A COMPARATIVE EVALUATION OF FRACTURE RESISTANCE OF CUSTOMIZED 3D PRINTED POST AND CASTABLE METAL POST WITH UNIVERSAL TESTING MACHINE AND THEIR ADAPTATION WITH CBCT : AN IN-VITRO STUDY.

DISSERTATION

Submitted to the

BABU BANARASI DAS UNIVERSITY, LUCKNOW, UTTAR PRADESH

In the partial fulfillment of the requirement for the degree

Of

MASTER OF DENTAL SURGERY

In the subject of

CONSERVATIVE DENTISTRY AND ENDODONTICS

Submitted by

Dr. LAXMI PANDEY

Under the guidance of

Dr. AKANKSHA BHATT

DEPARTMENT OF CONSERVATIVE DENTISTRY AND ENDODONTICS

BABU BANARSI DAS COLLEGE OF DENTAL SCIENCES, LUCKNOW

Batch: 2020-2023

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DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled "**A Comparative Evaluation Of Fracture Resistance Of Customized 3d Printed Post And Castable Metal Post With Universal Testing Machine And Their Adaptation With Cbct : An In-Vitro Study.**" is a bonafide and genuine research work carried out by me under the guidance of **Dr. Akanksha Bhatt**, Reader, Department of Conservative Dentistry & Endodontics, Babu Banarasi Das College of Dental Sciences, Babu Banarasi Das University, Lucknow, Uttar Pradesh.

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CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **A Comparative Evaluation Of Fracture Resistance Of Customized 3d Printed Post And Castable Metal Post With Universal Testing Machine And Their Adaptation With Cbct : An In-Vitro Study.**" is a bonafide work done by **Dr Laxmi Pandey**, under our direct supervision & guidance in partial fulfillment of the requirement for the degree of **Master of Dental Surgery** (M.D.S.) in the speciality of Conservative Dentistry and Endodontics.

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CERTIFICATE BY THE CO-GUIDE

This is to certify that the dissertation entitled **A Comparative Evaluation Of Fracture Resistance Of Customized 3d Printed Post And Castable Metal Post With Universal Testing Machine And Their Adaptation With Cbct : An In-Vitro Study.**" is a bonafide work done by **Dr Laxmi Pandey**, under our direct supervision & guidance in partial fulfillment of the requirement for the degree of **Master of Dental Surgery** (M.D.S.) in the speciality of Conservative Dentistry and Endodontics.

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ENDORSEMENT BY THE HEAD OF THE INSTITUTE

This is to certify that this dissertation entitled "**A Comparative Evaluation Of Fracture Resistance Of Customized 3d Printed Post And Castable Metal Post With Universal Testing Machine And Their Adaptation With Cbct : An In-Vitro Study.**" is a bonafide work done by **Dr.Laxmi Pandey**, under the direct supervision & guidance of **Dr. Akanksha Bhatt, Reader**, Department of Conservative Dentistry & Endodontics, Babu Banarasi Das College of Dental Sciences, Babu Banarasi Das University, Lucknow, Uttar Pradesh.

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Signature of the candidate

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"The most important function of education at any level is to develop the personality of the individual and the significance of his life to himself and to others''

At the very start, I bow my head to the Almighty GOD, who blessed me with his

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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.

Dr. Laxmi Pandey

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LIST OF ABBREVIATION

S.N0	Abbreviation	Full form
1	CEJ	Cemento enamel junction
2	CBCT	Cone beam computer tomography
3	3D	Three-dimensional printing
4	GIC	Glass ionomer cement
5	BMA	Base metal alloy

ABSTRACT

Aim: The aim of this study is to compare Comparative evaluation of fracture resistance of customized 3d printed post and castable metal post with universal testing machine and their adaptation with CBCT: an in- vitro study.

Methodology: A total of 40 human mandibular premolars indicated for orthodontic extraction will be subjected to root canal treatment and collected for in vitro study and stored in normal saline at room temperature (24-28°C). Biomechanical preparation, followed by the obturation will be carried out on all the specimens. The selected teeth will randomly be assigned into two experimental groups with twenty in each group (Group A: Castable metal post, Group B: 3D printed post) The samples will be decoronated at cemento-enamel junction and post space will be prepared. Post space preparation will be done by removing the gutta-percha with peeso-reamer and leaving 5 mm of gutta-percha apically. In group A: Castable metal post will be fabricated. In group B: CBCT imaging will be performed to see the post space, and a customized 3D post will be reconstructed and printed. Selected posts will cemented with dual cure resin cement. Post-operative CBCT imaging will be performed for all the samples of Group A and B for evaluation of voids around the post. All specimens will then be mounted on the acrylic block, and subjected to the compressive force at 1 mm diameter using Instron Universal Testing Machine. The force at fracture was measured in Mpa.

Results: The mean fracture load was higher in the castable post as compared to 3D printed post and less voids and amount of space in 3d printed post as compare to castable post.

Conclusion: this **study shows castable post has higher fracture resistance as compare to 3D printed and voids and amount of space is less in 3D printed post as compare to castable post.**

INTRODUCTION

Endodontically treated teeth presence a very high risk of biomechanical failure due to the loss of tooth structure resultant on access opening cases, dehydration and alteration of mechanical, chemical and physical characteristics. The restoration of endodontically treated teeth is a critical step in successful root canal treatment. Reconstruction of endodontically treated teeth is often necessary before the final restoration is placed, especially when the remaining coronal tooth structure is not adequate enough to provide retention and resistance for the final restoration. When there is a loss of large amount of clinical crown due to damage, it is often impossible to achieve sufficient anchorage of a restoration in the remaining dentin. In such situations, a root-canal-retained restoration is required. Hence, posts are indicated for endodontically treated teeth that are highly susceptible to fracture because of their insufficient coronal tooth structure.

Endodontically treated teeth have been reported to be more susceptible to fracture when compared to vital teeth. This necessitates adequate protection of remaining tooth structure by proper restoration protocols. Excessive tooth structure removal during endodontic therapy and subsequent dehydration of both coronal and radicular dentin are principal factors which have been responsible for affecting the fracture resistance of restored tooth structure after completion of endodontic treatment procedure. The remaining dentin in a endodontically treated tooth should be preserved as resistance to fracture depends primarily on remaining root dentin thickness, especially in the buccolingual direction. (Sedgley and Messer in 1992)[1]

A number of reasons have been put forward for the tooth being susceptible for fracture of root structure. This includes loss of tooth structure due to caries or trauma, excessive removal of tooth structure during root canal preparation, the dehydration of dentin subsequent to endodontic treatment, excessive radicular dentinal structural loss during post space preparation, creation of excessive stress during obturation and increased use of higher concentration of irrigants with prolonged exposure times. This in a clinical situation would mean a reduction in the

long term survival rate, which is undesirable. The achievable target of endodontic therapy should be reinforcement of the residual tooth structure in such a way that it prevents untoward events in the long term.

The anatomy of the root canal system and its variations, curvature of the roots especially in posterior teeth pose a challenge to the clinician during preparation of the root canal space, irrigant delivery, replacement and debridement in the apical one third. In the case of curved canals this becomes even more difficult where in order to access the apical third of the canal system and to achieve sufficient cleansing and debridement, a considerable amount of dentin in the coronal and middle third of the root is removed which weakens the root structure and decreases fracture resistance.[2]

The cast post and core method of post endodontic reconstruction has been traditionally used and can be considered as gold standard. This technique has its own limitations. There is a greater removal of radicular dentinal structure, need for multiple clinical leading to more turnover time and has a elastic modulus which is high compared to tooth structure. (200 Gpa) which can lead to fractures. (SarkisOnofre R et al in 2014)[3]

3D printed castable post is indicated when there is extensive loss of tooth structure, wide, non-circular or extremely tapered canal. The 3D printing technologies can quickly accept CAD data moreover, it can rapidly manufacturer single and small batch parts new samples, complex shapes products. The main advantage of 3D printing is that it can be tailor made to the shapes of the root canal, high material utilization, adaptation, accuracy, high economic benefits, high precision and personal customization and the production of certain scale products on demand. However, it still has several disadvantages such as high cost of processing and the processing of 3D materials is still controversial, Nowdays three dimensionally (3D) printing technology and the industry developed many manufacturing technologies, which have been numerous field. With this technique complex 3D components produced from 3D data. 3D printing technologies restoration was generally fabricated by milling. Currently 3D printed restorations have shown that edge and internal gap values of 3D printing restoration are significantly lower than those of milling

restoration. A castable metal post advantage of conforming closely to the configuration of the prepared canal.

The optimum length of post for restoration of the endodontically treated tooth using a particular type of post remains a controversial topic due to factors such as availability of wide range of post core systems, differences in physical properties of posts, and differences in study design comparing various length of posts. In analysis of Prosthodontics and endodontics literature reveals various guidelines regarding the optimum length of posts for the restoration of the endodontically treated tooth.

"While Rosen, Kafalias and Goldrich" proposed that the length of the posts should be equal to the length of the clinical crown[4],

Weinberg advocated that the post length of two third of the radicular length is the most favorable for the longevity of post –core treated teeth.[5]

A literature review by Goodacre and spolnik indicates that the post length equal to three fourth of the rooth canal length or at least equal to the length of the crown leaving 4 mm of gutta percha is a commonly followed clinical guideline for post – core restorations.[6]

Brega et al says if neither goal can be reached, the post must extend at least half of the root length.[7] It should be noted however that these recommendations were applicable to metal post may not suitable for adhesively retained other posts also.

Adaption of the posts with wide variety of materials being introduced with advanced technology, an adapation of the post is one of the important aspects to be taken into consideration.

Adaption is defined as the degree of fitting between the prosthesis and supporting structure[8] A poorly adapted posts might create levers within the root canal, making the tooth more susceptible to fracture. When increase the stress within the root and increases the chances of failure. A poorly adapted post will create a marginal gap in which the presence of insufficient cementation can lead to microleakage and prolong leakage will cause the separation of the post from the root canal and eventually lead

to common failures of the post –core systems. Oral fluid, bacterial toxin and all kind of ions that penetrate through the interfacial space between the restoration and the tooth may lead to marginal discoloration secondary caries and marginal fracture.

A posts passive retention is improved when it adapts properly into the prepared post space and if the luting agent is thin and even, a thin layer of cement instead of different amount of luting agents surrounding the customized post helps to limit stress concentration in the root canal.

The cement dentine interface is the site at which decementation generally occurs due to the bubbles and pore that form due to curing stress, therefore a well-adapted post that fits the root canal shape can reduce the risk of debonding which I subsequently leading to failure of the post.

When post a post not adopted well, a gap or space will be created in the canal which will become a harbouring place for bacterial infection. Despite having good apical seal from remaning gutta percha, bacteria from the coronal portion can spread through it, it may take only a few days for bacteria to pass the apical area.

In 1986, Charles Hull introduced the first three –dimensional (3D) Printing technology and the industry developed many different manufacturing technologies, which have been applied to numerous fields. In 1986, Hull patented stereolithography (SLA) and built and developed a 3D printing system.[9] In 1990, Scott Crump received a patent for fused deposition modeling (FDM). Since then, 3D printing has been increasingly progressing.

Three-dimensional printing, the alias of additive manufacturing, is an advanced manufacturing technology. It is based on computer-aided design (CAD) digital models, using standardized materials to create personalized 3D objects through specific automatic processes. It is used for rapid prototyping, which has been widely used in industry, design, engineering, and manufacturing fields for nearly 30 years. With the rapid development of new materials, printing technologies, and machines, 3D printing is likely to completely change the traditional teaching and experimental models.

In the field of dentistry, its applications range from prosthodontics, oral and maxillofacial surgery, and oral implantology to orthodontics, endodontics, and periodontology. The applications of 3D printing in dentistry can assist in providing patients with lower cost and more personalized services and simplify the complex workflow related to the production of dental appliances. For example, before the popularization of 3- printing technologies, the restoration was generally fabricated by milling. Currently, 3D-printed restorations have shown several advantages. Some studies have shown that the edge and internal gap values of 3D printing restorations are significantly lower than those of milling restoration. For example, dental crowns are generally fabricated from traditional plaster models, and currently, dental crowns fabricated from 3D printing models are also popular.

Cone beam computed tomography (CBCT) has recently introduced three-dimensional (3D) imaging into dentistry and brought benefits to specialties that had not yet enjoyed the advantages of medical CT due to its lack of specificity. Computerized tomography (CT) is an important, nondestructive and noninvasive diagnostic imaging tool. CBCT produces 3D images of a structure because it adds a new plane: depth. Its clinical application ensures high accuracy and is useful in nearly all areas of dentistry.

The main purpose of the study is to determine a post and core system that has better adaptation to the canal configuration and to evaluate the fracture resistance offered by customized 3D printed post in comparison to castable metal post.

AIM OF THE STUDY

To evaluate fracture resistance of customized 3D printed post and castable metal post with universal testing machine and their adaptation with CBCT.

OBJECTIVES

- To evaluate fracture resistance of customized 3D printed post through Universal testing machine.
- To evaluate fracture resistance of Castable metal post through Univeral machine.
- To evaluate the voids and amount of space around customized 3D printed post inside the root through CBCT.
- To evaluate the voids and amount of space around castable metal post inside the root through CBCT.
- To compare the fracture resistance of customized 3D printed post and castable metal post through universal testing machine.
- To compare the voids and amount of space around customized 3D printed post and castable metal post through CBCT.

REVIEW OF LITERATURE

1. Raygot C G et al (2001)[10] evaluated the fracture resistance and mode of fracture of endodontically treated incisors restored with cast post and-core, prefabricated stainless steel post, or carbon fiber –reinforced composite post systems. Their results suggested the use of carbon fiber–reinforced composite posts did not change the fracture resistance or the failure mode of endodontically treated central incisors compared to the use of metallic posts.

2. Camarinha S.M.L.B,Pardini L.C, Garcia S.C, Pires-desouza F.D.C.P(2009)[11]conducted a study to evaluate adaptation of cast metal cores using two impression materials and two intracanal impression techniques. Intracanal impression were obtained with addition silicon and condensation silicon material using two intraradicular supports The intracanal impression technique using hypodermic needle allowed a more accurate reproduction of the prepared canal space and provided significantly better cast metal core adaption when the cores were obtained from addition silicone impression.

3. Makade C.S, Meshram G.K, Warhadpande M, Patil P.K.G(2011)[12] Conducted a study to compare the fracture resistance and the mode of failure of endodontically treated teeth restored with different post-core system. Three experimental group and one control group. All the samples were prepared for ideal abutment preparation. Endodontically treated teeth without post cores system showed the least fracture resistance. Stainless steel post with composite core showed the highest fracture resistance among all the experimental group.

4. Omrani R, Yassini E, Mirzaei M, Abbasi M, et al(2012)[13]
Conducted a study Laboratory assessment of fracture resistance of endodontically treated teeth restored with three different post and core systems . 36 human premolars were divided into three groups; namely, group 1 non precious cast post and core, group 2 prefabricated metal post with amalgam core, group 3 FRC post and composite core. All groups received crowning. The mean failure load for the three

groups was 794, 647 and 724 N, respectively. This type of post and core does not have a significant effect on the fracture resistance, but it has a significant effect on the failure mode.

5**. Shukri B.M, Al-Zaka M.I, Mustafa A.S, Jamal Aziz M (2012)**[14] evaluated the fracture resistance of two types of post materials and two types of core material. Forty extracted human mandibular premolar were selected. After root canal preparation and obturation with gutta percha the roots were divided into two groups according to the type of post material, group F restored with fiber post and group T restored with titanium post then each group was subdivided into two subgroup according to the type of core materials which include composite and amalgam restorative materials. Then all the teeth were subjected to compressive load at 130o angle from the horizontal plan at a 5mm/min crosshead speed until fracture. Results showed that there was significant different between groups in term of fracture loads (P= 0.0156). Also the fracture loads of teeth restored with titanium post and composite core has highest mean fracture load (812N), whereas teeth restored with fiber post and amalgam core demonstrated the lowest mean fracture load (643.1N). The study concluded that the teeth restored with metal titanium post were more fracture resistant than those restored with fiber posts. But the combination of a fiber post and composite core has the favorable mode of fracture that considered reparable, while considered unfavorable when restored with titanium post.

6. Pereira J.R, Neto E.M.R, Pamato S. et.al(2013)[15] conducted a study to compared the resistance to fracture of endodontically treated teeth restored with different intraradicular posts with different lengths and full coverage metallic crowns. Sixty extracted human canine teeth were randomly divided into 6 groups. The specimens were submitted to dynamic cyclic loading and those that resisted to this load were submitted to load compression using a universal testing machine. Compressive load was applied at a 45-degree angle to the long axis of the tooth until failure. This study showed that increasing intraradicular post length also increases resistance to fracture of endodontically treated teeth. On the other hand, most

endodontically treated teeth restored with pre-fabricated tin posts (provisional posts) failed in the dynamic cycling test.

7. Singh S, Thareja P (2014)[16] evaluated the fracture resistance of endodontically treated maxillary central incisor with varying ferrule height and configurations. 40 maxillary central incisor were collected. Teeth were allocated into following four groups of each having 10 teeth. Crown prepration were perform with varying ferrule heights. Endodontically treated maxillary central incisor with a uniform 2mm ferrule were more fracture resistance than those with a uniform 1mm ferrule.

8. Singh V, Bogra P ,Gupta S, Kukreja N, Gupta N (2015)[17] conducted a study to compare the fracture resistance of endodontically treated teeth restored with resin fiber and stainless steel post. Post), prefabricated stainless steel post (Coltene/Whaledent Parapost) were used. Forty-five maxillary central incisors were obturated and divided into 3 groups: Control Group (Group I) without any post (n = 15), Resin Fiber Post Group (Group II) (n = 15) and Stainless Steel Post Group (Group III) (n = 15). In all Groups except control group, post space was prepared; a post was cemented, and a core build-up was provided. Teeth restored with resin fiber post showed higher fracture resistance values than prefabricated stainless steel post.

9.Sonkesriya S, Olekar T.S, Saravanan V, Somasunderam P,Chauhan R.S, Chaurasia R.V(2015)[18] evaluated the fracture resistance of custom made, metal glass fiber reinforced and carbon reinforced posts in endodontically treated The fracture resistance to the compressive force of sample was measured using universal testing machine. The carbon reinforced fiber post and glass fiber posts showed good fracture resistance compared to custom made and metal post.

10.**Muttlib N.A.A**, **Azman A.N.P, Seng Y.T, Alawi R, Ariffin Z (2016)[8]**conducted a study to evaluate intracanal adaptation of a fiber reinforced post system as compared to a cast post and core. The length of the Cast post core was measured from the coronal part of the apical seal up to the coronal opening with

additional 2mm. there was no significant difference in adaption between the conventional cast post and core and fiber reinforced composite posts.

11. Saritha M.K, Pauf U, Keswani K, Jhamb A, Mhatre S.H, Sahoo K.P (2017)[19] conducted a study to evaluate Comparative evolution of fracture resistance of different post systems. A compressive load was applied using universal testing machine and fracture force was measured in MPa. The study concluded that zirconia had good fracture resistance compared to glass fiber carbon post.

12. Sampaio C, Atria P, Coelho P, Hirata R(2017)[20] this study was to evaluate and quantify void and gap area formations of different fiber post cementation techniques using microcomputed tomography (mCT). 4 groups (n=6) according to different fiber posts cemented with the resin cement (FB), fiber posts relined with composite resin followed by cementation (FBR), fiber posts cemented using an ultrasonic device (FBU), and fiber posts relined with composite resin and cemented using an ultrasonic device (FBRU). Each specimen was scanned twice using micro-computed tomography. Digital imaging and communications in medicine (DICOM) files were transferred into 3-dimensional (3D) reconstruction software for analysis. The use of a composite resin to reline the fiber post significantly decreased the void formation in the cementation procedure when no ultrasonic device was used.

13. Denis R, Spina F, et.al(2017)[21] to evaluate the fracture resistance of custom – made CAD/CAM post and cores manufactured with different aesthetic materials. the specimens were randomly divided into three equal groups according to the material: hybrid ceramic Vita Enamic (HC); nano-ceramic resin composite Lava Ultimate (RC); and experimental epoxy-resin reinforced by glass-fibre (FG). The post-and-cores were manufactured using CAD/CAM and cemented using a self-adhesive resin cement (Rely X Unicem2). A subgroup of 30 specimens (n=10) was subjected to fatigue (1,000,000 cycles at 5 Hz) and then to the FR test. CAD/CAM custom-made esthetic

post-and-cores showed good performance relative to fracture resistance and bond strength to root canal dentin walls.

14.Barcellous R.R, Correia D.P.D, Farina A.P,(2018) [22] Conducted a study Fracture resistance of endodontically treated teeth restored with intra-radicular post: the effects of post system and dentine thickness. Seventy upper canine teeth were divided into seven groups (n=10), one control (sound teeth) and six experimental groups resulting from the interaction between the two study factors: post system (FB, fiber post; FPC, fiber post relined with resin composite; CPC, cast Ni-Cr alloy post and core) and amount of remaining root tooth tissue (2 or 1mm of thick root). All teeth were restored with metal crowns and exposed to 250,000 cycles in a controlled chewing simulator. Roots restored with FPC had the highest fracture strength of the experimental groups, being statistically similar to the intact teeth group ($P>0.05$). FP and CPC did not differ statistically ($P>0.05$) and were statistically lower than those of FPC ($P<0.05$).

15. Fráter M, Lassila L, Braunitzer G, Pekka K. Vallittu, Garoushi S(2019)[23] Conducted a study to evaluate Fracture resistance and marginal gap formation of post-core restorations: influence of different fiber-reinforced composites. Eighty-seven intact upper premolars were collected and randomly divided into six groups. After endodontic procedure, standard MOD cavities were prepared and restored with their respective fiber-reinforced post-core materials: group 1: prefabricated unidirectional FRC-post + conventional composite core; group 2: prefabricated unidirectional FRC-post + short fiber composite (SFRC) core; group 3: individually formed unidirectional FRC-post + conventional composite core; group 4: randomly oriented SFRC directly layered as post and core; group 5: individually formed unidirectional FRC + randomly oriented SFRC as post and core. SFRC application in the root canal (groups 4 and 5) showed significantly higher fracture load (876.7 N) compared to the other tested groups (512–613 N) ($p < 0.05$). Post/core restorations made from prefabricated FRC-post (group 1) exhibited the highest number of microgaps (35.1%) at the examined interphase in the root canal.

16. Palepwad A.B, Kulkarni R. S,(2020)[24] Conducted a study to compared to fracture resistance of zirconia, glass-fiber, and cast metal post with different lengths. The teeth were restored with one of the three post : CP, GFP, or ZPs with intraradicular length of either 6 or 8 mm (n=10) . the highest and lowest values of fracture resistance were reported with ZP8 and GFP6 respectively.

17. Jafarian Z, Mohrammi M, Sahebi M, Alikhasi M(2020)[25] conducted a study to compare the adaptation of conventionally cast post and cores to digitally milled counterparts in round and oval shaped canal and to evaluate the retention of the milled posts. One cast post and one milled post were fabricated for each of 26 selected teeth, which had either round or oval shaped canals. The apical gap was evaluated with radiography and coronal gap was evaluated by stereolithographic models. Conventionally cast post and cores revealed significantly better adaptation compared to milled group.

18. Eid R, Tribst J.P.M, Ozcan J.J.M(2021)[26]conducted a study to evaluate the effect of material types on the fracture resistance of maxillary central incisor restored with CAD/CAM post and core. post and cores were fabricated using the following materials fiberreinforced composite high density polymer, polymer infiltered ceramic network and nonprecious metal alloy as a control group the tested post and cores have comparable fracture resistance to that of metallic cast post and cores in the anterior region.

19. Bhaktikamala A, Chengprapakorn W, Serichetaphongse P(2022)[27] conducted a study to evaluate the Effect of Different Post Materials and Adaptability on Fracture Resistance and Fracture Mode in Human Endodontically Treated Teeth. Sixty extracted human mandibular premolars were selected and divided into 6 groups (n 10) according to the restorative method after endodontic treatment: no ferrule presented and restored without fiber post (Group C), 2.0 mm ferrule presented and restored without fber post (Group CF), restored with D.T. Light-Post (Group PDT), restored with anatomically customized D.T. Light-Post, relined with

resin composite (Group ADT), restored with Hi-Rem prosthetic post (Group PHR), and restored with anatomically customized Hi-Rem prosthetic post, relined with resin composite (Group AHR). customized posts presented highest fracture resistance among all groups. • ere was no significant difference in fracture mode across all groups.

20. Dasi G, Muhamaad H.R, Khan S.A, Chaudhary M.A.G,(2022)[28] a study to evaluate the assessment of Fracture Resistance of PEEK and Fibre Posts of the Endodontically Treated Teeth. Two main groups (n=20/group): group 1, (PEEK); group 2, fibre post. PEEK post was manufactured with a computer-aided design/computer-aided manufacturing system further divided into four sub groups (P7, P12, F7, F12) based on lengths 7 and 12 mm at which the posts were cemented. the fracture resistance of these post-and-cores was comparable to that of fiber posts customized with a nanohybrid resin composite and lower than that of PEEK posts.

21. Faisal D al-Qarni (2022)[29] A total of twenty-two manuscripts were selected for analysis, of which fourtee Materials used for manufacturing posts and cores are categorized as metallic or non-metallic. Custom cast post and cores are made from gold alloys, such as type III and type IV, silver-palladium, or base metal alloys. Given the high success rate, favorable mechanical properties, and ease of fabrication, the cast gold post and cores are considered superior to other material were in-vitro studies, four were technical articles, and four were clinical reports. With increasing evidence of success with CAD/CAM customized post and cores, this approach can be considered as an alternative to conventional techniques. Although these post and core restorations offer good fracture resistance, bond strength, adaptation, and superior aesthetics.

22. Gutie´rrez M A, Guerrero C .A, Baldion P.A(2022)[30] conducted a study to to compare the comparative efficacy of computer-aided design (CAD) and computer-aided manufacturing (CAM) glass fiber posts with prefabricated and metal cast posts for the restoration of endodontically treated teeth (ETT). No significant differences were found in fracture resistance between prefabricated and CAD/CAM glass fiber posts or between CAD/CAM glass fiber and metal cast posts, although the

latter demonstrated higher fracture resistance than the prefabricated glass fiber posts. Restoration with a full crown was not necessary to increase the fracture resistance in the presence of the ferrule effect. CAD/CAM glass fiber and metal cast posts had higher bond strength, lower nanoleakage, and better adaptation to the root canal. The results of these studies indicated that the CAD/CAM glass fiber and metal cast posts showed greater efficacy in terms of fracture resistance, retention, and adaptation, compared to prefabricated glass fiber posts.

23.Bhaktikamala A, Chengprapakorn W, Serichetaphongse P (2022)[31] conducted a study to investigate the effect of dierent post materials and adaptability on fracture resistance and fracture mode of endodontically treated teeth. Sixty extracted human mandibular premolars were selected and divided into 6 groups (n 10) according to the restorative method after endodontic treatment: no ferrule presented and restored without ˆ ber post (Group C), 2.0 mm ferrule presented and restored without ˆ ber post (Group CF), restored with D.T. Light-Post (Group PDT), restored with anatomically customized D.T. Light-Post, relined with resin composite (Group ADT), restored with Hi-Rem prosthetic post (Group PHR), and restored with anatomically customized Hi-Rem prosthetic post, relined with resin composite (Group AHR). After restoring with core build-up materials, all specimens were loaded at 45° in a universal testing machine until failure. Visual inspection of all specimens for fracture modes was performed. Anatomically customized posts presented highest fracture resistance among all groups. there was no significant deference in fracture mode across all groups.

MATERIALS & METHOD

The present in-vitro study was conducted in the Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Sciences, Lucknow in Collaboration with Central Institute Of Plastic Engineering And Technology, Lucknow.

Study Subjects:

Fourty single rooted permanent human mandibular premolar teeth.

TABLE-1 MATERIALS AND ARMAMENTARIUM

S.N0	Materials & Armamentarium	Manufacture
1.	Ultrasonic Scaler with tips	Coltene, Switzerland
2.	Explorer	API, India
3.	Normal saline	Aculife, India
4.	Airotor hand piece	NSK India
5.	Micromotor (Slow speed)	Marathon, India
6.	Endo acces bur (2)	Denstply Maillefer, Ballaigues
7.	DG-16	API, India
8.	Tapered fissures bur	Denstply Maillefer, Ballaigues
9.	K-files (ISO #6,8,10,15,20,25)	Denstply Maillefer, Ballaigues

10.	**Hyflex CM**	**Coltene, Switzerland**
11.	**Sodium hypochlorite3%**	**Pyrax India**
12.	**Endomotor**	**Denstply Maillefer, Ballaigues**
13.	**Gutta percha**	**Denstply Maillefer, Ballaigues**
14.	**AH Plus sealer**	**Denstply Maillefer, Ballaigues**

2) For Post Space Preparation, Placement And testing

1.	**Peesoreamer(1,2,3)**	**Denstply Maillefer, Ballaigues**
2.	**CBCT Machine**	**Acteon. Japan**
3.	**Base metal alloy**	**I Bond 02, India**
4.	**Resin**	**Phrozen Aqua grey**
5.	**Silicone impression material**	**Zeta plus, Turkey**
6.	**Cold cure acrylic resin**	**DPI, India**
7.	**Digital calliper**	**Hoover, India**
8.	**Glass inomer cement**	**GC India**
9.	**Universal testing machine**	**Instron Industries, USA**

Sample preparation

A total of 40 single rooted permanent human mandibular premolar were selected according to inclusion and exclusion criteria from the Department Of Oral And Maxillofacial Surgery, Babu Banarasi Das College of Dental Science, Lucknow. The collected teeth were autoclaved, cleaned using ultrasonic scaler and then stored in water until further use.

Preoperative radiographs were taken in mesiodistal and buccopalatal direction to evaluate the following inclusion & exclusion criteria to select the teeth.

INCLUSION CRITERIA

Completely developed single rooted human permanent maxillary central incisor teeth with straight and single canal (one orifice and one foramen) determined radiographically.

EXCLUSION CRITERIA

1. Teeth with any crack, caries or calcification.
2. Teeth with any developmental anomaly.
3. Teeth with any restoration
4. Endodontically treated teeth.

Standardization of teeth

The length of the crown and the root as well as the buccolingual and mesiodistal width were measured at the cementoenamel junction (CEJ) with a digital calliper (Hoover, India). The crown length was confined to 6 ± 1.75 mm, and the root length was confined to 13 ± 1.75 mm. The buccolingual and mesiodistal width at CEJ was confined to 4.75 ± 0.25 mm and 4.25 ± 0.25 mm, respectively.

Endodontic Treatment:

Once canal orifices were identified and a glide path was created, a working length assessment using a 10#K file was done. File was introduced inside the canal till it

was radiographically visible at the apex keeping From that length 0.5 mm was substracted and taken as working length. Hand filing till #25K was done. The cleaning and shaping was continued using crown down technique and the root canals for all the teeth were prepared to a file size of F2 of Protaper gold rotary file system setting the torque to 312gcm and speed to 300 rpm as per manufacturer's recommendation. For irrigation 3ml of 3% sodium hypochlorite was used between each file instrumentation. For the removal of smear layer 5ml of 17% EDTA was flushed onto the canal and the canal was finally rinsed with 10 ml of normal saline. The canal was then dried with paper points and with the help of a lentulospiral the sealer was placed inside the canal (AH Plus). The obturation was done with single cone insertion method using using #F2 GP point (Dentsply).

The teeth were stored in saline at room temperature for the sealers to set.

Post space preparation

The samples were sectioned just below the cemento–enamel junction with diamond disc under coolant, such that the remaining root length will be 14 ± 1 mm. The obturating material was removed to 9 mm with the heated pluggers in order to prepare post spaces. The walls were cleared of the sealer using hedstrom files and a size-1 peeso reamer with care not to remove radicular dentin. The samples were assessed using radiovisiography for consistent finish and gutta-percha removal from within the canal system.

The samples were divided into two groups with 20 samples in each group.

Group I – Castable post (20 teeth)

Group II -3D Printed post (20 teeth)

Table 2: Post material and their composition

Manufacturer Name	Composition	Weight/ Volume
3D printed post(phrozen)	1-methyl-1,2 ethanedyl hexamethyl diacrylate	15-20%
	Acrylate oligomer	20-30%
	Titanium dioxide	0.1-0.2%
	Additive	0-2%
Castable post (I Bond 02)	Cobalt	35-65%
	Chromium	0-30%
	Molybednum	2%
	Beryllium,silicon	Traces

After post space prepration both the group send the lab for cone beam computed tomography to check the space and diameter of the canal.

Group 1-Castable post

Indirect Pattern Procedure For castable post- after the preparation of post indirect impression were taken with the help polyvinyl siloxane **(Zeta plus, Turkey)** and orthodontic 26 gauze wire (Sammit stainless steel, India).

Fabrication Of Castable post- Direct technique was used to fabricate a castable post pattern using a prepared stainless-steel sprue former (18 g) with a medium Inlay wax (Dental inlay casting wax, GC). A separating media was used to aid the easy removal and insertion of the pattern. Subsequently after debubblizing and investing the pattern was cast (BEGO Induction casting machine) with base metal alloy **(**I Bond 02, India) using a lost wax technique.

Group II -3D Printed Post

Indirect Pattern Procedure For castable post- after the preparation of post indirect impression were taken with the help polyvinyl siloxane (Zeta plus, Turkey) and orthodontic 26 gauze wire (Sammit stainless steel, India).

Fabrication-3D Printed Post- after taking the impression the impression was placed in 3Dholder and the impression was scan by Medit scanner,(T-series, Japan) with the help of exocad software this scaning impression was convert by STL (stereolithography)file and then print by 3D printer (fusion1000).

Luting the castable post and 3D printed post-

Both the group of post, castble posts (base metal alloy) and 3D-printed post(Resin ,Phrozen) were seating and assessed with radiovisiography for apical fit after which they were luted to the respective prepared teeth using type I glass ionomer cement (Fuji GC corporation, Japan).

After seating both the group of post ie castable post and 3D printed post again send the lab to compare the gap, voids by CBCT(cone beam computed tomography.

Simulation of pdl ligament

The samples were dipped in melted wax 2 mm below the CEJ to produce a 0.2 - 0.3mm layer to simulate the thickness of the periodontal ligament. The specimens were then embedded vertically in self cure acrylic resin block (2.5#2.5#2.5cm) Following resin polymerization, the teeth were retrieved from the acrylic resin and the wax was removed. Consequently, the spaces of the wax were filled with the polyvinyl silicone impression material (Zeta plus, Turkey) to imitate periodontal ligament. The teeth were then inserted back into the sockets and excess material was removed using a blade #12.

FRACTURE RESISTANCE TEST

Each specimen were submitted to the fracture resistance testing (universal testing machine, instron) the compressive load was applied in the buccal surface at 90 degree and crosshead speed of 1mm/mm to the long asix on a universal testing machi

FLOWCHART OF METHODOLGY

40 mandibular Premolar

↓

Working length determination

↓

Obturation done

↓

Group Allocation

GROUPS	**NO OF SAMPLES**	POST MATERIAL
GROUPS A (Castable post)	20	Base metal alloy
GROUPS B(3D printed Post)	20	Resin

↓

↓

Post space preparation

↓

Determine the post space with the help of CBCT

Post cementation

Compare the space and voids, adaptation with the help of CBCT

Measurement of fracture resistance

Results recorded and compared

Statistical Analysis

The results obtained were tabulated and subjected to One-way ANOVA and Tukey's post-hoc using Statistical Package for Social Sciences (SPSS, V 16.0) package with significance value (p) kept at less than 0.05

Fig 1: Teeth collected for experiment

Fig 2 : Autoclave

Fig 3 : Storage of sterlized teeth in normal saline

Fig 4 : Biosonic scaler

Fig 5:Armamentarium for shaping of root canal

Fig 6 : Armamentarium for irrigation (a). Sodium hypochlorite (b). side vented needle (c). 3ml syringe (d). Normal saline

Fig:7 For shaping of root canal

Fig 8: for obturation endodontic sealer obturtation

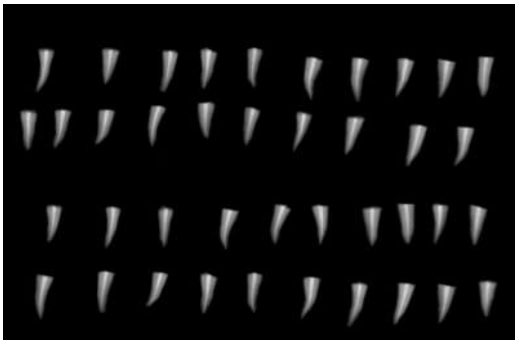


Fig 9: Radiographic evalution of

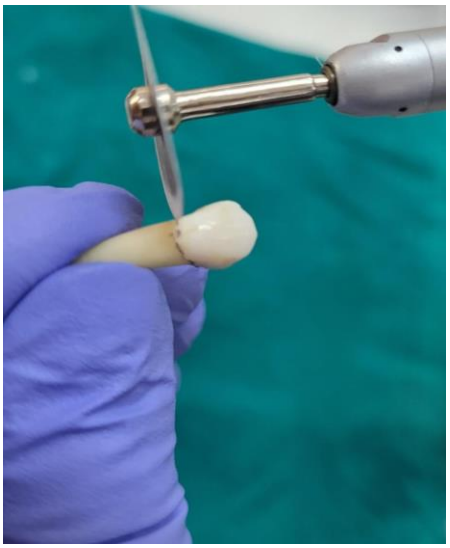


Fig 10: Decoronation at the level of CEJ

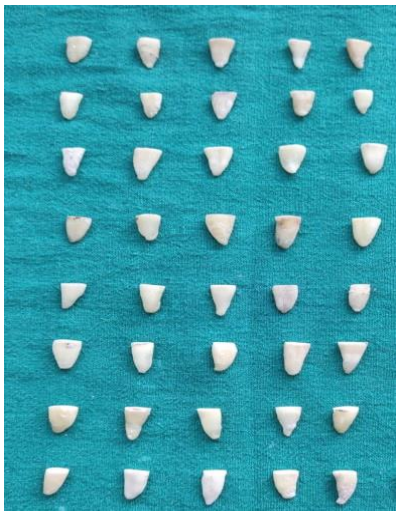
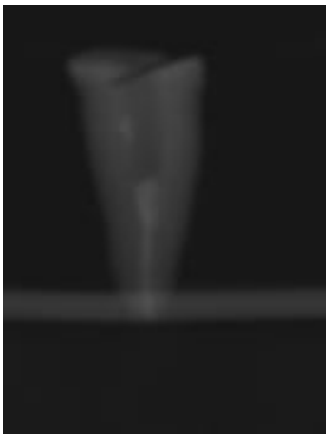


Fig 11:Decorontion done all the sample

Fig 12: Equipments for Decoronation of teeth

Fig 13:Cone beam computed tomography



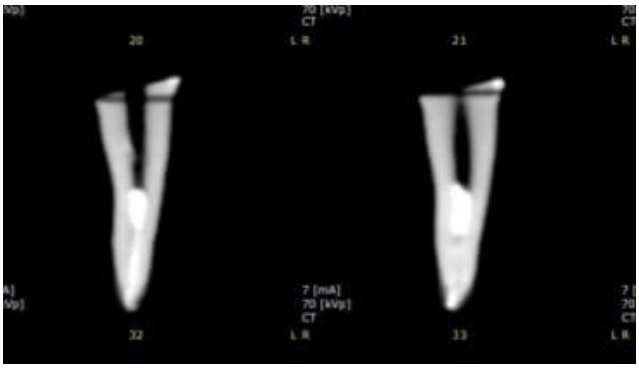
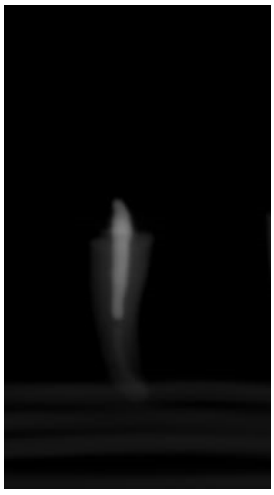
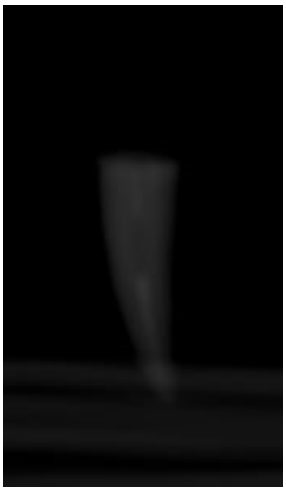


Fig :14 Evalution of amount of space by CBCT Fig:15 Sectional evalution of amount of space by cbct





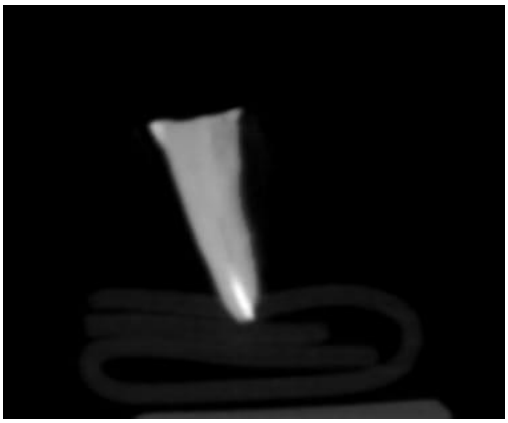


Fig :16 CBCT evalution of post placement(castable post) Fig ; 17 CBCT evalution of post placement(3Dprinted post)

Fig 18 : Materials for simulation of pdl space

Fig 19: Insertion of teeth into the prepared mold

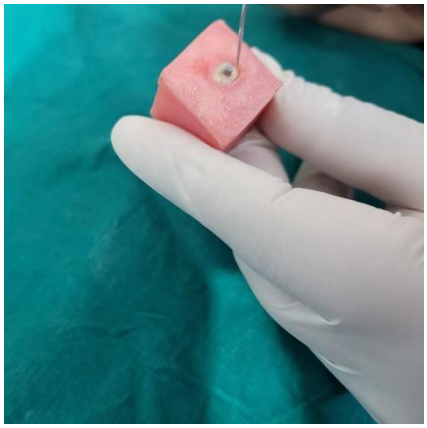


Fig 19 : Removal of excess material

Fig 20 : Universal testing machine

Fig 21 : Placement of samples at 90 angulation for testing

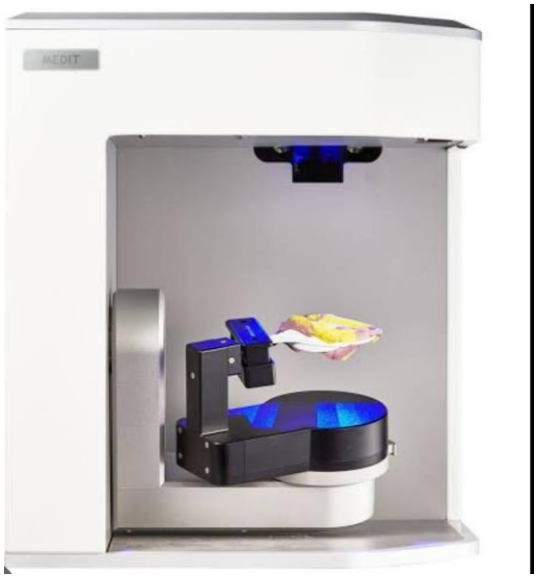


Fig 22 : Medit Scanner

OBSERVATION AND RESULTS

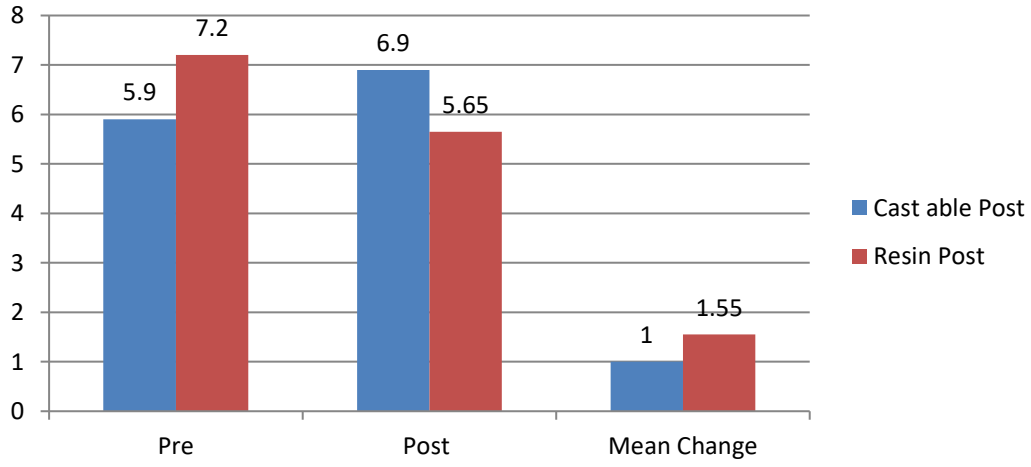
The test used to determine the results for this in vitro study was fracture resistance test. This test was conducted at Central Institute of Petrochemicals Engineering and Technology, Lucknow. The fracture resistance and_intergroup comparison of voids and amount of space between the groups was determined and their intergroup comparisons were done.

INTERGROUP COMPARISON OF VOIDS AND AMOUNTOF SPACE BETWEEN THE GROUPS

	Pre	Post	Mean Change	P value	Significance
Cast able Post	5.90±0.91	6.90±0.71	-1.00±0.72	0.001	Significant
Resin Post	7.20±1.10	5.65±0.74	1.55±0.68		

Independent t test at p value of 0.05

The mean number of voids in the castable post was 5.90±0.91 at the pre-treatment level, 6.90±0.71 at the post treatment level. In the resin post mean number of voids were 7.20±1.10 at the pre-treatment level, 5.65±0.74 at the post treatment level. The mean increase in voids from pre to post treatment level was -1.00±0.72 in the castable post and mean decrease from pre to post treatment level was 1.55±0.68

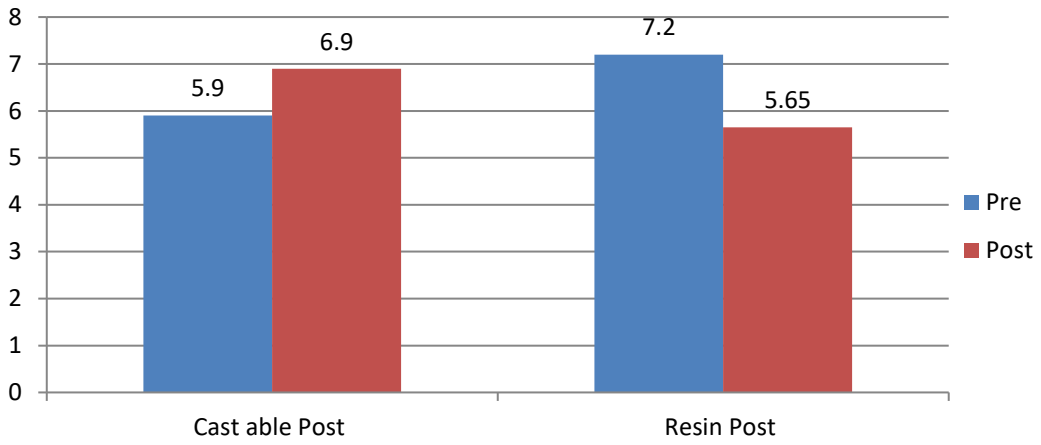


INTRAGROUP COMPARISON OF VOIDS AND AMOUNT OF SPACE BETWEEN THE GROUPS

	Pre	Post	P value	Significance
Cast able Post	5.90±0.91	6.90±0.71	0.021	Significant
Resin Post	7.20±1.10	5.65±0.74	0.001	Significant

Paired t test at p value of 0.05

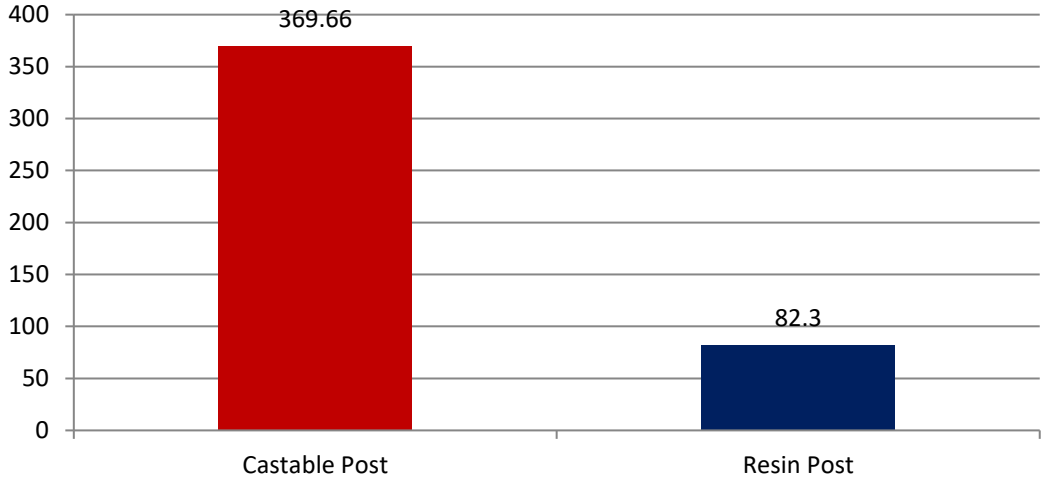
The mean number of voids in the castable post was 5.90±0.91 at the pre treatment level, 6.90±0.71 at the post treatment level. In the resin post mean number of voids were 7.20±1.10 at the pre treatment level, 5.65±0.74 at the post treatment level. The mean increase in voids from pre to post treatment level in the castable post and mean decrease from pre to post treatment level was statistically significant in both the groups



INTERGROUP COMPARISON OF FRACTURE LOAD BETWEEN THE GROUPS

	Mean	SD	P value	Significance
Cast able Post	369.66	9.91	0.001	Significant
Resin Post	82.30	5.67		

Independent t test at p value of 0.05



The mean fracture load in the castable post was 369.66. In the resin post mean fracture loads was 82.30 The mean fracture load was higher in the in the castable post as compared to resin post and difference was statistically significant (p=0.001)

STATISTICAL ANALYSIS

The data for the present study was entered in the Microsoft Excel 2007 and analyzed using the SPSS statistical software 23.0 Version. The descriptive statistics included mean, standard deviation . The intragroup comparison for the different time intervals was done using paired t test to find the difference between the individual time intervals The level of the significance for the present study was fixed at 5%.

The intergroup comparison for the difference of mean scores between two independent groups was done using the unpaired/independent t test

The Shapiro–Wilk test was used to investigate the distribution of the data and Levene's test to explore the homogeneity of the variables. The data were found to be homogeneous and normally distributed. Mean and standard deviation (SD) were computed for each variable

Mean

$$\overline{X} = \frac{\Sigma X}{N}$$

Where:

$\overline{X}$ = the data set mean

$\sum$ = the sum of

X = the scores in the distribution

N = the number of scores in the distribution

Range

$$range = X_{highest} - X_{lowest}$$

Where:

$X_{highest}$ = largest score

X_{lowest} = smallest score

Variance

$$SD^2 = \frac{\Sigma(X - \overline{X})^2}{N}$$

The simplified variance formula

$$SD^2 = \frac{\Sigma X^2 - \frac{(\Sigma X)^2}{N}}{N}$$

Where:

SD^2 = the variance

$\sum$ = the sum of

X = the obtained score

$\overline{X}$ = the mean score of the data

N = the number of scores

Standard Deviation (N)

$$SD = \sqrt{\frac{\Sigma(X - \overline{X})^2}{N}}$$

The simplified standard deviation formula

$$SD = \sqrt{\frac{\Sigma X^2 - \frac{(\Sigma X)^2}{N}}{N}}$$

Where:

SD = the standard deviation

$\sum$ = the sum of

X = the obtained score

$\overline{X}$ = the mean score of the data

N = the number of scores

Paired t test

$$t = \frac{\bar{x} - 0}{SE(d)} = \frac{\bar{x}}{SD(x)/\sqrt{n}}$$

A paired t-test is used to compare two population means where you have two samples in which observations in one sample can be paired with observations in the other sample. Examples of where this might occur are: - Before-and-after observations on the same subjects (e.g.

students'diagnostic test results before and after a particular module or course) or A comparison of two different methods of measurement or two different treatments where the measurements/treatments are applied to the same

Independent t-test

Independent t Test can be used to determine if two sets of data are significantly different from each other, and is most commonly applied when the test statistic would follow a normal distribution. The independent samples *t*-test is used when two separate sets of independent and identically distributed samples are obtained, one from each of the two populations being compared

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\left(\frac{(N_1 - 1)s_1^2 + (N_2 - 1)s_2^2}{N_1 + N_2 - 2}\right)\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}}$$

Where X1 =Mean of the first Group, X2 =Mean of the Second Group

DISCUSSION

The objective and aim of the root canal treatment procedure is to achieve a three-dimensional hermetic seal during canal obturation and adequately reinforce the root canal space so as to increase resistance to fracture of the remaining tooth structure.

Endodontically treated teeth have been reported to be more susceptible to fracture when compared to vital teeth. This necessitates adequate protection of remaining tooth structure by proper restoration protocols.

During endodontic therapy the entire root canal system has to be adequately accessed, cleansed of all the necrotic tissues, remnants, debris, microbes and subsequently appropriately restored. This process of cleansing of the root canal space is called the biomechanical preparation.

The root canal system presents a complex structure and is colonized by the microorganisms during an infection which have been demonstrated in the dentinal tubules half way through radicular dentin. Therefore while treating the infected root canal space the process of shaping and cleansing i.e, the biomechanical preparation of the canal is viewed as a vital step during endodontic therapy. The inherent variations of anatomy of the canal system, the curvature of the roots especially in the mandibular and maxillary posterior teeth pose a challenge during biomechanical preparation.[32]

The occlusal one third of the canal system is highly accessible, middle one is third fairly accessible and the apical one third is the least accessible. In the case of curved roots in order to access the apical third of the canals and to achieve sufficient cleansing and debridement, considerable amount of radicular dentin in the coronal and middle third is removed intentionally which would possibly can affect the structural integrity of the of the tooth. This makes the endodontically treated tooth more prone to fracture (Sornkul *et al* 1992)) Continuous development in the field of endodontic and restorative procedures has led to tooth retention and longevity. However, it has been noticed that a sufficient number of endodontically treated teeth

require intraradicular devices to restore their function.[33] So the question arises as to when are these intraradicular devices required.

According to Cohen BI *et al*.[33] when there is not sufficient amount of remaining tooth structure to retain the core – a post is indicated. This post should provide adequate retention and resistance form to the displacement of core material. According to Fernandes AS et al.[34] selection of post depends on a variety of factors.33 These factors include tooth anatomy, position of tooth in the arch, root length, root width, canal configuration, functional requirements of the tooth, torqueing forces, stresses, development of hydrostatic pressure, post design, post material, material compatibility, bonding capability, core retention, retrievability, esthetics and crown material.

The history of post dates back to 1700s, when Fauchard[35] inserted wooden dowels in root canals to aid for crown retention. But it was noticed that over a period of time, the wood would expand due to moisture in the environment and unfortunately, lead to root fracture. In 1800s, the use of intra radicular devices was limited due to failure of endodontic therapy in that era.[36] In 19th centuryagain, several dentists used wooden posts but a few dentists reported the use of metal posts which was favoured by Black [37] In this, a screw was passed through a gold lined root canal to secure a porcelain faced crown. In mid 1800s, Clark introduced a device that allowed drainage from the apical area and this device was considered quite practical for its time. In 1878, Richmond crown was introduced[38].

It was a screw retained crown with a threaded tube in the canal. Later, modifications were made in 1957 by Demas NC et al. and in 1958 by Hampson EL et al.[39]which eliminated the threaded tube and redesigned it to a one piece dowel and crown. However, because of their impractical nature, they lost their popularity. This was became very obvious when divergent paths of insertion for remaining tooth structure and post space existed mostly for abutments of fixed partial denture. Also, when crowns and FPD required replacement and removal, one piece dowel crowns created problems.

All of these difficulties led to the development of post and core restorations to be treated as separate entities in which artificial crowns were cemented over the core and remaining tooth structure. Posts can be fabricated from a variety of materials that include cast gold, stainless steel, titanium and titanium alloys, goldplated brass, ceramic and fiber reinforced polymers. However, according to Deutch *et al*[40] for a post to achieve optimum results it should be made up of a suitable material. This material should have properties similar to that of dentin, should be biocompatible, non corrosive and bond well to the tooth structure.

According to Fredriksson M *et al*.[41] the post material should act as a good shock absorber, transferring only limited stresses to the residual tooth structure. Cast gold post and cores had a 90.6% clinical success rate in 6 years in retrospective studies but their high cost became matter of concern. Stainless steel posts have been used for a long time as a prefabricated post but show nickel sensitivity. Also, brass posts and stainless steel posts depicted corrosive behaviours. Pure titanium posts had low fracture strength and tended to break easily than stainless steel posts during removal in retreatment cases. Most titanium posts showed density similar to gutta percha and were difficult to identify on radiographs. Ceramic posts showed good physical properties like flexural strength and flexural strength and toughness and were also esthetically pleasing under all ceramic crowns. However, two in vitro studies reported their poor resin bonding capability to dentin under fatigue loads.

Different methods were used to evaluate the voids and gaps with regard to leakage; however, the presence of voids and gaps was evaluated with 2-dimensional images. Overall, some of these studies have proven that there is a positive correlation shared by voids and gaps)[42]. We can put forth that the voids became a part of the cementation during the process of mixing or through the technique used to apply the cement in the root canal. Mixing the paste components when they are not complete can result in voids within the root canal)[43]. This, in some way, explained a dependence on the photoactivation of the cementation materials [44] The root dentin is filled with numerous accessory canals that

will combine with the presence of voids and gaps and increase the chance of re-infection from the accessory canals [45] Ideally, the area in the middle of the dentin and post surface should not have any gaps and voids in order to produce a homogeneous one-unit structure [46]Our study's results show that the highest mean value of void formation (0.012%) was noticed incastable group while the lowest value (0.002%) was presented in the 3D Printed post group.

CONCLUSION

This study stated that the maximum fracture resistance test showed that group 1 (castable post) showed highest fracture resistance followed by group 2(3-D printed post) and the more amount of space and voids were found in castable post (group1) and less in 3-D printed post.

The mean number of voids in the castable post was 5.90±0.91 at the pre- treatment level, 6.90±0.71 at the post treatment level. In the resin post mean number of voids were 7.20±1.10 at the pre- treatment level, 5.65±0.74 at the post treatment level. The mean increase in voids- from pre to post treatment level in the castable post and mean decrease from pre to post treatment level was statistically significant in both the groups.

The mean fracture load in the castable post was 369.66. In the resin post mean fracture loads was 82.30 The mean fracture load was higher in the in the castable post as compared to resin post and difference was statistically significant. Independent t Test can be used to determine if two sets of data are significantly different from each other, and is most commonly applied when the test statistic would follow a normal distribution.

A paired t-test is used to compare two population means where you have two samples in which observations in one sample can be paired with observations in the other sample. Examples of where this might occur are: -Before-and-after observations on the same subjects The intragroup comparison for the different time intervals was done using paired t test to find the difference between the individual time intervals The level of the significance for the present study was fixed at 5%.

The intergroup comparison for the difference of mean scores between two independent groups was done using the unpaired/independent t test.

So we conclude that the maximum fracture resistance test showed that group 1, showed highest fracture resistance followed by group 2 and the more amount of space and voids were found in castable post (group1) and less in 3-D printed post conclude by the study that 3D printed post has better adaptation than castable Post.

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INSTITUTIONAL RESEARCH COMMITTEE APPROVAL FORM

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

INSTITUTIONAL RESEARCH COMMITTEE APPROVAL

The project titled "Comparative Evalution of Fracture Resistance of Customized 3D Printed Post and Castable Metal Post with Universal Testing Machine and their Adaptation with CBCT: An In- Vitro Study" submitted by **Dr Laxmi Pandey** Post graduate student from the **Department of Conservative Dentistry and Endodontics** as part of MDS Curriculum for the academic year 2020-2023 with the accompanying proforma was reviewed by the Institutional Research Committee present on **11th October 2021** 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

Received
16/NOV/21

ETHICAL COMMITTEE APPROVAL FORM

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 IXth Institutional Ethics Sub-Committee

IEC Code: 37

BBDCODS/04/2022

Title of the Project: Comparative evalution of fracture resistance of customized 3D printed post and castable metal post with universal testing machine and their adaptation with CBCT: An in- vitro study.

Principal Investigator: Dr Laxmi Pandey **Department:** Conservative Dentistry & Endodontics

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

Type of Submission: New, MDS Research

Dear Dr Laxmi Pandey,

The Institutional Ethics Sub-Committee meeting comprising following four members was held on 07th April, 2022.

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, BBDCODS, Lucknow
4.	Dr. Akanksha Bhatt Member	Reader, Department of Conservative Dentistry & Endodontics, 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

(Dr. Lakshmi Bala)
Member-Secretary
IEC

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

Received
Lucknow
27/4/22

(Dr. Puneet Ahuja)
Principal
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AUTHENTICATION CERTIFICATE

केंद्रीय पेट्रोरसायन अभियांत्रिकी एवं
प्रौद्योगिकी संस्थान (सिपेटः आई.पी.टी.)
(पूर्व में केंद्रीय प्लास्टिक इंजीनियरिंग एवं तकनीकी संस्थान)
रसायन एवं पेट्रोरसायन विभाग,
रसायन एवं उर्वरक मंत्रालय, भारत सरकार
बी-२७, अमौसी इण्डस्ट्रियल एरिया, लखनऊ-२२६ ००८
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स्वच्छ भारत
एक कदम स्वच्छता की ओर

आज़ादी का अमृत महोत्सव

Certificate No.CON -037
Date: 20.12.2022

Issued to:

Dr. Laxmi Pandey,
MDS Student
Babu Banarasi Das University
BBD City, Faizabad Road,
Lucknow – 226028

CERTIFICATE

PART-A

PARTICULARS OF SAMPLE SUBMITTED

Sample details	:	**Testing of Sample** as stated by the party Your Ref. No. : BBDCODS/Gen._Int./2022/154 Date : 02.12.2022
Size/Class	:	--
Quantity of samples	:	40 Nos. .(20 Nos. of group1, 20 Nos. of group2)
Date of Manufacturing	:	---
Condition of receipt of sample	:	---
Sealed or not	:	Not sealed
Date of sample received	:	07.12.2022
Any other details	:	Payment received on 09.12.2022

Note:
(i) This Test Report/ Certificate is issued only for the samples submitted to CIPET.
(ii) The results stated above related only to the items tested.
(iii) The quality of the subsequent production lot has to ensured by the purchaser.
(iv) The test certificate shall not be reproduced in full except without the written approval of the laboratory.
(v) Statement of conformity of a specification or standard is provided by laboratory taking into account the level of risk associated/borderline cases with the decision rule employed

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/-

PLAGIARISM REPORT

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