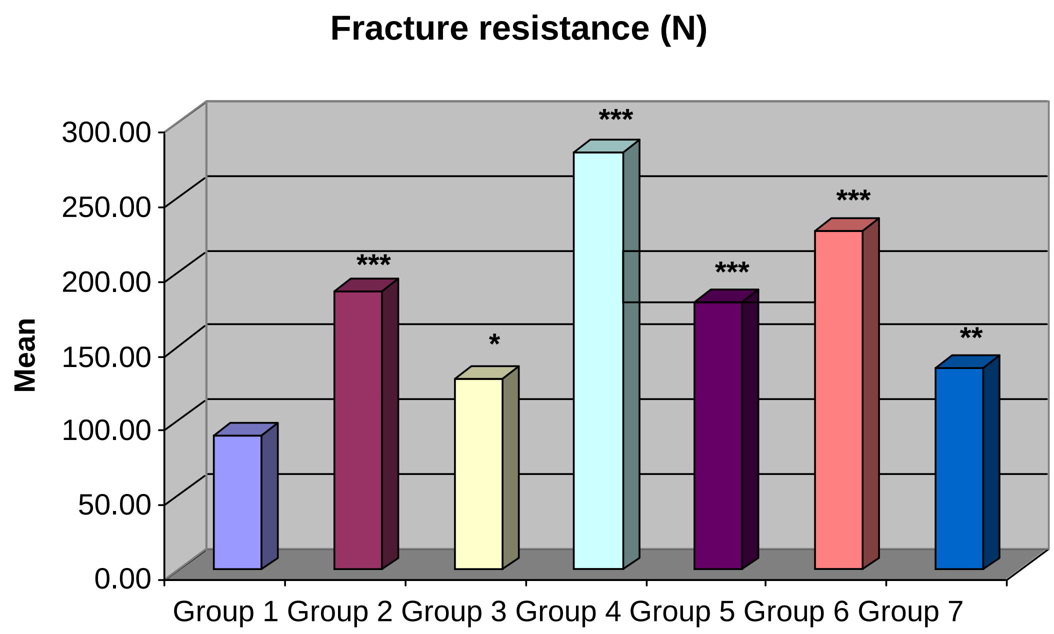


Fig. 2. Bar graphs showing mean fracture resistance of 7 different groups.

Table 3: Comparison of difference in mean fracture resistance (N) between groups by Tukey test

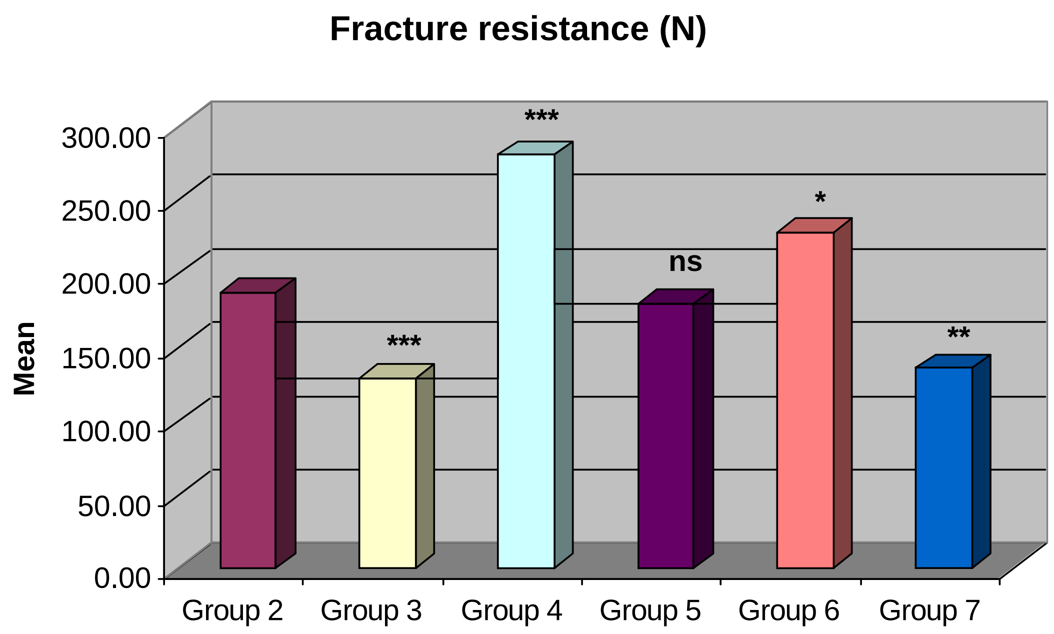
Comparison	Mean diff.	q value	*P* value	95% CI of diff.
Group 1 vs. Group 2	-97.19	11.54	P < 0.001	-133.5 to -60.90
Group 1 vs. Group 3	-38.62	4.59	P < 0.05	-74.91 to -2.326
Group 1 vs. Group 4	-190.50	22.62	P < 0.001	-226.8 to -154.2
Group 1 vs. Group 5	-90.21	10.71	P < 0.001	-126.5 to -53.92
Group 1 vs. Group 6	-138.20	16.42	P < 0.001	-174.5 to -101.9
Group 1 vs. Group 7	-45.84	5.44	P < 0.01	-82.13 to -9.546
Group 2 vs. Group 3	58.57	6.96	P < 0.001	22.28 to 94.86
Group 2 vs. Group 4	-93.29	11.08	P < 0.001	-129.6 to -57.00
Group 2 vs. Group 5	6.98	0.83	P > 0.05	-29.31 to 43.27
Group 2 vs. Group 6	-41.04	4.87	P < 0.05	-77.33 to -4.746
Group 2 vs. Group 7	51.35	6.10	P < 0.01	15.06 to 87.64
Group 3 vs. Group 4	-151.90	18.04	P < 0.001	-188.2 to -115.6
Group 3 vs. Group 5	-51.59	6.13	P < 0.01	-87.88 to -15.30
Group 3 vs. Group 6	-99.61	11.83	P < 0.001	-135.9 to -63.32
Group 3 vs. Group 7	-7.22	0.86	P > 0.05	-43.51 to 29.07
Group 4 vs. Group 5	100.30	11.91	P < 0.001	63.98 to 136.6
Group 4 vs. Group 6	52.25	6.21	P < 0.001	15.96 to 88.54
Group 4 vs. Group 7	144.60	17.18	P < 0.001	108.3 to 180.9
Group 5 vs. Group 6	-48.02	5.70	P < 0.01	-84.31 to -11.73
Group 5 vs. Group 7	44.37	5.27	P < 0.01	8.076 to 80.66
Group 6 vs. Group 7	92.39	10.97	P < 0.001	56.10 to 128.7

diff: difference, **CI:** confidence interval, **q value:** Tukey test value



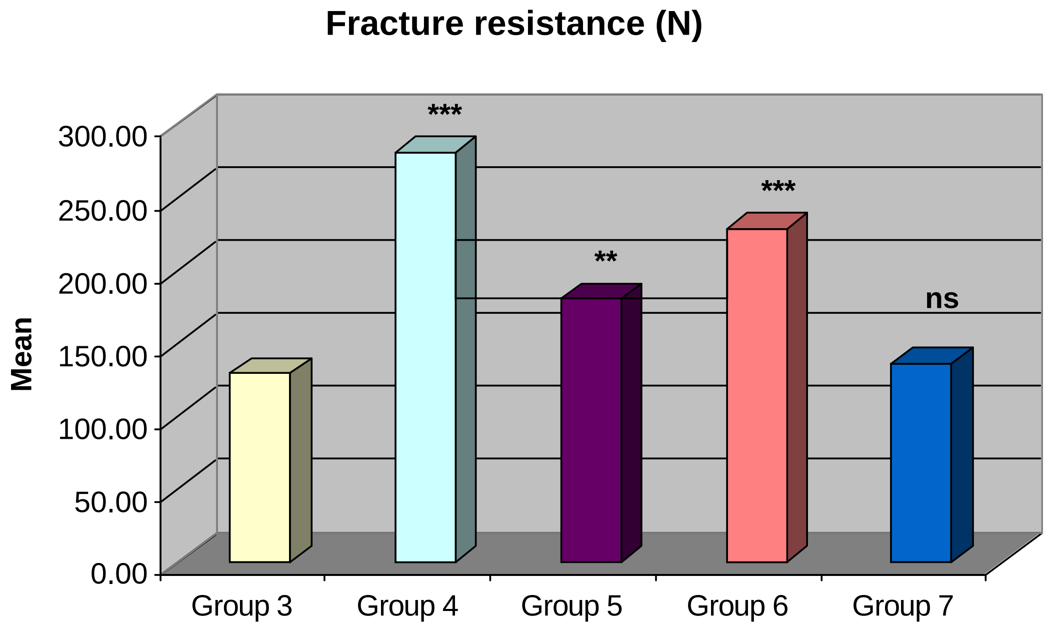
$^{*}P < 0.05$ or $^{**}P < 0.01$ or $^{***}P < 0.001$- as compared to Group 1

Fig. 3. Bar graphs showing comparison of difference Fracture resistance between 7 different groups.



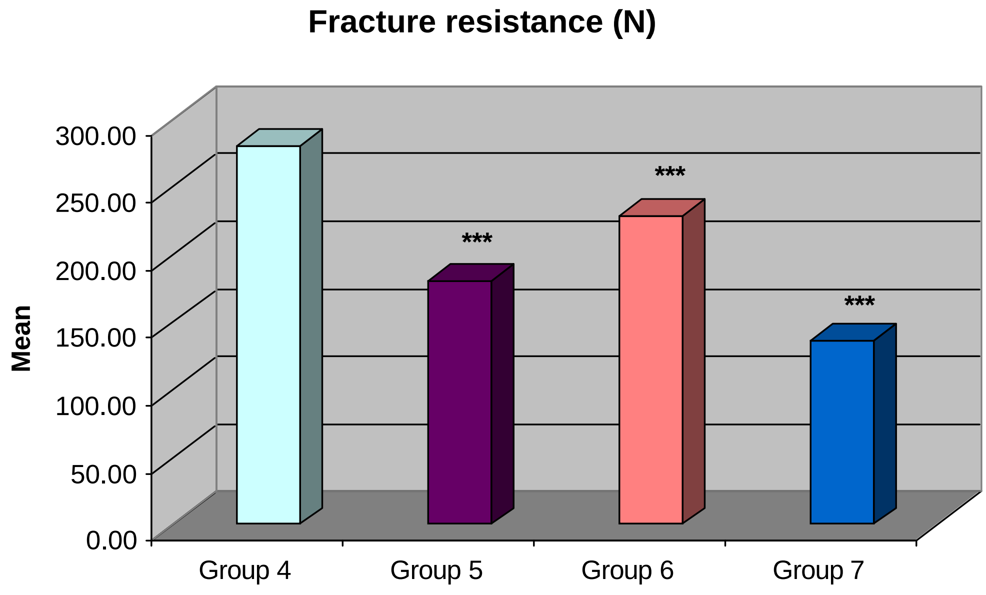
$^{ns}P > 0.05$ or $^{*}P < 0.05$ or $^{**}P < 0.01$ or $^{***}P < 0.001$- as compared to Group 2

Fig. 4. Bar graphs showing comparison of difference in mean fracture resistance between 6 different groups.



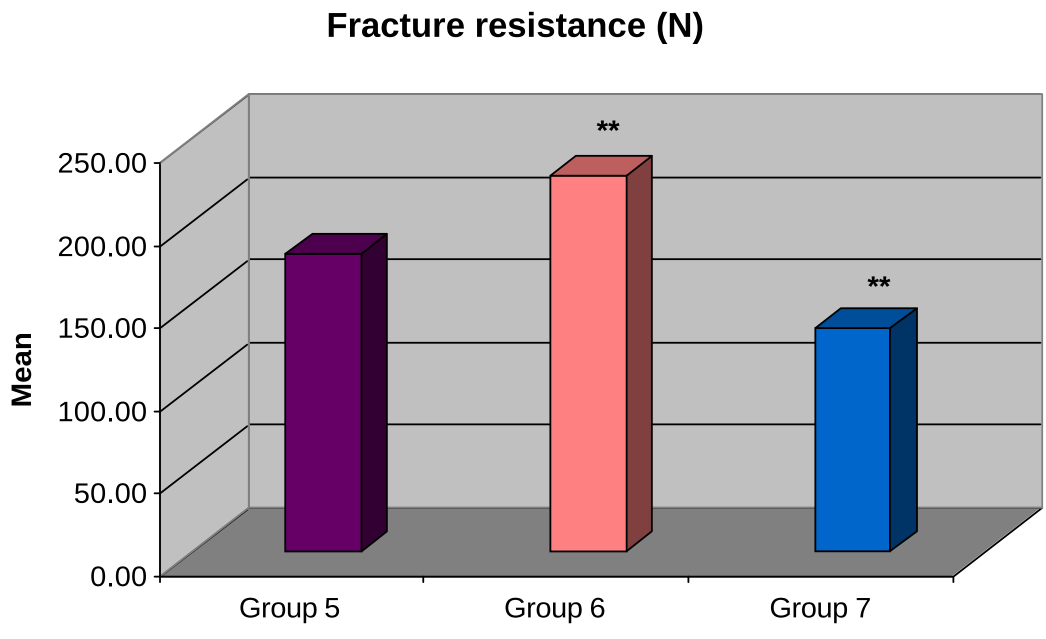
$^{ns}P > 0.05$ or $^{**}P < 0.01$ or $^{***}P < 0.001$- as compared to Group 3

Fig. 5. Bar graphs showing comparison of difference in mean fracture resistance between 5 different groups.



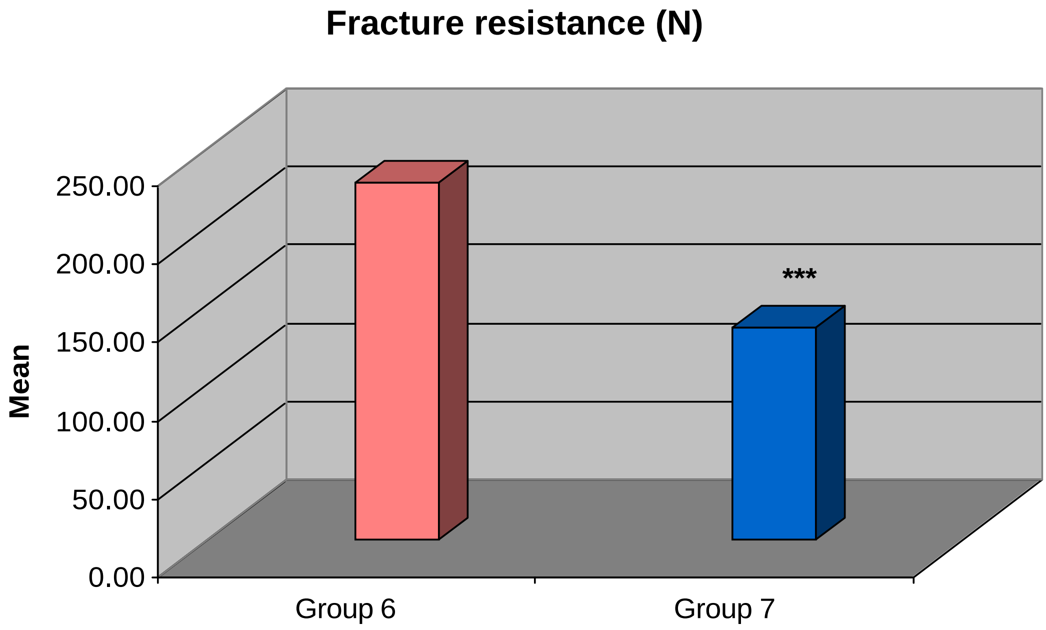
$^{***}P < 0.001$- as compared to Group 4

Fig. 6. Bar graphs showing comparison of difference in mean fracture resistance between 4 different groups.



$^{**}P < 0.01$- as compared to Group 5

Fig. 7. Bar graphs showing comparison of difference in mean fracture resistance between 3 different groups.



***$P < 0.001$- as compared to Group 6

Fig. 8. Bar graphs showing comparison of difference in mean fracture resistance between 2 different groups.

DISCUSSION

Teeth which are endodontically treated usually present with a considerable portion of lost coronal tooth structure due to loss of moisture supplied by dentin , trauma, caries , Access cavity preparation , failure of restoration and aesthetic conciderations which makes the tooth week. Controversy exists regarding the restorative techniques of these endodontically treated teeth especially severely damaged teeth.

Dental clinicians have always been in search of restorative techniques with higher durability and survival rate, lower cost, and fewer procedural steps for such teeth. Casting post and cores, prefabricated posts, and coronal restorations with amalgam and composite are among the practiced techniques for this purpose.[71]

According to Wadhwani K,et al To restore the strength of badly broken root canal treated teeth, an ideal solution is the use of a post and core which protects the weakened tooth. 6 The evaluation of whether a post is needed depends on how much natural tooth substance remains to retain a core buildup and support the final restoration after caries removal and endodontic treatment are completed.[72]

Durability, resistance, hardness, and mechanism of bonding of core materials to intracanal posts and dentin can affect the longevity and clinical service of the reconstructed crowns and subsequently the survival rate of the prosthetic crowns.[73]

Traditionally custom fabricated post and core had been widely used to re-establish the dental structures lost during endodontic treatment .This procedure requires casting a post and core as a separate component from the crown . Advantages of cast post are custom fit to the root configuration. They are adaptable to large irregularly shaped canals and orifices .It can be adapted to be used with prefabricated plastic patterns. custom fabricated post and core a poor retention, poor stress distribution, root fractures, more time consuming , Frequently involves greater laboratory , temporization between appointments is more difficult and difficulty to retrieve them from root canals .[1]

To overcome there disadvantage of cast post , prefabricated posts were introduced and these posts can be metallic and non metallic post system or stiff and flexible .[2]

Advantage of prefabricated post is simple to use ,require less chair side time ,can be complete in one appointment and they are easy to temporize.

However prefabricated metal posts also are rigid , dislodgment ,chemical reaction , difficult to retrieval of active post, lack bonding ability and different Modulus of elasticity from the tooth structure ,which induced stress and result in fracture of root therefore ,fibre reinforced composite post have been preferred choice.

Recently, the material of choice for restoration of root filled teeth has changed from very rigid materials to materials with mechanical characteristics similar to dentine. [2]

Prefabricated aesthetic posts has improved the esthetics of teeth restored with post and cores . Zirconium dioxide and glass fibre reinforced composite resins in particular are the foundation of many modern post and core concepts. These newer systems have paid attention on physical properties, such as modulus of elasticity (rigidity) to reduce stress concentrations within the root canal and reduce the incidence of fractures.

prefabricated FRC posts are made of carbon, glass & quartz fibre/ zirconia. The biomechanical properties of these posts have been reported to be close to those of dentin.[4]

The retention of post also varies, depending on the type of luting cements. The luting agents currently available for dental restoration are zinc phosphate, polycarboxylate, glass ionomer, resin modified glass ionomer, and adhesive resin cements. [2]

In this study glass ionomer and resin cement were used , glass ionomer cements are commonly used for metallic post cementation. **Li XJ, et al** Demonstrated resin cement are essentially insoluble in oral fluids and possess high compressive strengths. Resin luting systems are generally recommended to cement fibre an zirconia ceramic posts. Composite resin cement systems with their effective bonding , flexibility and cushing effect of the cement layer , contribute to uniform stress distribution between the post and the dentinal wall .[9]

In addition , they also absorb micromovement of an artificial crown resulting from occlusal forces ,more effectively than conventional brittle cements and hence, the failure of cementation , damage of post , core and root dentin might be prevented. Resin cement has been found to significantly increase retention of posts & fracture resistance of tooth compared with other cements . [1]

In there centroversally results of studies of the fracture resistance of fibre post with luting agents (resin cement)was higher than glass ionomer cement .[1,2]However according to **Narmin Mohammad et al** concluded that no any significant different in fracture resistance between glass ionomer and resin cements used for post cementation.[8]

In present study several new types of prefabricated fibre post material including carbon fibre ,glass fibre , zirconia fibre have been used with glass ionomer and resin cement .

Today various newer prefabricated fibre post have claimed to possess superior fracture resistance to their predecessors. Due to lack of substantial conclusive literature on the strength and success of these materials ,the present in vitro study was designed. The present study compared fracture resistance of three recently introduced prefabricated fibre post system i.e carbon fibre post (Angelous Reforpost Brazilian) ,Glass fibre post (Everstick Post ,GC Australia) and zirconia fibre post Post (Easy post ,Densply Switzerland) using with two different luting agents i.e glass ionomer cement (Fuji 1 GC ,japan)and dual core resin cement (Flurocore Dentsply , Switzerland)using as Universal Testing Machine .

The present study was done in vitro as the clinical functions and characteristics are difficult to evaluate under in vivo conditions. The in vitro tests give possibility to evaluate mechanical properties of restored teeth, and are considered as a predictor of the possible clinical performance of the material .

The main aim of the study to evaluate the force required to fracture i.e fracture resistance of teeth with different prefabricated post system and luting agents , is possible by in vitro study only .

Human teeth have been commonly used for the in vitro testing of post restorations .**Sturb et al** reported that higher fracture loads were observed with natural test teeth than with artificial roots. Taking all this into consideration extracted human teeth were used for the preparation of the test specimens in this study, even though the disadvantage of the use of human teeth is the relatively large variation in size and mechanical properties, often resulting in large standard deviations. In addition, dentinal changes can be caused by different water content, pulpal condition before tooth extraction, patient age, and composition of dentin. [74]

In the present study, maxillary incisor was selected as it is the most vulnerable tooth to trauma because of its position, being in the front and thereby requiring maximum restoration in terms of post core.

Extracted maxillary incisors were initially sterilized in an autoclave at 121 c ,15 psi, for 15 min . This was done as a precautionary measure to prevent cross-contamination and to provide a practical level of infection control and safety. Later on, they were immersed in normal saline solution to prevent desiccation. **Simarpreet v.sandhu et al** reported that this method of sterilization of extracted human teeth did not seem to affect the feel and cutting characteristics of the teeth.[75]

In these study all teeth were shortened 2 mm above the most incisal point of the CEJ using diamond disk for standerization of root length . **Ng et al** reported that 2 to 3 mm of remaining coronal tooth structure beneficially increased their fracture resistance of endodontically treated teeth restored with prefabricated posts, composite resin cores, and complete crowns.[76]

In this study all teeth received endodontic treatment, even though some investigations [22] do not report root canal preparation, it seems crucial to include this step to carefully simulate all clinical and oral parameters. Teeth receiving post-anchored restorations are always endodontically treated, resulting in a small but not negligible loss of tooth structure.[77] Because this could influence the results, an endodontic treatment is mandatory to obtain reliable results in terms of clinical application. According to **Sareh habibzadeh et al** performed standered root canal treatment were carried out in all the testing sample for evaluate for fracture resistance .[78]

Biomechanical preparation of all the specimens in the present study , was done by crown down technique [79] to form a continuously tapering funnel with the narrowest diameter at the apex and widest diameter at the access to the cavity. This narrow apical opening acted like a matrix against which mass of gutta-percha was forcibly condensed and this junction prevented excess filling material from being forced beyond the apical foramen. Use of ProTaper gold file system ensures the uniform preparation of the canals of all specimens. This file system the ability to follow the anatomy of the canal very closely , more flexible ,less resistance ,reducing the risk of ledging , transportation , or perforation. The canal was irrigated by EDTA and sodium hypochlorite . because it has tissue dissolution property ,and antimicrobial property. All the teeth were obturated with AH plus sealer . It has a very good mechanical properties , high radiopacity , little polymerization shrinkage and low solubility . **Anuve Hrishi phukan** found that AH plus sealer can enhance the fracture resistance of endodontically treated teeth because of its higher bond strength to dentin , due to its reaction with exposed amino in collagen to form covalent bond between the resin and the collagen when the epoxide ring opens .[80] **According to Ashutosh B. et** In there study were used of AH PLUS sealer for obturation of teeth for evaluate of fracture resistance of post. [81]

In present study after letting the root canal sealer to set for 48 hours, gutta percha was removed from the root canals. **Zmener** found no difference in the leakage of root canal filling material between gutta percha removal after 5 minutes and 48 hours for post space preparation. Gutta-percha was removed from the root canals with a peso reamer to a depth of 11 mm, leaving atleast 4-5 mm of root canal filling in the apical 1/3rd of the root [82]. **Kantorowicz G.F.** 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.[13]

In present study post space was prepared with a number 3 titanium drill (ParaPost) to a depth of 11 mm for standardization .**As Shillingburg HT et al** measured 700 root dimensions to determine the post diameter that would minimize the risk of perforation . Also based on not exceeding one third the mesiodistal root width , they recommended maximum post diameter 1.5 mm for maxillary central incisior. [84]

Already it has been proven that tapered and threaded post increase root fracture 20 times in comparison to parallel post .More use of parallel post because they give better retention and cause less incidence of root fracture & are passively fitting .[27]

In the present study, for standardisation, parallel posts space prepared which probably deprived additional mechanical retention provided by small undercuts present in the canal, therefore, prefabricated serrated parallel side posts (carbon, glass, zirconia fibre posts) were used, which provided additional retentive features, as they get embedded into the resin luting cement and resist dislodging forces on pulling.[85]

In this study, standardized composite resin core foundation were fabricated over the posts using a vinyl polysiloxane impression material mold made with a core former . The post-supported core were not resorted with crowns. As in similar previous studies ,[22] the compressive load was directly applied to the inclined surfaces of the cores.

Assif D. et al [84]stated in their study that when forces were applied directly on core, there was a wedging effect on the root. However , if the core was covered by a complete crown , the wedging effect disappeared with a shift of stress concentration to the CEJ. The crown changed the distribution of forces to the root and the post and core complex, rendering the post characteristics insignificant. In this manner, the probale altering of parameters , such as material structure , shape, length , and thickness, by crown restorations was avoided .It was considerd that by eliminating such parameters , the structural integrity and fracture resistance of a post and core foundation could be tested more precisely.

Thermal cycling was used for aging and to mimic the clinical conditions. [14]To simulate physical conditions found in tooth sockets as nearly as possible, each root was embedded in an acrylic resin socket lined with a Polyvinyl siloxane impressions material approximately 0.25 mm thick (roughly the width of the periodontal ligament) and allows freedom of movement as in the periodontal ligament.[24] This movement appears to be small, although no measurements of actual mobility were made. The root was then mounted with the long axis perpendicular on a custom made prefabricated holder with a cold-curing resin material. In the embedding process of specimens into the auto polymerizing acrylic resin, specimens were removed from the resin blocks after the first signs of the polymerization. Thus, effect of heat of polymerization in dentin was eliminated. The heat generated may lead to decreased moisture content, crazing, and weakening of the sample, which will indirectly affect the fracture resistance value.[85]

The loading angle of 130 to 135 degrees from lingual to labial was selected in the present study on the basis that it simulates the average angle of contact between maxillary and mandibular incisors in Class I occlusion. This loading angle more closely resembles a test of function than a test of external impact as this angle has been used in a various other studies.[56]

A cross head speed of 1.5 mm/min was selected to allow time for distribution of the force from the point of application ,for fracture resistance test in an universal testing machine .[86]

In the present study , 3 different post system compared and evaluated fracture resistance (Newton) with 2 different luting agents. The highest fracture resistance was observed in group 4 ,in which glass fibre posts and resin cement system were used for restoration. The mean value of group 4 was 280.46 N, (Table 2)

Everstick post is a recently introduced glass fiber post consisting of unidirectional E-glass and unpolymerized BisGMA matrix, and it has elastic modulus similar to dentin.[2] This could be explained as fibre posts and resin cement possess a modulus of elasticity much better matched to that of dentin. This creates a mono-block of dentin-post-core system through the dentinbonding. This inturn allows better distribution of applied forces evenly along the length of the post and root. Therefore, the excessive loads would be absorbed. [2]

Our result is also supported with in one year comparative clinical study by **GA Preethi et al** concluded that glass fibre post higher fracture resistance compare than carbon fibre post.[7]

The above results are also consistent with **Omar Ahmed**[87] who demonstrated the highest mean fracture resistance values for glass fibre post.

However these results are contrary to the findings of **Dayalan M et al**[88] who compared the fracture strength of the zirconia oxide posts and prefabricated glass fiber post and concluded that zirconium oxide posts showed higher fracture strength when compared to glass fibre posts.

In present study Fracture resistance of zirconia post with resin cement (Group 6) is lower than glass fibre post. The mean value of group 6 was 228.21 N, (Table 2) This could be explained as zirconia fibre posts and resin cement possess a modulus of elasticity is 200 GPa (Guazzato et al., 2004) causes stress to be transferred to the less rigid dentin, thereby resulting in root fractures.[50] (Bateman et al., 2003). However, there is little consensus with regard to their mechanical behavior and reliability and other factors which would contribute to their optimal performance.

Above results also supported with the in vitro study by **Sareh habibzadeh et al,** concluded that fracture resistance of zirconia post was lower than glass fiber posts .[78]

Above results also supported with the in vitro study by **Neena chandran et al,** concluded that fracture resistance of zirconia post was lower than glass fiber posts and composite core.[2]

This result is in agreement with the invitro study by **Abduljabbar T**, which concluded that fracture resistance of zirconium custom posts was higher than glass fiber post. [4] Zirconia posts had 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; consequently, less stress is exerted on the tooth (Butz et al., 2001).

However these results are contrary to the findings by **Rajini jununthula et al** ,which concluded that fracture resistance of zirconia posts and composite core was higher than glass fiber posts and composite core .[5]

In the current study the mean difference of fracture resistance between the group 4 (glass fibre post with resin cement) and 6 (Zirconia fibre post wuth resin cement) was 52.25 N (Table no 3). Ever Stick post luted with resin cement was associated with the highest fracture forces. This could be due to the multiphase polymer matrix of these types of posts consisting of both linear and cross-linked polymer phases (semi interpenetration polymer network, semi-IPN). The monomers of the adhesive resins and cements can diffuse into the linear polymer phase, swell it, and by polymerization, form inter diffusion bonding resulting in monoblock effect. This will result in reduced stress formation at post/dentin and post/cement interfaces. The zirconia posts were supplied in a hardened form (with prepolymerized monomer), which might have reduced their potential for bonding to the resin cement and thus might have allowed relatively lower fracture forces than Everstick posts.

This result is also supported with in vitro study by **Neena chandran et al,** concluded that fracture resistance was higher of glass fiber post with resin cement than zirconia fibre posts with resin cement. [2] However these results are contrary to the findings by **Suneel V Vadavadagi et al** ,which concluded that higher fracture resistance with carbon fibre post compared to glass fibre post .[89]

In present study Fracture resistance of carbon fibre post with resin cement (Group 2) is lower than glass fibre post and zirconia fibre post . The mean value of group 6 was 187.17 N,

(Table 2) This could be explained , higher modulus of elasticity of carbon fibre post compared with dentin would have lead to the stress concentrations, and might be responsible for root fracture at lower fracture loads. Rigid metallic posts were responsible for stress concentration at the apical end and the coronal third of the canal wall, resulting in vertical root fractures.[19]

The above results are supported to the findings of **Joel G Varghese et al** concluded that the carbon fiber posts had least fracture resistance than glass fiber posts and zirconia fibre post .[90]

This result is also supported with the in vitro study by **Anamika Thakur et al** concluded that carbon fibre post least fracture resistance compare than glass fibre post .[91]

This finding is consistent with **Kaur et al**. who demonstrated higher fracture with carbon fibre post compared to glass fibre post .

This results are supported to the findings of study by **Mavari karibasappa et al** which concluded that zirconia fibre post higher fracture resistance compare to carbon fibre post .

In the current study the mean difference of fracture resistance between the group 2 (carbon fibre post with resin cement) ,and group 4 (glass fibre post with resin cement) was 93.29 . Mean difference of fracture resistance between the group Group 2 (carbon fibre post with resin cement) and group 6 (zirconia fibre post with resin cement) was 41.04 ,(Table 3). This could be due to the , higher modulus of elasticity of carbon fibre post compared with dentin would have lead to the stress concentrations, and might be responsible for root fracture at lower fracture loads. Rigid metallic posts were responsible for stress concentration at the apical end and the coronal third of the canal wall, resulting in vertical root fractures.

However these results are contrary to the findings of **Suneel V Vadavadagi,et al** concluded that the carbon fiber posts had higher fracture resistance than glass fiber posts.[89]

In the current study the mean difference of fracture resistance between the group 4 (glass fibre post with resin cement) and group 2 (Carbon fibre post with resin cement) was 93..29 N and mean difference of fracture resistance between the group 6 (Zirconia fibre post with resin cement) and group 2 (Carbon fibre post with resin cement) was 41.04 N.

However these results are contrary to the findings of **Joel G Varghese et al** concluded that the zirconia fiber posts had higher fracture resistance than glass fiber posts and carbon fibre post .[90]

In present study Glass fibre post with Glass ionomer cement (Group 5) is least Fracture resistance (180.19) than glass fibre post with resin cement (Group 4) ,zirconia fibre post with resin cement (Group 6) and Carbon fibre post with resin cement (Group 2). This could be explained as glass fibre posts with glass ionomer cement ,Glass ionomer powder has been shown to be weak and brittle as compared with resin-based materials.22Glass ionomers have also exhibited unfavorable in vitro cyclic fatigue characteristics and low compressive strengths compared with resin-based luting cements.

Above results also supported with the in vitro study by **Neena chandran et al,**[2] concluded glass fibre post with glass ionomer cement was lower fracture resistance than glass fiber posts with resin cement (Group 4) ,zirconia fibre post with resin cement (Group 6) and Carbon fibre post with resin cement (Group 2).

In current study zirconia fibre post with Glass ionomer cement (Group 7) is least Fracture resistance (135.82N)than zirconia fibre post with resin cement (Group 6), glass fibre post with resin cement (Group 4) ,and Carbon fibre post with resin cement (Group 2) and glass fibre post with Glass ionomer cement (Group 5). Glass ionomer cement, were chosen as

G.I.C. bonds chemically to tooth structure and resin cement is gaining recognition as various investigators have reported advantages related to their use. [11m] The resin cements are highly resistant to moisture and therefore become highly durable cements.

Above results also supported with the in vitro study by **Shivaughn MARCHAN et al,** concluded Zirconia fibre post luted with glass ionomer cement was lower fracture resistance than Zirconia fiber posts with resin cement .[93]

In the present study, groups with the resin luting system showed considerably higher mean fracture loads than those with glass ionomer cement. The statistical analysis also revealed significant difference between the groups with different luting cements. The results indicate that adhesive composite resin luting systems provided additional fracture resistance to metallic post.

In current study carbon fibre post with Glass ionomer cement (Group 3) is least Fracture resistance than Carbon fibre post with resin cement (Group 2), glass fibre post with resin cement (Group 4) ,zirconia fibre post with resin cement (Group 6) and and glass fibre post with Glass ionomer cement (Group 5) zirconia fibre post with Glass ionomer cement (Group 7) Because resin cement showed bonding to both dentin and carbon fiber posts giving a single unit effect and causing uniform stress distribution but glass ionomer cement showed chemical bonding only to dentin.

Above results also supported with the in vitro study by **Rajneesh kumar et al,** they concluded carbon fibre post luted with glass ionomer cement was lower fracture resistance than carbon fiber posts with resin cement .[1]

According to Cohen BI et al Adhesive composite resin luting systems are generally recommended for the cementation of fibre and zirconia ceramic post.[51] Cementation of a post with a dentin-bonding system could theoretically provide internal bracing of the root and preserve the critical interface between dentin and post. In addition to providing flexibility and cushioning effect of the cement layer, resin cements might contribute to uniform stress distribution between the post and the dentinal walls, and absorb micromovements of an artificial crown resulting from occlusal forces more effectively than conventional brittle cements. Thus, loss of cement seal of the artificial crown and damage of post, core and root dentin might be prevented. The restoration of teeth with adhesively cemented internal restorations offered improved mechanical stability over cemented restorations.

Glass ionomer powder has been shown to be weak and brittle as compared with resin-based materials.[94] Glass ionomer have also exhibited unfavorable in vitro cyclic fatigue characteristics and low compressive strengths compared with resin-based luting cements. Glass-ionomer cements are known to require several days and even several weeks to reach maximum strength, making this choice unsuitable as cement for post.

The failure loads , In group 4 (Glass fibre post with resin cement) was significantly greater than group 5 (Glass fibre post with Glass ionomer cement). In group 6 (zirconia fibre post with resin cement) was significantly greater than group 7 (zirconia fibre pots with glas ionomer cement) as shown in table 3,in group 2 (carbon fibre post with resin cement) was significantly greater than group 3(carbon fibre post with glass ionomer cement)as shown in table These results indicated that adhesive composite resin luting systems provided additional fracture resiatance cements.

From the data it is observed that group 1 i.e. control group demonstrated the least mean fracture resistance values as compared to experimental groups. It was observed that the highest fracture resistance was observed with glass fibre posts luted with resin cement system, and the lowest fracture resistance was observed with carbon fibre post luted with glass ionomer cement.

Showing comparison of failure loads in different experimental groups (group 2, group 3, group 4, group 5 , group 6 ,group 7) from group 1 (control group), „t" Value „p" Value Significance Group 1 vs group 7 .(Table 3)

The mean value of group 4 was 280.46 N, Followed by 228.21 N of group 6 with Zirconia fibre post with resin cement ,187.17N of group 2 with carbon fibre post resin cement ,180.19 N of group 5 with glass fibre post with glass ionomer cement ,135.82 N of group 7 with zirconia fibre post system with glass inomer cement , 128.60 N of group 3 with carbon fibre post system with glass inomer cement , 89.98 N of group 1 (control group) with root canal treated without post system. The lowest fracture resistance was recorded for at the mean value of 89.98of group 1with control group (Table 2).Significant difference of fracture resistance were detected between group 7 and Control ($P \leq 0.001$).

In the literature [95] , maximum incisal forces of anterior teeth varied, but the amount was almost always below 200 N which is much lower than the failure loads of fibre post found in this study.

The results obtained in this vitro investigation, may not accurately reflect the in vivo situation. For example, fracture resistance was evaluate by applying a heavy load to a single point or static loading ; by contrast, in vivo fracture typically occurs in response to mild or moderate loads applied repeatedly over a long period. The present study was done to simulate the clinical situations by the formation of simulated periodontal ligament and core placement. However it is difficult to extrapolate the results directly into clinical practice as the oral conditions cannot be replicated perfectly. Therefore, further research is suggested, using dynamic loading combined with thermocycling as well as further long-term follow-up in vivo survival studies of teeth restored with fiber-reinforced posts.

Conclusion

Our study concluded that highest fracture resistance was observed with glass fibre post luted with resin cement system and lowest fracture resistance was observed with carbon fibre post with glass ionomer cement. The endodontically treated teeth without post system showed the least fracture resistance demonstrating the need to reinforce the tooth.

Finally, within the limitations of this in vitro study, it can be stated that glass fibre posts with resin cement can be recommended as a better alternative to the zirconia fibre post and carbon fibre posts in the maxillary anterior teeth region .Glass fibre post can be recommended as a esthetic restoration and force resistant restoration of endodontically treated anterior teeth.

REFRENCES

1. Rajnish Aggarwal ,et al Comparative evaluation of fracture resistance of various post systems using different luting agents under tangential loading: J. oral bio and craniofacial Res .(2013)63 _67

2. Neena Chandran., Noushad M C And Biji Balana Comparative Evaluation Of Fracture Resistance Of Endodontically Treated Teeth Restored With Three Different Post And Core Systems And Two Different Luting Agents – An Invitro Study Int J. Of Rec Sci Rec. Vol. 8, Issue, 5, Pp. 17087-17091, May, 2017.

3. Makade CS, Meshram GK, Warhadpande M, Patil PG. A comparative evaluation of fracture resistance of endodontically treated teeth restored with different post core systems-an in-vitro study. The journal of advanced prosthodontics. 2011; 3(2):90-5

4. Abduljabbar Tariq, Sherfudhin Haneef, AlSaleh SA, Al-Helal Abdulaziz A, Al-Orini Saleh S, Al-Aql Naif A. Fracture resistance of three post and core systems in endodontically treated teeth restored with all-ceramic crowns. KSUJDS. 2012;3:33e38.

5. Rajini Jununthula , Sunanda Gaddalay Comparison of Fracture Resistance of Three Recent Esthetic Post and Core Systems with Cast Metal Post and Core to Compressive Loading - An in vitro Study IJSR : (2016): 79.57

6. George Freedman The Carbon Fibre Post: M Etal.Fr Ee,Post.En Do Dontic Rehabilitation Oral Health · March 1996

7. GA Preethi ,M Kala , carbon fibre reinforced carbon endodontic post ,glass fibre reinforced post with cast post and core:J conserve Dent oct 2008 :vol 11 ,4.

8. Narmin Mohammad et al Different luting cements on fracture resistance in endodontically treated teeth ;Int Endod J 2008:3,4.

9. XJ, Zhao SJ, Niu LN, Tay FR, Jiao K, Gao Y, Che n JH. Effect of luting cement and thermo-mechanical loading on retention of glass fibre posts in root canals. Journal of dentistry. 2014 Jan 31;42(1):75-83.

10. Colley IT, Hampson EL, and Lehman ML.; Retention of post crowns: Br. Dent. J. 1968; 63:124-28

11. Angmar- Mansson, Omnell KA and Rud J.; Root fractures due to corrosion: Metallurgical aspects Odont. Revy. 1969; 20: 245.

12. Dawson PE.; Pin-retained amalgam. D.C. N.A. 1970; 14: 63-71

13. Kantorowicz G.F.; Inlays, Crowns, and Bridges, ed 2. Baltimore, 1970, The WilliamS & Wilkins Co., chap 7.

14. Standlee JP., Caputo, A.A., Collard, E.W. and Pollack M.H.: Analysis of stress distribution by endodontic posts. Oral Surg 1972; 33:952.

15. Weine F.S.; Endodontic therapy St. Louis, 1972, The C.V. Mosby Company, pp. 385-394.

16. Hanson EC, Caputo AA; Cementing mediums and retentive characteristics of dowels. J Prosthetic Dentistry 1974: 32:551 – 559.

17. Caputo AA., Standlee JP., Pins and posts-why, when and how. Dent. Clin. North Am. 1976; 20:299

18. Hock D. Impact resistance of posts and cores. [Master‟s Thesis,] Ann Arbor: University of Michigan, School of Dentistry; 1976.

19. Johnson J., Schwart N. and Blackwell R.; Evaluation and restoration of endodontically treated posterior teeth. J. AM. Dent. Assosc. 1976; 93:597s

20. Rud J and Omnell K. Root fractures due to corrosion. Scand J. Dent. Res 1976; 78:397

21. Henry, P.J.: Photoelastic analysis of post core restoration. Aust Dent J 1977; 22:157

22. Lovdahl PE, Nicholls JI. Pin-retained amalgam cores vs cast-gold dowel-cores. J Prosthet Dent 1977; 38:507-514.

23. Johnson JK, Sakamura JS.; Dowel form and tensile force. J Prosthetic Dentistry 1978; 40:645-49

24. Guzy GE., Nicholls JI,; In vitro comparison of intact endodontically treated teeth with and without endo-force reinforcement. J Prosthetic Dent 1979; 42;39-44.

25. Chan F W, Harcourt J K, Brockhorst P J. The effect of post adaptation in the root canal on retention of posts cemented with various cements. Aus Dent J 1993 feb; 38(1); 39-45

26. Mattison G.D.; Photoelastic stress analysis of cast-gold endodontic posts. J Prosthet Dent 1982, 48:407

27. Desort K D; The prosthodontics use of endodontically treated teeth: Theory and biomechanics of post preparation. J Prosthetic Dent.,1983; 49:203-6.

28. Deutsch A.S., Musikant B.L., Cavallari J. and Lepely J.B.; Prefabricated Dowels: A literature review. J Prosthet Dent 1983; 49:498-503.

29. Assif D, Bleicher S.; Retention of serrated endodontic posts with a composite luting agent; effect of element thickness. J Prosthet Dent. 1986; 56 (6):689-91

30. J Darold Brown, John C M. Retentive Properties of Dowel Post Systems. Operative Dentistry, 1987, 12, 15-19.

31. Eissman H F., Radke R.A.; Post endodontic restoration. In: Cohen, S., Burns K.C., ed. Pathways of the Pulp, 4th ed. St. Louis, C.V. Mosby, 1987; 640-3.

32. Cohen BI, Musikant BL, Deutsch AS.; Comparison of retentive properties of four post

systems. J Prosthet Dent. 1992 Aug; 68(2):264-8.

33. Chan F W, Harcourt J K, Brockhorst P J. The effect of post adaptation in the root canal on retention of posts cemented with various cements. Aus Dent J 1993 feb; 38(1); 39-45.

34. Mendoza DB,Eakle WS:Retention of the post cemented with various dentinal bonding cements .J Prosthet Dent 1997; 72: 591 -94.

35. Keyf F, Sahin E. Retentive properties of three post-core systems. Aust Dent J. 1994 Feb; 39(1):20-4.

36. Leary J M, Holmer D C, Johnston W T Post and core retention with different systems. Gen Dent 1995 Sep-Oct 43(5): 416-9.

37. Holmes DC, Diaz-Arnold AM, Leary JM, Influence of post dimension on stress distribution in dentin. J Prosthet Dent 1996; 75:140-7.

38. Potashnick Steven R, Weine FS, Strauss S. Restoration of endodontically treated tooth. Weine Franklin S. Endotherapy, Fifth Edition, Mosby, 1996, pp. 756-804.

39. Purton DG and Payne JA. Comparison of carbon fibre and stainless steel root canal posts. Quintessence Int. 1996; 27:93-7.

40. Morgano SM Brackett SE.Foundation restoration in fixed prosthodontics ;current knowledge and future needs .J Prosthet Dent 1999;82:643-57.

41. Ulter J N, Wong BH, Miller BH. The effect of cementing procedures on retention of prefabricated metal posts. J Am Dent Assoc, 1997, 128:1123.

42. Love RM, Purton DG. The effect of Serrations and carbon fibre posts retention within the root canal core retention and rigidity. Int J Prosthodont 1996; Sep-Oct 9(5); 484-8.

43. Martinez-Insua A., Dasilva L, Santana U.; Comparison of the fracture resistances of pulpless teeth restored with a cast post and core or carbon- fibre post with a composite core. J Prosthet Dent 1998; 80:527-32.

44. D G Purton, N P Chandler and R M Love. Rigidity and Retention of root canal posts. British Dental Journal 1998; 184:294-296.

45. Cohen BI, Pagnillo M, Musikant BL, Deutsch AS. Comparison of the retentive and photoelastic properties of two prefabricated endodontic post systems. J Oral Rehabil. 1999 Jun; 26(6): 488-94.

46. Cohen BI, Pagnillo MK, Newman I. Retention of four endodontic posts cemented with composite resin. Gen Dent 2000 May-Jun 48(3); 320-4.

47. Mitchell CA, Selection of materials for post cementations. Dent Update 2000 Sep; 27,350-4.

48. Roesentritt M, Furer C, Behr M, Lang R, Handel G. Comparison of in vitro fracture

strength of metallic and tooth colored posts and cores. J. Oral. Rehab. 2000; 27(7):595-601.

49.Hew Y S, Purton DG, and Love RM. Evaluation of prefabricated root canal post. J Oral Rehab 2001, Mar:28-3, 207-11

50. Akkayan B, Gulmez T. Resistance to fracture of endodontically treated teeth restored with different post systems. J Prosthet Dent. 2002 Apr; 87(4):431-7.

51. Heydecke G, Butz F, Hussein A, Strub JR. Fracture strength after dynamic loading of endodontically treated teeth restored with different post-and-core systems. J Prosthet Dent. 2002 Apr; 87(4):438-45.

52. Nergiz I, Schmage P, Ozcan M, Platzer U. Effect of length and diameter of tapered posts on the retention. J Oral Rehabil. 2002 Jan; 29(1):28-34.

53. Pontius O, Hutter JW, Survival rate and fracture strength of incisors restored with different post and core systems and endodontically treated incisors without Coronoradicular reinforcement. J Endod. 2002 Oct; 28(10):710-5.

54. Newman MP, Yaman P; Fracture resistance of endodontically treated teeth restored with composite posts. J Prosthet Dent. 2003 Apr; 8:360-7.

55. Ertugrul H Z, Ismail Y H. An in vitro comparison of cast metal dowel retention using various luting agents and tensile loading. J Prosthet Dent. 2005; 93-446-452.

56. Clarisse C. H. Ng, Herman B. Dumbrigue, Manal I. Al-Bayat, Jason A. Griggs, and Charles W. Wakefield, Influence of remaining coronal tooth structure location on the fracture resistance of restored endodontically treated anterior teeth. J Prosthet Dent 2006; 95:290-6.

57. Faruk Taner Dilmener, Cumhur Sipahi, and Mehmet Dalkiz, Resistance of three new esthetic post-and-core systems to compressive loading. J Prosthet Dent 2006; 95:130-6.

58. Gu X M, Kern M. Fracture resistance of crowned incisors with different post systems and luting agents. J Oral Rehabil. 2006; 33:918-923.

59 .Giuseppe Varvara, Giuseppe Perinetti, Donato Dilario, Giovanna Murmura and Sergio Caputi, In vitro evaluation of fracture resistance and failure mode of internally restored endodontically treated maxillary incisors with differing heights of residual dentin. J Prosthet Dent 2007; 98:365-372.

60 .Kivanç BH, Görgül G. Fracture resistance of teeth restored with different post systems using new-generation adhesives. J Contemp Dent Pract. 2008 Nov 1;9(7):33-40.

61. Wang YJ, Zhang L, Chen JH, Goracci C, Ferrari M. Influence of C-factor on the microtensile bond strength between fiber posts and resin luting agents. Journal of Adhesive Dentistry. 2008 Sep 1;10(5).

62. Dorriz H, Alikhasi M, Mirfazaelian A, Hooshmand T. Effect of ferrule and bonding on the

compressive fracture resistance of post and core restorations. J Contemp Dent Pract. 2009 Jan 1;10(1):1-8.

63. Poskus LT, Sgura R, Paragó FE, Silva EM, Guimarães JG. Influence of post pattern and resin cement curing mode on the retention of glass fibre posts. International endodontic journal. 2010 Apr 1;43(4):306-11.

64. Bitter K, Eirich W, Neumann K, Weiger R, Krastl G. Effect of cleaning method, luting agent and preparation procedure on the retention of fibre posts. International endodontic journal. 2012 Dec 1;45(12):1116-26.

65. Nova V, Karygianni L, Altenburger MJ, Wolkewitz M, Kielbassa AM, Wrbas KT. Pull-out bond strength of a fibre-reinforced composite post system luted with self-adhesive resin cements. Journal of dentistry. 2013 Nov 30;41(11):1020-6.

66. Li XJ, Zhao SJ, Niu LN, Tay FR, Jiao K, Gao Y, Chen JH. Effect of luting cement and thermo-mechanical loading on retention of glass fibre posts in root canals. Journal of dentistry. 2014 Jan 31;42(1):75-83.

67. Turker SB, Alkumru HN, Akalin B. Fracture Resistance of endodontically treated canines restored with different sizes of fiber post and all-ceramic crowns. The journal of advanced prosthodontics. 2016 Apr 1;8(2):158-66.

68. Neena chandran , Naushad m c & Biji Balan. Fracture resistance of endodontically treated teeth restored with three different post and core system & two different luting agents .Int.J .Rec Sci Res 2017; 8:17087-17091.

69. Ibtisam O.M Alnaqbi .Haitham Elbishan & Emad S. Elsubeihi , Effect of fibre post resin matrix composition on bond strength. Int .J. Dent. 2018.

70. Sonal Maurya , Fracture resistance of endodontically treated teeth restored with three different types of fibre reinforced composite post system . Int. J .Curr.Res 2019; 11:1684-88.

71. Alireza Izadi et al Effect of photo core, LuxaCore, and core max II core building materials on fracture resistance of endodontically-treated teeth restored with fiber-reinforced composite posts and ParaPosts. Dent Resh Journal 2020. heung W.

72. A review of the management of endodontically treated teeth. Post, core and the final restoration. Journal of the American Dental Association (1939). 2005; 136(5):611-9

73. Garoushi S, Lassila L, Vallittu PK. Resin-bonded fiber-reinforced composite for direct replacement of missing anterior teeth: A clinical report. Int J Dent 2011;2

74 .Sturb JR,et al Fracture strengthof incisiors restored with different post and core system, J Dent .Res 2000:79:628.

75. Simarpreet V.et al sterilization of extracted human teeth: A comparative analysis , Journal

of Oral Biology and Craniofacial Research 2012 SeptembereDecember Volume 2, Number 3; pp. 170e175

76. Ng CC, Al Bayat MI ,Dumbridge HB :Effect of no ferrule on failure of teeth restored with bonded posts and cores.Gen Dent 2004:52:143_6.

77. Reeh ES, Messer HH,Reduction in tooth stiffness as a result of endodontic and restorative procedures. J Endod 1989 :15 ,512 _516.

78. Sareh Habibzadeh et al zirconia ,cast ni cr , and fibre glass composite post under all ceramic crown. J Adv Prostthodont 2017:9:170_5.

79. Morgan LF .An evaluation of the crown down pressure less technique. J Endod 1984:10.

80. Onay EO, Ungor M Push out bond strengths: The epiphany Resilon endodontic obturation system compared with different pairings , of epiphany ,Resilon, AH Plus , Guttapercha .J Endod 2006:39:643_7.

81. Ashutosh B. Palepwad, Rahul Shyamrao Kulkarni fracture resistance of zirconia, glass-fiber, and cast metal posts with different lengths. J of Indian Prosthodod 2020. 82.Zmener O. Effect of dowel preparation on the apical seal of endodontically treated teeth. J Endod 1980:6:687.

83. Shillingburg HT, Kessler JC, Wilson EL. Root dimensions and dowel size. CDA J. 1982;10:43

84. Assif D, Bitenski A, Pilo R, Oren E. Effect of post design on resistance to fracture of endodontically treated teeth with complete crowns. J Prosthet Dent. 1993 Jan;69(1):36_40.

85. Toksavul S, Toman M, Uyulgan B, Schmage P, Nergiz I. Effect of luting agents and reconstruction techniques on the fracture resistance of pre-fabricated post systems. J Oral Rehabil. 2005;32:433e440.

86. Fredriksson M, et al ,A retrospective study of 236 patient with teeth restoredby carbon fibre re inforced epoxy resin posts. J.prosthet Dent 1998:80 :151 _ 7.

87. Abo El-Ela OA, Atta OA, El-Mowafy O. Fracture resistance of anterior teeth restored with a novel nonmetallic post. Journal (Canadian Dental Association). 2008; 74(5):441.

88. Dayalan M, Jairaj A, Nagaraj K, Savadi RC. An evaluation of fracture strength of zirconium oxide posts fabricated using CAD-CAM technology compared with prefabricated glass fibre posts. The Journal of Indian Prosthodontic Society. 2010; 10(4):213-8.

89. Suneel V Vadavadagi et al Comparison of Different Post Systems for Fracture Resistance: Journal of Contemporary Dental Practice, March 2017;18(3):205-208

90. Goel G Varghese et al . Fracture Resistance of Glass Fiber, Carbon and Zirconia Posts in Endodontically Treated Teeth: A Comparative Study. Res Adv Dent 2019;10:1:67-70.

91. Anamika Thakur, Sathyanarayanan Ramarao. A comparative evaluation of fracture resistance of endodontically treated premolar teeth reinforced with different prefabricated and custom-made fiber-reinforced post system with two different post lengths: J of Conservative Dent 2019.

92. C han FW, Harcourt JK, Brockhurst PJ. The effect of post adaptation in the root canal on retention of posts cemented with various cements. Australian dental journal. 1993; 38(1):39-45. |

93. Shivaughn Marchan et al . Retention of zironia based ceramic post luted with glass ionmer and resin cement .Braz. Dent .J.16 (3).Dec 2005.

94. Cohen BI, Pagnillo MK, Newman I. Retention of three endodontic posts cemented with five dentinal cements. J Prosthet Dent. 1998;79:520e525.

95. Anusavice KJ. Phillips" Science of Dental Materials. 11th ed. St. Louis: Elsevier; 2003:93e94. 598- 603.

ANNEXURE I

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 Various Prefabricated Post & Core System Using Different Luting Agents: An *In Vitro* Study."** submitted by **Dr. Anamika Kumari** Post graduate student from the **Department of Conservative Dentistry and Endodontics** 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

ANNEXURE II

Babu Banarasi Das University
Babu Banarasi Das College of Dental Sciences,
BBD City, Faizabad Road, Lucknow – 226028 (INDIA)

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

Communication of the Decision of the VII[th] Institutional Ethics Sub-Committee

IEC Code: 33 **BBDCODS/01/2019**

Title of the Project: Comparative Evaluation of Fracture Resistance of Various Prefabricated Post & Core System Using Different Luting Agents: An *In Vitro* Study.

Principal Investigator: Dr. Anamika Kumari **Department:** Conservative Dentistry & Endodontics

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

Type of Submission: New, MDS Project Protocol

Dear Dr. Anamika Kumari,

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

Forwarded by:

Lakshmi Bala
22/01/19

(Dr. Lakshmi Bala)
Member-Secretary
IEC

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

(Dr. B. Rajkumar)
Principal
BBDCODS

PRINCIPAL
Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow

ANNEXURE III

सिपेट : इंस्टीट्यूट ऑफ प्लास्टिक्स टेक्नोलॉजी (आई.पी.टी.)
रसायन एवं पेट्रोरसायन विभाग,
रसायन एवं उर्वरक मंत्रालय, भारत सरकार
बी-२७, अमौसी इण्डस्ट्रियल एरिया, लखनऊ-२२६ ००८
फोन : +९१-५२२-२४३६२२७, ७६०७१९४०१४
E-mail: cipetlko2@gmail.com
www.cipet.gov.in

CIPET सि पे ट
probe • perform • practice • Plastics

स्वच्छ भारत
एक कदम स्वच्छता की ओर

CIPET : INSTITUTE OF PLASTICS TECHNOLOGY (IPT)
Deptt. of Chemicals & Petrochemicals
Ministry of Chemicals & Fertilizers, Govt. of India
B-27, Amausi Industrial Area, Lucknow-226 008
Phone : 0522- 2436227, 7607194014
E-mail: cipetlko2@gmail.com
www.cipet.gov.in

Certificate No.CON – 012
Date: 23.11.2020

Issued to:
Dr. Anamika Kumari
MDS Studen in Department of
Conservative Dentistry & Endodontics,
Babu Banarasi Das University,
BBD City, Faizabad Road,
Lucknow- 226 028 (U.P.), India

Page No 1 of 2

CERTIFICATE

PART-A

PARTICULARS OF SAMPLE SUBMITTED

Sample details	:	**Dental sample** as stated by the party Your Ref. No. : BBDCODS/Gen-Corres/2020 Date : 18.11.2020
Size/Class	:	--
Quantity of samples	:	07 Nos. group in each code
Code No.	:	---
Date of Manufacturing	:	---
Condition of receipt of sample	:	---
Sealed or not	:	Not sealed
Date of sample received	:	20.11.2020
Any other details	:	Payment received on 18.11.2020

Note: 1. This Certificate, in full or part, shall not be published, advertised, used for any legal action, unless prior permission has been secured.
2. This Certificate is only for the sample tested.

PART-B

SUPPLEMENTRY INFORMATIONS

a)	Reference to sampling procedure wherever applicable	:	Supplied by the party
b)	Supporting documents for the measurements taken and Results derived like graphs, tables, sketches and/or Photographs as appropriate to test report, if any (to be attached).	:	Nil
c)	Deviation from the test methods as prescribed in Relevant work instruction, if any	:	Nil

Contd….2/-

ANNEXURE IV

Formula used for the analysis

Arithmetic Mean

The most widely used measure of central tendency is arithmetic mean, usually referred to simply as the mean, calculated as

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

Standard deviation and standard error

The standard deviation (SD) is the positive square root of the variance, and calculated as

$$SD = \sqrt{\frac{\sum X_i^2 - \frac{(\sum X_i)^2}{n}}{n-1}}$$

and SE (standard error of the mean) is calculated as

$$SE = \frac{SD}{\sqrt{n}}$$

where, n= no. of observations

Minimum and Maximum

Minimum and maximum are the minimum and maximum values respectively in the measure data and range may be dented as

Range = Min to Max or Min-Max

and also evaluated by subtracting minimum value from maximum value as

Range = Maximum value-Minimum value

Median

The median is generally defined as the middle measurement in an ordered set of data. That is, there are just as many observations larger than the median as there are smaller. The median (M) of a sample of data may be found by first arranging the measurements in order of magnitude (preferably ascending). For even and odd number of measurements, the median is evaluated as

M= $[(n+1)/2]^{th}$ observation- odd number

M= $[n(n+1)/2]^{th}$ observation – even number

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 4istribution 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.

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

where,

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

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

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.

Chi-square test

The chi-square (χ^2) test is used to compare the categorical data as

$$\chi^2 = \Sigma\Sigma \frac{(Fij - fij)^2}{fij}$$

where, Fij is the observed frequency while fij the expected frequency. The degrees of freedom (DF) is calculated as

DF= (r-1) (c-1)

Statistical significance

Level of significance "*P*" is the probability signifies level of significance. The mentioned p in the text indicates the following:

$P > 0.05$ -Not significant (ns)

$P < 0.05$- Just significant (*)

$P < 0.01$- Moderate significant (**)

$P < 0.001$- Highly significant (***)

ANNEXURE V

	Group	Sample size	Fracture resistance (Newton)
Control group	Group 1	1	230.8
		2	104
		3	69.81
		4	73.36
		5	66.43
		6	111
		7	66
		8	83
		9	92.5
		10	71.6
Carbon fibre post with resin cement	Group 2	1	102.9
		2	204.7
		3	210.3
		4	198.2
		5	220.3
		6	107.8
		7	207.9
		8	211.6
		9	190.3
		10	149.2
Carbon fibre post with glass ionomer cement	Group 3	1	152.8
		2	224.3
		3	180.1
		4	163.4
		5	179.6
		6	155.7
		7	170.9
		8	203.4
		9	210.2
		10	192.3
Glass fibre post with resin cement	Group 4	1	221.5

		2	291
		3	293.2
		4	301.3
		5	295.4
		6	270.3
		7	275.2
		8	230.5
		9	245.4
		10	297.6
Glass fibre post with glass ionomer cement	Group 5	1	129.3
		2	106.9
		3	130.2
		4	138.1
		5	125.2
		6	108.3
		7	134.9
		8	112.9
		9	137.9
		10	128.8
Zirconia fibre post with resin cement	Group 6	1	242.9
		2	277.8
		3	201.4
		4	211.1
		5	207.6
		6	233.9
		7	254.4
		8	263.6
		9	225.4
		10	239.6
Zirconia fibre post with glass ionomer cement	Group 7	1	123.2
		2	75.4
		3	89.9
		4	103.8
		5	92.7
		6	121.9
		7	109.3
		8	89.4
		9	97.3
		10	120.4

ANNEXURE VI

URKUND

Urkund Analysis Result

Analysed Document: thesis palagrism final (1).docx (D110223494)
Submitted: 7/7/2021 5:21:00 AM
Submitted By: 1180322001@bbdu.ac.in
Significance: 7 %

Sources included in the report:

theisis chetna.docx (D109879015)
https://www.ecronicon.com/ecde/pdf/ECDE-19-01362.pdf
https://1library.net/document/qm0xlp4y-comparative-evaluation-fracture-resistance-endodontically-restored-different-different.html
http://www.gmj.ir/index.php/gmj/article/view/113/html_32
https://www.researchgate.net/publication/11359446_Resistance_to_fracture_of_Endodontically_treated_teeth_restored_with_different_post_systems
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4306975/
https://www.ijsr.net/archive/v7i2/ART20178982.pdf

Instances where selected sources appear:

23