COMPARATIVE FRACTURE STRENGTH EVALUATION OF ENDODONTICALLY TREATED TEETH HAVING DIFFERENT ACCESS CAVITY DESIGN, RESTORED WITH SDR AND BULK FILL COMPOSITE AS A DENTIN REPLACEMENT: AN IN-VITRO STUDY

DISSERTATION

Submitted to the

BABU BANARASI DAS UNIVERSITY, LUCKNOW, UTTAR PRADESH

In the partial fulfilment of the requirement for the degree

of

MASTER OF DENTAL SURGERY

In the subject of

CONSERVATIVE DENTISTRY & ENDODONTICS

Submitted by

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Under the guidance of

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DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled **" Comparative Fracture Strength Evaluation Of Endodontically Treated Teeth Having Different Access Cavity Design, Restored With SDR And Bulk Fill Composite As A Dentin Replacement: An In-Vitro Study"** is a bonafied, & genuine research work carried out by me under the guidance of **Dr. TANU TEWARI,** Reader, Department of Conservative Dentistry & Endodontics, Babu Banarasi Das College of Dental Sciences, Babu Banarasi Das University, Lucknow, Uttar Pradesh.

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Place: Lucknow

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CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **" Comparative Fracture Strength Evaluation Of Endodontically Treated Teeth Having Different Access Cavity Design, Restored With SDR And Bulk Fill Composite As A Dentin Replacement: An In-Vitro Study"** is a bonafide work done by **Dr. KARISHMA RAO**, under our direct supervision & guidance 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.

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This is to certify that this dissertation entitled " **Comparative Fracture Strength Evaluation Of Endodontically Treated Teeth Having Different Access Cavity Design, Restored With SDR And Bulk Fill Composite As A Dentin Replacement: An In-Vitro Study"** is a bonafide work done by **Dr. KARISHMA RAO**, under the direct supervision & guidance of **Dr. TANU TEWARI,** Reader, Department of Conservative Dentistry & Endodontics, Babu Banarasi Das College of Dental Sciences, Babu Banarasi Das University, Lucknow, Uttar Pradesh. .

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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.*

OM NAMAH SHIVAAY

Dr. Karishma Rao

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURE

ABBREVIATIONS

TEC	TRADITIONAL ENDODONTIC ACCESS CAVITY
CEC	CONSERVATIVE ENDODONTIC ACCESS CAVITY
SDR	SMART DENTINE REPLACEMENT
FBF	FILTEK BULK FILL FLOWABLE
LED	LIGHT CURING UNIT
UDMA	RETHANE DIMETHACRYLATE

ANNEXURES

ABSTRACT

Title: comparative fracture strength evaluation of endodontically treated teeth having different access cavity design, restored with SDR and Filtek Bulk Fill composite as a dentin replacement: an in-vitro study.

Aim: Comparing the fracture strengths of mandibular molar teeth prepared using traditional (TEC) and conservative endodontic cavity (CEC) methods and restored using SDR (Dentsply Caulk, Milford, DE) and Filtek^{TM} Bulk Fill Flowable base composite materials.

Method: 100 first mandibular molar teeth were randomly divided into 5 groups. In group A (control group), samples were kept intact. In group B and group C, TECs and CECs were prepared respectively, and samples were restored with Filtek^{TM} Bulk Fill base and composite resin Filtek Z250. In group D and group E, TECs and CECs were prepared respectively, and samples were restored with SDR and composite resin Ceram.X Mono. The load was applied on the samples at 1 mm/min speed using 6 mm round-head tip until fracture. Forces resulting in fracture were recorded in newton units. Data were analysed using Kruskal-Wallis and Pearson correlation tests at 5% significance level.

Result: Mean fracture strengths of samples in control group were significantly higher than experimental groups ($p < 0.05$). Mean fracture strengths of samples in group D vs group B, group E vs group C and group C vs group B was significantly higher ($p < 0.05$) while group E and group D had no significant difference ($p > 0.05$).

Conclusion: Fracture strengths of teeth restored with the SDR base was higher than that of teeth restored with Filtek^{TM} Bulk Fill Flowable. CEC prepared samples had significantly higher fracture strength as compared to TEC prepared samples when Filtek^{TM} Bulk Fill was used as restorative base while difference was insignificant when SDR base was used.

INTRODUCTION

Our objective should be the perpetual preservation of what remains than the meticulous restoration of what is missing. —M. M. De Van

The fundamental aim of root canal treatment is to remove the bacteria from the root canal and to treat apical periodontitis using biomechanical preparation, infection control and complete obturation of the root canal system. In order to carry out any of the above technical stages effectively, adequate access to the root canal system is required. An access cavity is defined as "The opening prepared in a tooth to gain entry to the root canal system for the purpose of cleaning, shaping and obturation". (1)

Traditionally the technical stages of root canal therapy was described as 'clean, shape and fill'. The significance of the access cavity in this process was frequently overlooked. A poorly executed access cavity will compromise the remaining technical stages and result in an increased risk of procedural errors. (1)

Design of the access cavity is crucial to maintain the healthy tooth structure. A diagnostic radiograph is a prerequisite to prepare minimally invasive access cavities. However, before access cavity preparation, insufficient coronal restorations and caries lesions should be removed and a pre-endodontic restoration performed to minimize the risk of recontamination of the endodontic system during treatment procedures.

The preparation of the access cavity is divided into two steps:

1) Primary access cavity: Cleaning the whole pulp chamber including complete removal of hard tissues that may impede the straight-line access to the root canals represents the first step.
2) Secondary access cavity: The number of root canal orifices in a particular tooth can never be known prior to the commencement of the treatment. Hence, canal orifices should be identified with the utmost care. (2)

In the last decade, several access cavity designs involve minimal removal of tooth structure for gaining entry to pulp chambers during root canal treatment. The premise behind this concept that maximum preservation of as much of the pulp chamber roof as possible during access preparation .However, the smaller the access cavity, the more difficult it may be to visualize and debride the pulp chamber as well as locate, shape, clean and fill the canals. At the same time, a small access cavity may increase the risk of iatrogenic complications because of poor visibility, which may have an impact on the treatment outcome.

Influence of minimally invasive access preparation on the fracture resistance of teeth

One of the most important conditions that contribute to the susceptibility of a tooth to fracture includes the removal of large amounts of sound dentine during the endodontic and restorative procedures.

Hence, the minimally invasive concept in endodontics was founded on the premise that dentine conservation during access cavity preparation was an essential measure to maintain optimal strength, fracture resistance needed for the long-term function and survival of root filled teeth.

Trauma, caries, extensive cavity preparation, and endodontic treatments are the most common reasons for tooth fragility. Because of the loss of water content and anatomic structures, such as the pulp chamber roof, endodontically treated teeth are more susceptible to fracture than are vital teeth. The amount of residual coronal dentin is considered of primary importance in the prognosis of endodontically treated teeth. Supporting the remaining dental structures is crucial for the long-term success of treatment. Deciding how to implement a restorative protocol for endodontically treated teeth with variable remaining tooth structure is challenging for operators when excessive structure has been lost. There are many different direct and indirect treatment options for these kinds of teeth, such as direct resin-based restorative materials, onlays/inlays, and crowns (with or without post placement).

Restoration of a tooth with adhesive procedures and direct resin composites eliminates excessive loss of sound tooth structure and over preparation. Direct resin-based composite restorations are applied in single appointment. As there are many different types of tooth-colored direct restorative materials available in the dental market, it is important to determine which materials are successful to ensure a long-lasting restoration in endodontically treated teeth.

Although conventional resin composites are used for restoration of endodontically treated teeth, their major shortcoming, polymerization shrinkage, is still present. In larger cavities, the polymerization shrinkage that leads to higher stress accumulation on the tooth than on the restoration is considered responsible for a series of clinical complications, including higher risk of tooth fracture. In order to reduce polymerization shrinkage stress and to maintain adequate depth of cure, incremental placement of resin composites has been routinely used in daily practice. However, the use of 2-mm thick resin composite materials incrementally for direct restorations is time consuming, increases the risk of contamination between layers and may include voids in the restoration.

Bulk fill resin composites are an innovative class of dental resin composite materials, developed to simplify the placement of direct composite restorations. They include low-viscosity, flowable and high-viscosity material types. According to the manufacturers, they can be efficiently light-cured at depths up to 4-5 mm and cause low polymerization shrinkage stress at the same time. The only drawback of low viscosity material was low hardness and low modulus of elasticity; hence, there is a requirement of a final top layer of conventional composite. (3)

SDR has an increased depth of cure because of increased translucency. SDR includes a flexible polymer that does not translate the shrinkage stress to the tooth. 3M™ ESPE™ Filtek™ Bulk Fill Flowable Restorative, is a low viscosity, visible-light activated, radiopaque flowable composite. This low stress flowable material is semi-translucent enabling a 4mm depth of cure.

Considering these facts the present study has been undertaken to observe and measure the fracture strength of molar by using traditional and conservative access cavity preparation there by restoring them SDR, Bulk fill resin composites and Nano-hybrid composites.

All the samples are tested for fracture strength using "Inston Universal testing machine".

AIM AND OBJECTIVES

AIM:

To compare the fracture strength of endodontically treated teeth with two different access cavity designs restored with Smart Dentin Replacement and Filtek™ Bulk Fill Flowable composites.

OBJECTIVES:

1. To evaluate the fracture strength of endodontically treated molars by using traditional endodontic access cavity preparation and conservative endodontic access cavity preparation, restored with smart dentin replacement and Filtek™ Bulk Fill Flowable composites.
2. To compare the fracture strength of endodontically treated molar by using traditional endodontic access cavity preparation and conservative endodontic access cavity preparation, restored with SDR and Filtek™ Bulk Fill Flowable composite materials.

The null hypotheses of the present study were as follows:

1. The access cavity preparation designs would have no effect on the fracture strength of endodontically treated mandibular molar teeth.
2. No significant difference would be seen in the fracture strength of the teeth restored post endodontically with two different base metal composites.

REVIEW OF LITERATURE

Mannan G, Smallwood ER, Gulabivala K, et al. (2001)[4] Conducted a study to examine the effect of access cavity location and design on degree and distribution of instrumented root canal surface in maxillary anterior teeth. They concluded that mechanical preparation did not allow instrumentation of the entire root canal wall, straight-line access allowed the greatest proportion of the root canal wall to be instrumented and the lingual cingulam access the least.

Tang W, Wu Y, et al. (2010)[5] had done a study to identify and reducing risk for potential fracture in endodontically treated teeth. They found that post endodontic tooth fracture might occur because of the loss of tooth structure and induced stress caused by endodontic and restorative procedure such as access cavity preparation, instrumentation and irrigation of the root canal, post space preparation and coronal restoration and form inappropriate selection of tooth abutment for prosthesis.

Krishna R, plaque F, et al. (2014)[6] Conducted a study to measure the impacts of conservative endodontic cavity on root canal instrumentation efficacy and resistance to fracture assessed in incisor, premolar and molar. They found that conservative endodontic cavity was associated with the risk of compromised canal instrumentation only in molar distal canal. It conserved coronal dentin in the 3-tooth type and conveyed a benefit of increased fracture resistance in mandibular molar and premolar.

Mannocci F, Cowie J, et al. (2014)[7] had done a study on restoration of endodontically treated teeth. They concluded that the preservation of tooth structure is critical to the survival of an endodontically treated tooth.

Eaton JA, Clement DJ, Lloyd A, et al. (2015)[8] conducted a study to examine the Micro – computed tomographic evaluation of the influence of root canal curvatures in mandibular molars. They concluded that the use of different landmarks to establish access outline design affected the primary angle of curvature in relatively calcified mandibular molar.

Moore B, Veredelis K, et al. (2016)[9] had done a study to assess the impacts of conservative endodontic cavity on instrumentation efficacy and axial strain response in maxillary molar. They found that conservative endodontic cavity did not affect instrumentation efficacy and biomechanical response compared with traditional endodontic access cavity.

Zehnder MS, Connert T, Weiger R, et al. (2016)[10] conducted a study to examine the guided endodontics: accuracy of a novel method for guided access cavity preparation and root canal location. They concluded that Guided endodontics allowed an accurate access cavity preparation up to the apical third of the root utilizing printed templates for guidance. All root canals were accessible after preparation.

Yuan K, Niu C, Xie Q, et al. (2016)[11] had done a study to examine the impact of minimally invasive preparation vs. conventional straight-line preparation on tooth biomechanics. This study aimed to compare the biomechanics on teeth after minimally invasive (MI) preparation and straight-line (SL) preparation using finite element analysis. The stress concentration areas of teeth with minimally invasive access cavities were smaller than those areas prepared with straight-line opening in coronal and cervical areas. The stress concentration points in the cervical areas increased with the increase of canal taper in the coronal third. Minimally invasive access preparation reduced the stress distribution in crown and cervical regions.

Plotino G, Grande NM, Isufi A, et al. (2017)[12] found that teeth with traditional endodontic cavity access showed lower fracture strength than the one prepared with conservative endodontic cavity or ninja endodontic cavity. Ultra conservative ninja endodontic cavity did not increase the fracture strength of teeth compared with the one prepared with conservative endodontic cavity. Intact teeth showed more restorable fracture than all the prepared one.

Rover G, Belladonna FG, Bortoluzzi EA, et al. (2017)[13] had done a study to assess the influence of contracted endodontic cavities on the root canal detection, instrumentation efficacy, and fracture resistance assessed n maxillary molar. Traditional endodontic cavity are used as reference for comparison. The results of the study did not show benefits associated with conservative endodontic cavity. This access modality in maxillary molar resulted in less root canal detection where no ultrasonic troughning associated to an operating microscope was used and did not increase fracture resistance.

Taha NA, Maghaireh GA, Ghannam AS, et al. (2017)[14] conducted a study to examine the effect of bulk-fill base material on fracture strength of root-filled teeth restored with laminate resin composite restorations. They concluded that the use of a bulk-fill flowable base material significantly increased the fracture strength of extracted root-filled teeth with MOD cavities; however, it did not improve fracture patterns to more favorable ones.

Özyürek T, Ülker Ö, Demiryürek EÖ, et al. (2018)[15] had done a study to examine the effect of endodontic access cavity preparation design on the fracture strength of endodontically treated teeth. –Traditional versus conservative preparation. They concluded that CEC preparation did not increases the fracture strength of teeth with class II cavities compared with TEC preparation.

Allen C, Meyer CA, Yoo E,,et al.(2018)[16] conducted a study to examine the effect of stress distribution in a tooth treated through minimally invasive access compared to one treated through traditional access. They concluded that traditional endodontic access cavity may render a tooth more susceptible to fracture compared with a minimally invasive access.

Corsentino G, Pedullà E, Castelli L, ,et al (2018)[17] had done a study to examine the influence of access cavity preparation and remaining tooth substance on fracture strength of endodontically treated teeth.They concluded that truss access do not increase the fracture strength of endodontically treated teeth in comparison with traditional and conservative endodonic access cavity.

Silva E, Rover G, Belladonna FG,et al.(2018)[18] conducted a study to examine the impact of contracted endodontic cavities on fracture resistance of endodontically treated teeth. They concluded that there is no evidence that supports the use of contracted over traditional endodontic cavity for the increase of fracture resistance in human teeth.

Sabeti M, Kazem M, Dianat O, et al.(2018)[19] had done a study to examine the Impact of Access Cavity Design and Root Canal Taper on Fracture Resistance of Endodontically Treated Teeth: They concluded that increasing the taper of the root canal preparation can reduce fracture resistance. Moreover, access cavity preparation can reduce resistance; however, CAC in comparison with TAC had no significant impact.

Marchesan MA, Lloyd A, Clement DJ et al.(2018)[20] had done a study to examine Impacts of Contracted Endodontic Cavities on Primary Root Canal Curvature Parameters in Mandibular Molars. They concluded that within the limitations of this study, the results suggested that instrumentation of curved mesial canals with engine-driven instruments reduced the severity and abruptness of PCC and shifted the PCC location apically similarly in mandibular molars with CEC and those with nonextended TEC. Treatment time in the molars with CECs was considerably longer, suggesting that extended treatment time should be taken into account along with other considerations when debating CECs versus TECs.

Alovisi M, Pasqualini D, Musso E,et al.(2018)[21] conducted a study to examine the Influence of Contracted Endodontic Access on Root Canal Geometry: An In Vitro Study. They concluded that TECs showed a greater preservation of the original root canal anatomy with less apical transportation than CECs, possibly because of the absence of coronal interferences and, therefore, fewer pecking motions required to complete instrumentation. Within the limitations of this study, TECs may lead to a better preservation of the original canal anatomy during shaping compared with CECs, particularly at the apical level.

Marchesan MA, Lloyd A, Clement DJ,et al.(2018)[22] had done a study to examine the Impacts of Contracted Endodontic Cavities on Primary Root Canal Curvature Parameters in Mandibular Molars. They concluded that instrumentation of curved mesial canals reduced the severity and abruptness of PCC and shifted the PCC location apically similarly in mandibular molars with CECs and those with nonextended TECs. The extended treatment time with CEC merits consideration when debating CECs versus TECs.

Abou-Elnaga MY, Alkhawas MAM, Kim HC et al. (2019)[23] conducted a study to examine the effect of Truss Access and Artificial Truss Restoration on the Fracture Resistance of Endodontically Treated Mandibular First Molars.They concluded that the truss access cavity preparation improved the fracture resistance of endodontically treated teeth with mesio-occluso-distal cavities, whereas the artificial truss restoration did not improve it.

Roperto R, Sousa YT, Dias T, et al. (2019)[24] had done a study to examine the Biomechanical behavior of maxillary premolars with conservative and traditional endodontic cavities. They concluded that regardless of the cavity design, conservative endodontic cavities that preserve marginal ridge integrity did not affect the resistance to fracture, failure mode, or stress distribution in maxillary premolars restored with composite resin. Endodontically treated teeth displayed biomechanical behavior similar to sound teeth.

Zhang Y, Liu Y, She Y, et al.(2019)[25] conducted a study to examine the Effect of Endodontic Access Cavities on Fracture Resistance of First Maxillary Molar Using the Extended Finite Element Method. They concluded that the fracture resistance of an endodontically treated tooth was increased by preparing the conservative endodontic cavity. The fracture of the maxillary first molar originated from the mesial groove of the enamel, propagated through the groove, and finally induced the damage in the dentin.

Saberi .E, Pirhaji.A and Zabetiyan et al.F(2020)[26] had done a study to examine effects of Endodontic Access Cavity Design and Thermocycling on Fracture Strength of Endodontically Treated Teeth.They concluded that TREC enhances the fracture strength of endodontically treated teeth under thermal stresses.

Barbosa AFA, Lima CO, Coelho BP, et al. (2020)[27] conducted a study to examine the influence of endodontic access cavity design on the efficacy of canal instrumentation, microbial reduction, root canal filling and fracture resistance in mandibular molars. They concluded that Conservative access cavities did not offer any advantage in comparison to the traditional endodontic cavities in any of the parameters considered. Furthermore, conservative methods were associated with larger percentages of unprepared canal surface area and larger volume of remaining root filling material within the pulp chamber.

Saber SM, Hayaty DM, Nawar NN, et al. (2020)[28] had done a study to examine The Effect of Access Cavity Designs and Sizes of Root Canal Preparations on the Biomechanical Behavior of an Endodontically Treated Mandibular First Molar: A Finite Element Analysis . They concluded that conservative and truss access designs preserved a significant volume of tooth structure. The extent of root canal enlargement should be as small as practical without jeopardizing the biologic objectives of root canal treatment.

Silva EJNL, Oliveira VB, Silva AA, et al. **(2020)**[29] conducted a study to examine effect of access cavity designs on gaps and void formation in resin composite restorations following root canal treatment on extracted teeth . They concluded that the access cavity design used during root canal treatment interfered with the adaptation of the restorative material. The minimally invasive access cavity design was associated with a greater number of voids within the restoration.

Isufi A, Plotino G, Grande NM, et al. (2020)[30] had done a study to examine Standardization of Endodontic Access Cavities Based on 3-dimensional Quantitative Analysis of Dentin and Enamel Removed. They concluded The percentage of volume of DER was less than 6% for the UEC group, up to 15% for the CEC group, and more than 15% for the TEC group, with a statistically significant difference among all groups in all of the tooth types analyzed ($P < .05$).The present study showed significantly different percentages of volume of DER among the groups analyzed (i.e. UEC < CEC < TEC).

Barbosa AFA, Lima CO, Coelho BP, et al(2020)[31] conducted a study to examine The influence of endodontic access cavity design on the efficacy of canal instrumentation, microbial reduction, root canal filling and fracture resistance in mandibular molars . They concluded that conservative access cavities did not offer any advantage in comparison to the traditional endodontic cavities in any of the parameters considered. Furthermore, conservative methods were associated with larger percentages of unprepared canal surface area and larger volume of remaining root filling material within the pulp chamber.

Wang Q, Liu Y, Wang Z, et al. (2020)[32] had done a study to examine the Effect of Access Cavities and Canal Enlargement on Biomechanics of Endodontically Treated Teeth: A Finite Element Analysis They concluded that Preserving coronal dentin by using conservative endodontic cavity significantly reduced the concentration of tensile stress and the failure probability of dentin, although the maximum principal stress and failure probability were less affected by taper of canal preparation.

Tüfenkçi P, Yılmaz K, Adigüzel M. (2020)[33] This study was conducted to evaluate the effects of traditional and contracted endodontic cavity (TEC and CEC) preparation with the use of Reciproc Blue (RPC B) and One Curve (OC) single-file systems on the amount of apical debris extrusion in mandibular first molar root canals. RPC B caused more apical debris extrusion in the CEC groups than did the OC single-file system. Therefore, it is suggested that the RPC B file should be used carefully in teeth with a CEC.

MATERIALS AND METHOD

Place of the study

The present in-vitro study was conducted in the Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Sciences, Lucknow.

Study subjects

Extracted human mandibular molar teeth, which are extracted due to periodontal purpose.

Study Sample and size

Hundred mandibular molar teeth

- Group A - 20
- Group B - 20
- Group C - 20
- Group D - 20
- Group E – 20

Eligibility Criteria

Inclusion criteria

- Teeth with complete root development.
- Teeth with similar buccolingual (11 mm +_ 0.5 mm) and mesiodistal (10.5 mm x 0.5 mm) dimensions.
- Teeth with single canal in distal root.

Exclusion Criteria

- Teeth with cracks or defects on the surface,
- Root fracture
- Previously restored teeth.

Materials and Equipments Used in the study with specifications and Company

For root canal preparation

- Endo access bur & Endo Z bur (Dentsply Maillefer, Switzerland)
- 15K file (Dentsply sirona,Ballaigues, Switzerland)
- ProTaper next file (Dentsply sirona)
- Endomoter (X-Smart plus endomoter, Dentsply sirona)
- 5.25% Sodium hypochlorite (Septodont)
- 17% EDTA (pyrax)
- Ah plus sealer (Dentsply Detrey, Germany)
- Gutta percha (Dentsply Sirona)

For Simulating the periodontal ligament

- Wax sheet
- Self-curing resin (Pyrax rapid repair)
- Silicon Impression material (Zhermack Elite Hd+light body normal set)

For Restoration of sample

- 35% phosphoric acid (Scotchbond Universal Etchant,3M ESPE, St Paul, MN, USA),
- Single Bond Universal (3M ESPE)
- a two-step etch-and-rinse n adhesive, (Dentsply/De Trey)
- Prime&Bond NT (Dentsply/De Trey)
- LED light curing unit (Woodpecker LED ,)
- Filtek™ Bulk Fill Flowable(3M ESPE)
- SmartDentin replacement(Dentsply caulk, mailfo)
- Filtek z250 composite resin(3m ESPE, St Paul, Mn)
- Ceram.X Mono (Dentsply)

For fracture strength test

Inston universal testing machine (Inston, buckinghamshire, uk)

Methodology

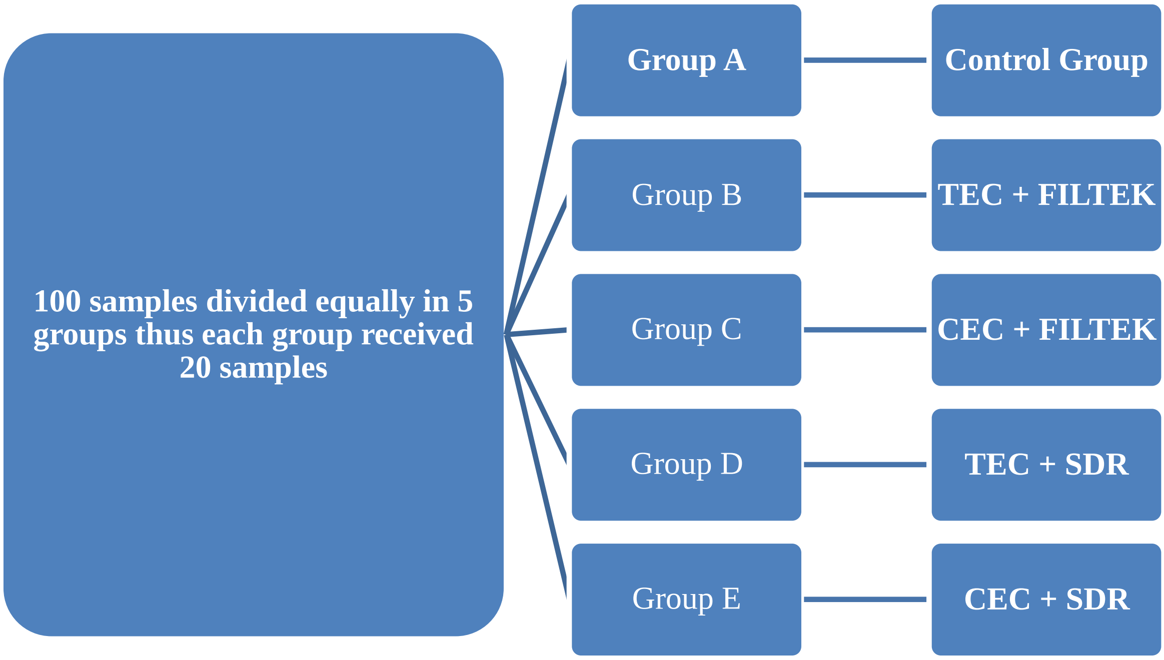

Figure1: Distribution of samples in different groups

A total of 100 extracted human molars irrespective of gender and age were collected from the Department of Oral and Maxillofacial Surgery, Babu Banarasi Das College of Dental Sciences, Lucknow. The teeth were extracted due to periodontal reasons. All extracted teeth were handled as per safety guidelines of ADA. The buccolingual (BL) and mesiodistal (MD) diameters of the teeth were measured using a caliper and ensure that all the selected teeth have similar dimensions for standardization. All collected teeth were then debrided with ultrasonic scalers & stored in 10% formalin solution until use.

After ethics committee approval 100 molar included in this study. Teeth are randomly divided in 5 groups.

1. *Group A:* Teeth in this group served as control group.
2. *Group B:* In this group, after traditional endodontic access cavity preparation, root canal treatment was performed, and Filtek™ Bulk Fill Flowable was applied as the base material. The final restoration was completed by using Filtek Z250 (3m ESPE St Paul, mn) composite resin.
3. *Group C:* In this group, after conservative Endodontic access cavity preparation, root canal treatment was done. Filtek™ Bulk Fill Flowable was applied as the base material. The final restoration was done by Filtek Z250 composite resin.
4. *Group D:* After traditional endodontic access cavity preparation, root canal treatment was done. SDR is applied as base material and final restoration was done by using Ceram.X Mono (Dentsply)
5. *Group E:* After conservative endodontic access cavity preparation, root canal treatment was done. SDR was applied as a base material and final restoration was done by Ceram.X Mono (Dentsply) composite resin.

TEC and CEC preparation

- In traditional endodontic access cavity preparation, occlusal enamel and dentin tissue between the root canal orifices was removed.
- In conservative endodontic access cavity preparation occlusal enamel and dentin tissue between the root canal orifices in the mesial and distal segment was not removed.
- Pulpal tissue in the pulpal chamber was completely removed using an ultrasonic scaler.

Root canal preparation and obturation

After preparing the endodontic access cavity, a#10k type canal file (Dentsply Sirona, sBallaigues, Switzerland) was placed into the root canal of the teeth under 2.5 x magnification, until the apical foramina was reached. The working length was set 1mm shorter than this working length. Biomechanical preparation was done by ProTaper next file. (Dentsply sirona)

X1 and X2 files of the ProTaper Next (Dentsply Sirona) rotary instrument system was used for shaping the mesial root canals, and X1, X2, X3, files are used for shaping the distal root canals. Each of the files was used to shape a maximum of 4 root canals.

The files were operated at 300-rpm speed and 300-g/cm torque using X- SMART Plus endodontic motor (Dentsply Maillefer) in accordance with the recommendations of the manufacturer.

While changing the files, the root canal is irrigated with 2ml 5.25% hypochlorite solution) Septodont(. To remove the smear layer, 2ml 17% EDTA (Ultradent Edta) was applied for 2 minutes and 2ml 5.25 %hypochlorite was applied in the final irrigation. After drying with paper points, the canal was filled with an Ah plus sealer (Dentsply DeTrey, Konstanz, Germany) and gutta percha (Dentsply Sirona).

Redundant gutta-percha was removed from the canal orifices using a hot excavator.

Simulating the periodontal ligament

The samples was coated with molten wax upto 2mm apical from the enamel cement line. Then using a metal mold, all the samples are embedded in self curing resin to 2mm apical of the enamel cement line. The teeth were then removed from the acrylic resin and molten wax removed using hot water. To simulate the periodontal ligament, the gap in acrylic resin was filled with silicone (Zhermack Elite Hd+light body normal set) impression material and the teeth was replaced in the gap.

Restoration of the sample

For group B and C, the cavities are etched for 30 seconds in enamel and 15 seconds in dentin with 35% phosphoric acid (Scotchbond Universal Etchant, 3M ESPE, St Paul, MN, USA), rinsed for 15 seconds , and gently air dried, leaving the tooth moist. The adhesive Single Bond Universal (3M ESPE), was applied for

20 seconds; the solvent was air dried for five seconds and then light cured for 10 seconds by LED .4mm thick Filtek ™Bulk Fill Flowable is applied as base material and then polymerised with an led light curing unit for 40 sec. Subsequently 2mm composite resin Filtek Z250 composite resin (3m ESPE, St Paul, Mn) is applied.

For the teeth in group D and E, after etching with De Trey Conditioner 36(Dentsply/De Trey) the cavities are etched for 30 seconds in enamel and 15 seconds in dentin rinsed for 15 seconds, and gently air dried, leaving the tooth moist, a two-step etch-and-rinse adhesive, Prime & Bond NT (Dentsply/De Trey), was applied and remained fully wet for 20 seconds; teeth were then gently air-dried for five seconds and light cured for 10 seconds. The cavities were filled with bulk fill flowable composite (SDR Flow, Dentsply) at up to 4 mm in thickness and were then cured for 40 seconds. The remaining parts of the cavities were restored with increments at a maximum of 2 mm in thickness using nanoceramic resin composite (Ceram.X Mono, Dentsply) and were light-cured for 40 seconds.

Surface polishing of all the restored samples was accomplished using SofLex (3M ESPE) finishing and polishing discs.

Fracture strength test

The teeth in all the groups was kept in distilled water at room temperature for 24 hours before the fracture strength test. For fracture testing all the samples was placed on an inston universal testing machine (Instron, Buckinghamshire, UK), which applies a compressive load on the central fossa in the lingual direction at a 15 degrees angle to the longitudinal axis of teeth. The load was applied on the sample at 1 mm/min speed using a 6 mm round head tip until fracture. The force resulting in fracture was recorded in Newton.

MATERIALS AND ARMAMENTARIUM

***Figure 1**: Teeth samples*

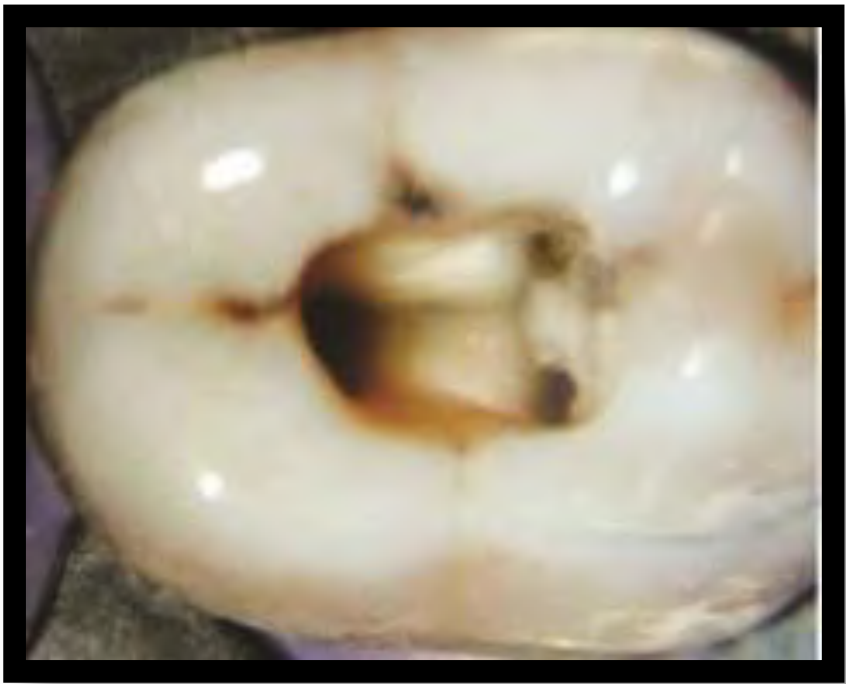

***Figure 2**: Traditional Endodontic access cavity preparation*

***Figure 3**: Conservative Endodontic access cavity preparation*

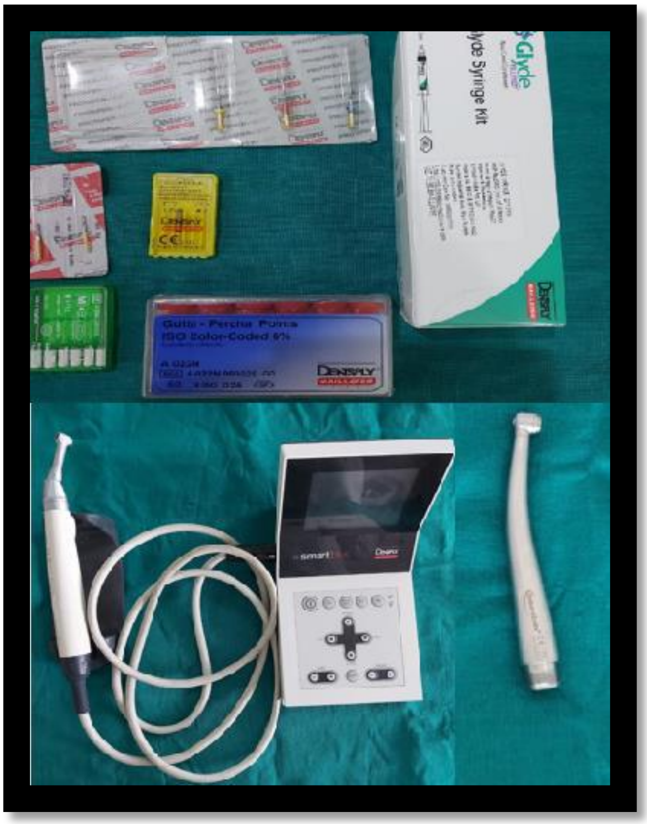

***Figure 4**: Armamentarium for root canal treatment*

Figure 5: Armamentarium for simulating periodontal ligament

Figure 6: Armamentarium for restoration of samples

Figure 7: Working length determination

Figure 8: Biochemical preparation

***Figure 9**: Master Cone*

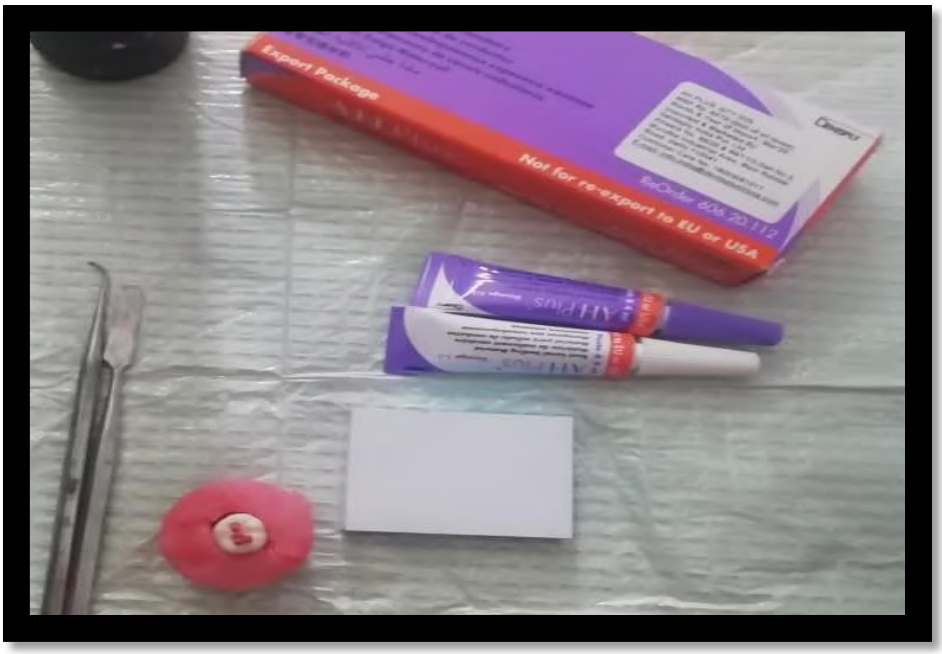

***Figure 10**: Sealer Application*

***Figure 11**: Obturation of canal*

***Figure 12**: Etchant Application*

Figure 13: Bonding agent application

Figure 14: Curing of bonding agent

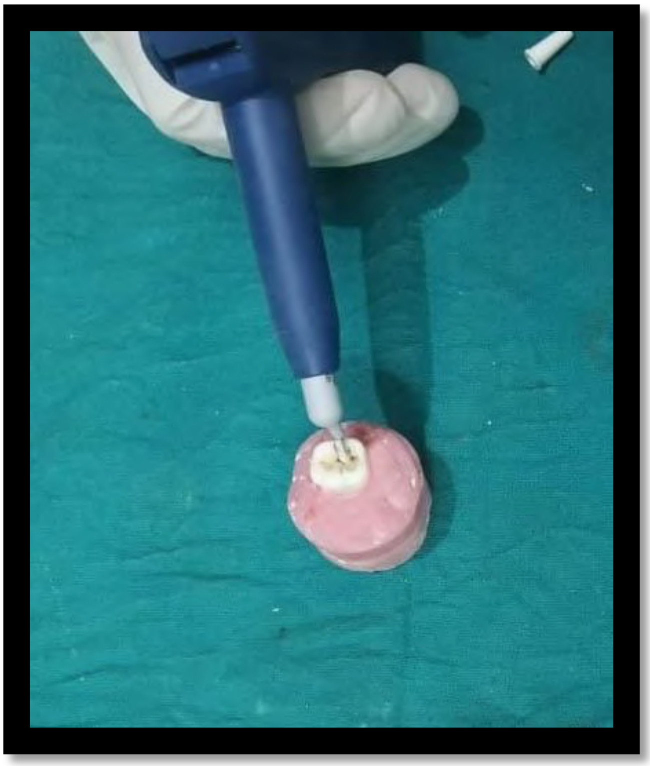

Figure 15: SDR Application

Figure 16: Filtek Bulk Fill Flowable application

***Figure 17**: Sample after restoration*

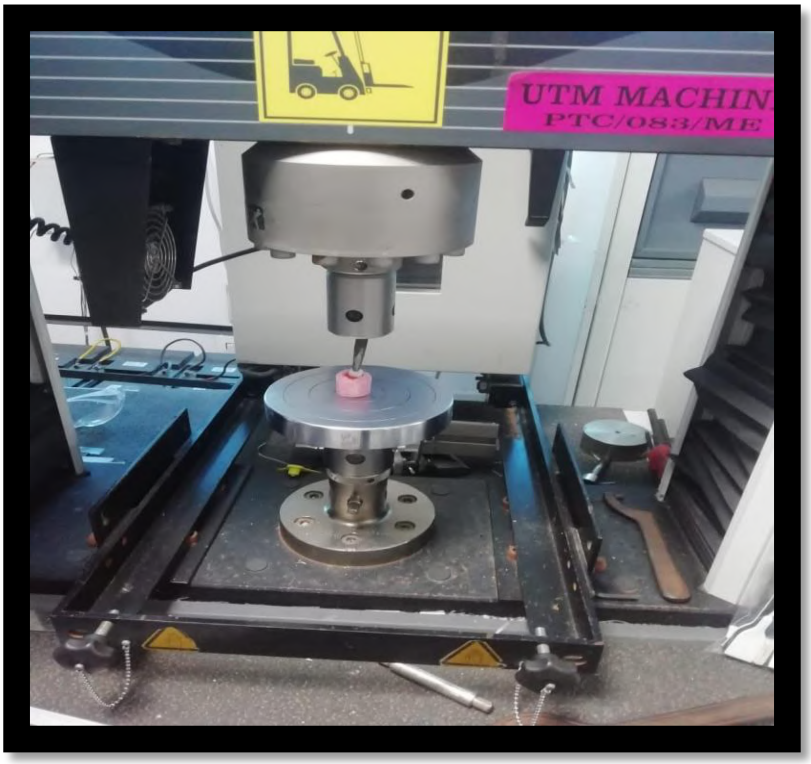

***Figure 18**: Inston universal testing machine*

OBSERVATION & RESULTS

STATISTICAL ANALYSIS

- Data were analysed using Microsoft excel 2016 and IBM SPSS.
- Descriptive study was done (Mean and Standard deviations were determined)
- Kruskal-Wallis test and Pearson correlation tests were used at 5% significance level.

Data of fracture strength of all samples are as follows:

***Table 1**: Data of fracture strengths of all samples in study*

	Group A	Group B	Group C	Group D	Group E
Preparation and material	**CONTROL**	**TEC + FILTEK BULK FILL**	**CEC + FILTEK BULK FILL**	**TEC +SDR**	**CEC +SDR**
	1812	1935.7	1649.3	1929	2039.3
	1972.4	1269.2	1817.5	2036.2	1907.3
	2439	1788.1	1506.7	1897.7	2246.2
	2112	1808.1	1732.6	1987.5	1890.7
	2092	1564.9	1603.2	2109.6	2080.7
	2097	1921.9	1517.9	2205.7	1968.9
	1990.3	1475.2	1852.7	1890.4	1967.2
	2255.7	1619.2	1962.3	1978.2	1967.4
	2173.7	1449.2	1608	1896.6	2205.7
	2206.8	1432.3	1809.9	2106.1	2198.7

	2398.7	1239.1	1762.3	2019.2	2027.6
	2197.5	1474.4	1471.8	1865.9	2124.7
	1990.7	1828.3	1952.7	1994.8	1976.9
	2309.9	1752.6	1701.5	2012.1	1799.6
	2207.6	1606.8	1901.1	2101.6	2298.8
	2152.8	1713.2	1765.5	1872.9	1798.9
	1997.5	1468.8	1879.8	1975.9	2098.6
	2091.4	1502.6	1462.3	1972.2	1986.9
	2107.9	1656.7	1793.7	1810.1	1909.4
	2180.8	1542.7	1917.2	1990.3	2291.9

<u>Distribution of fracture strengths of samples in each group shown as line diagram below</u>:

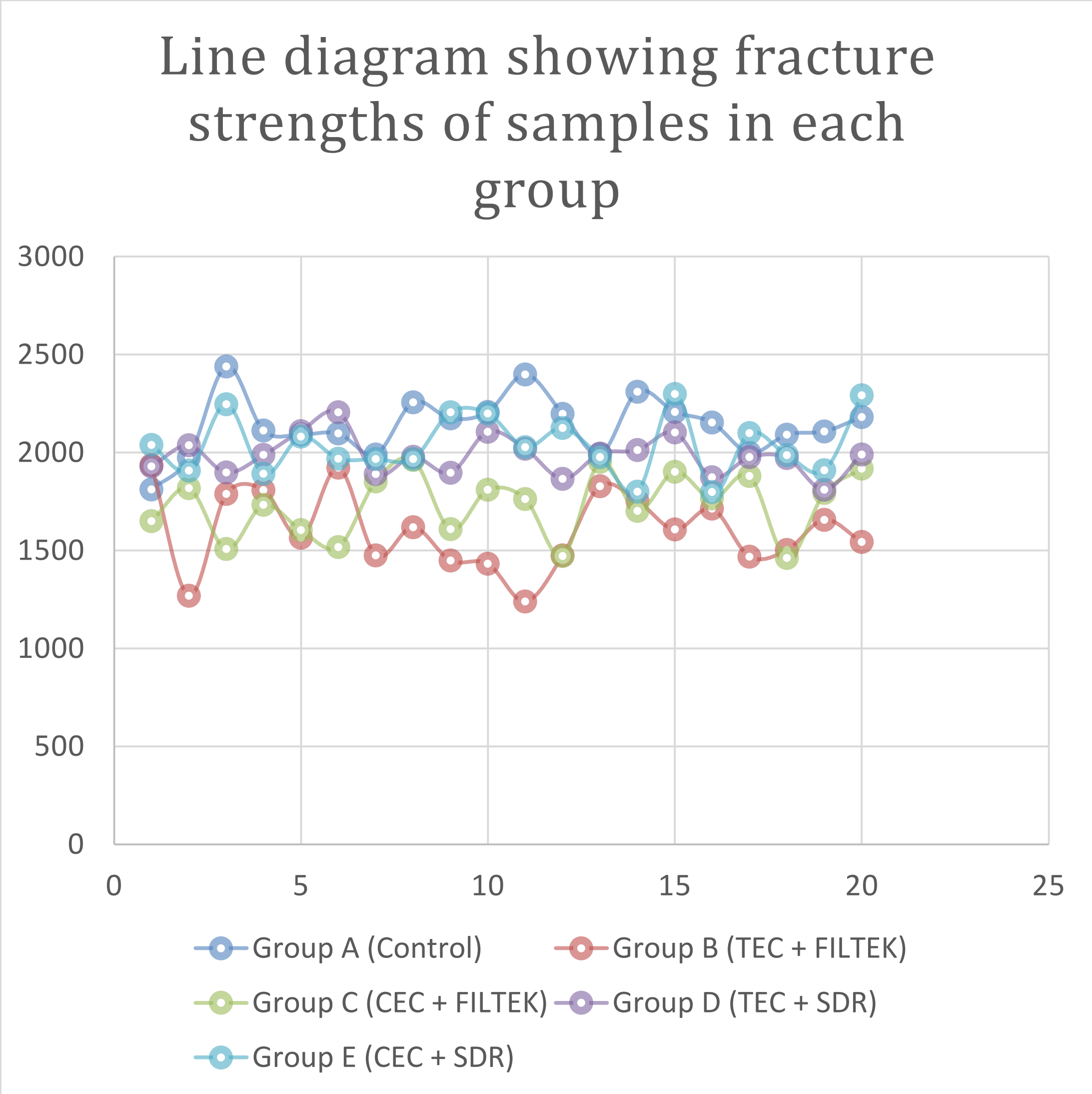

***Figure 1**: Line Diagram Showing fracture strengths of samples in each group*

Mean Fracture strength and Standard deviation of each group:

Table 2: Mean Fracture strength and standard deviation of each group

	Group A)Control(	**Group B)TEC + FILTEK(**	**Group C)CEC + FILTEK(**	**Group D)TEC + SDR(**	**Group E)CEC + SDR(**
Mean Fracture strength)N(	2139.3	1602.45	1733.4	1982.6	2039.3
Standard Deviation)SD(	145.41	192.33	157.64	95.44	147.19

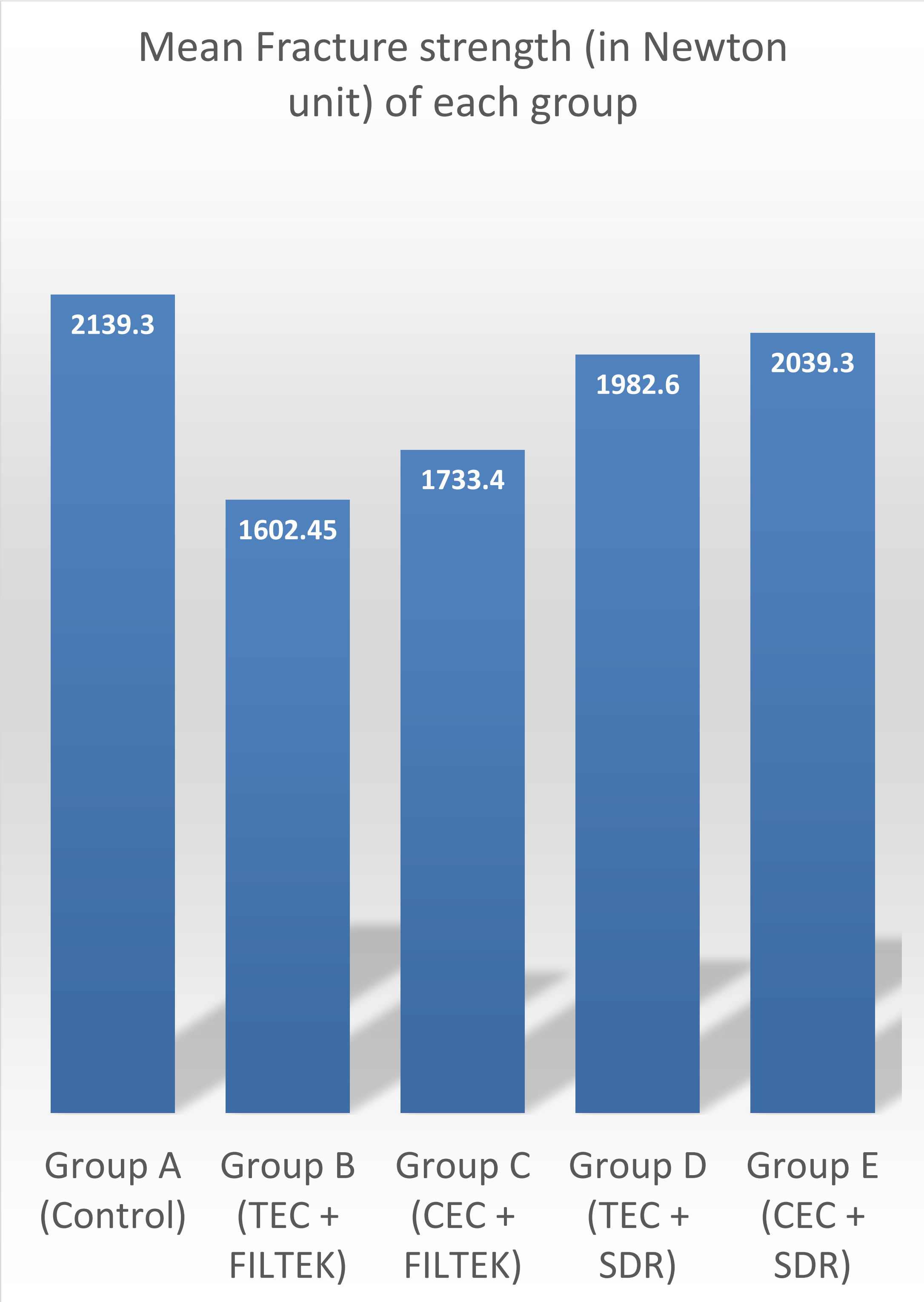

***Figure 2**: Bar Diagram comparing Mean Fracture strength of each group*

Groups as per their mean fracture strength:

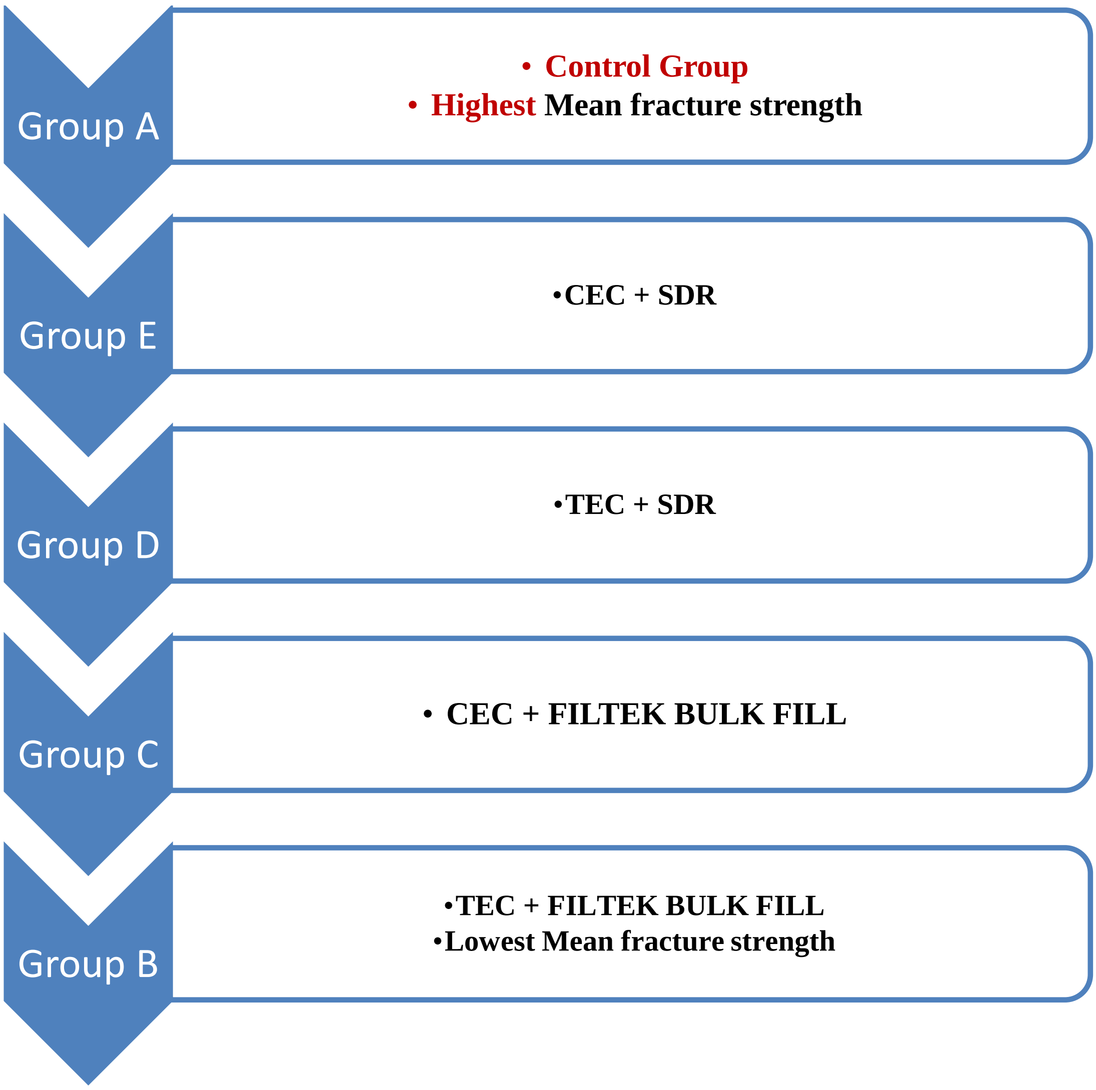

***Figure 3**: Groups arranged as per their mean fracture strength*

Control Group has highest mean fracture strength followed by Group E, Group D, Group C and Group B respectively in decreasing order of mean fracture strengths . Lowest mean fracture strength was in group B i.e .TEC prepared samples which were restored using Filtek Bulk Fill.

<u>Comparison of mean fracture strength of control group A with other groups</u>:

***Table 3**: Comparison of mean fracture strength of control group with groups using p-value*

p value	TEC + FILTEK BULK FILL	CEC +FILTEL BULK FILL	TEC +SDR	CEC +SDR
control	**< 0.05**	**< 0.05**	**< 0.05**	**< 0.05**

Mean fracture strength of control group) i.e .Group A (was significantly higher than other groups) i.e .Groups B, C, D and E.(

<u>TEC vs CEC when SDR is final restorative material</u>:

***Table 4**: TEC vs CEC when SDR is final restorative material*

	Mean Fracture strength)N(	p-value
Group E)CEC +SDR(	**2039.3**	**> 0.05)non-significant(**
Group D)TEC +SDR(	**1982.6**	

TEC and CEC prepared samples had no significant difference in their mean fracture strength When SDR was used as the restorative material.

TEC vs CEC when FILTEK BULK FILL is final restorative material:

***Table 5**: TEC vs CEC when Filtek Bulk Fill is final restorative material*

	Mean Fracture strength)N(	p-value
Group C)CEC +FILTEK BULK FILL(	1733.4	< 0.05)significant(
Group B)TEC +FILTEK BULK FILL(	1602.45	

CEC prepared samples had significantly higher mean fracture strength than TEC prepared samples when restorative material was FILTEK BULK FILL.

SDR vs FILTEK BULK FILL when TEC is the preparation method:

***Table 6**: SDR vs Filtek Bulk Fill when TEC is preparation method*

	Mean Fracture strength)N(	p-value
Group D)TEC +SDR(	1982.6	< 0.05)significant(
Group B)TEC +FILTEK BULK FILL(	1602.45	

TEC prepared samples had significantly higher mean fracture strength when SDR was used as restorative material as compared to FILTEK BULK FILL.

SDR vs FILTEK BULK FILL when CEC is the preparation method:

***Table 7**: SDR vs Filtek Bulk Fill when CEC is preparation method*

	Mean Fracture strength N	**p-value**
Group E)CEC +SDR(	**2039.3**	**< 0.05)significant(**
Group C)CEC +FILTEK BULK FILL(	**1733.4**	

CEC prepared samples had significantly higher mean fracture strength when SDR was used as restorative material as compared to FILTEK BULK FILL.

DISCUSSION

The present in-vitro study titled 'Comparative fracture strength evaluation of endodontically treated teeth having different access cavity design, restored with SDR and bulk fill composite as a dentin replacement' was conducted in the Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Sciences, Lucknow. The facility of inston universal testing machine (Instron, Buckinghamshire, UK), was availed at Central Institute of Plastics Engineering And Technology (CIPET Lucknow) Lucknow.

The methodology followed in the present study was in accordance with the study done by Taha Ozyurek et al. In present study, 100 mandibular molar were selected because the sample size 20 for each group was found to be statistically significant. In the present study, mandibular molar teeth were selected because vertical fractures are most frequently observed in mandibular molar teeth among endodontically treated posterior teeth. (34)

The buccolingual (11 mm x 0.5 mm) and mesiodistal (10.5 mm x 0.5 mm) dimensions of the selected crowns were measured with a vernier caliper at the most prominent point of the respective surfaces. We tried our best to standardize the dimensions in all teeth of the groups. Samples that did not meet these criteria were excluded and replaced.

In the present study, TEC and CEC preparation methods are compared. The aim of the study is to compare these 2 types of cavity preparation (TEC and CEC) and examine the effects of different materials on the fracture strengths of samples in the TEC and CEC groups.In endodontic treatment of posterior teeth, the main problem with cavities prepared using the TEC method is that the pulpal chamber floor also constitutes the cavity floor. (35) Among mandibular molar teeth, occlusal enamel and dentin located at the center of a tooth are subject to high chewing pressure. (36) By preserving the pulpal chamber roof using CEC preparation, the aim is to distribute the occlusal forces before they reach the pulpal chamber floor. (37) An additional aim is to preserve cervical dentin, which is very important for the lifetime and optimal function of teeth (38)

The main drawbacks of CEC preparation are the limitation in the examination of the pulp chamber and the difficulties in the debridement of the area under the pulp roof that does not get exposed. According to the findings of the present study, there was statistically significant difference in the fracture strengths of the samples prepared with the traditional (TEC) and conservative (CEC) methods when restored with the filtek bulk fill ($p < .05$)and when restored with SDR result is non-significant.

On the other hand, Moore et al (9) and Rover et al (13) found no significant difference between the TEC and CEC preparation methods in terms of fracture strength. In common with the findings of the present study, Plotino et al (12) found that the fracture strength of teeth prepared with the TEC method was significantly lower than that of teeth prepared with the CEC method and the ultra-CEC method.

According to the results obtained, the fracture strength of healthy teeth (positive control) was significantly higher than that of the other groups tested. This finding was also observed in studies by Moore et al. (9) , Consertino et al. (17) In 2018, Silva et al. (29) eemphasized the importance of maximum preservation of the pericervical dentin area, which would reduce the forces required for tooth fracture.

Similarly, Krishan et al. (4) and Plotino et al. (13) observed a significant difference in fracture strength in relation to the design of the access cavity preparation performed. In teeth subjected to minimally invasive access, a significantly higher fracture strength was observed when compared with teeth subjected to conventional access. These studies corroborate, to some extent that by Al-Omiri et al. (22), in which the authors report better fracture strength with preservation of the dentinal structure when minimally invasive endodontic access cavity preparation is used.

In the present study, bulk fill flowable material is used to reduce clinical working time for direct composite restorations while simultaneously keeping a satisfactory degree of conversion and reducing polymerization shrinkage than conventional composites and also less contamination. The biggest advantage of these materials is the possibility of application in 4-mm thick layers. In conventional composite resins, light attenuation due to light reflection from the material surface, scattering from filler particles and absorption by photoinitiators are limiting the depth of cure to approximately2 mm. Among other factors, filler content and particle size are critical to dispersion of light beam. In contrast to the trend of reducing the filler particle size and producing nanocomposites, fillers in bulk-fill composites are in the macro-filler range, in order to increase translucency of the material and increase the depth of cure. Larger filler particles have lower filler surface area and thus smaller resin-filler interface, which is responsible for the majority of light scattering.

Two groups of bulk-fill composites can be distinguished: (a) low-viscosity materials which are used as base materials and require an additional capping layer as their surface hardness and modulus of elasticity are low, and (b) high-viscosity materials which are sole cavity filling materials. (39)

In bulk fill composite, SDR and Filtek bulk fill was used, they are low viscosity composite. SDR bulk-fill composite contains a modified UDMA with a photoactive group incorporated into the monomer chain, which helps to delay gelation and reduce shrinkage stress without affecting the degree of conversion. This UDMA also has higher molecular weight (849 g/mol) than other commonly-used monomers, such as Bis-GMA (512 g/mol), Bis-EMA (496 g/mol) and conventional UDMA (470 g/mol). Thus, the shrinkage itself can be reduced by decreasing the number of reactive sites per unit volume. Flowable resin composites act as an intermediate layer and stress-breaker.

When the material is light activated, the polymerization process develops, and the volumetric reduction causes shrinkage of the material. However, the relationship between shrinkage and stress is not that simple because not all shrinkage causes stress. Residual stresses will only be generated when the composite material can no longer relax in a timely manner; not all polymerization shrinkage causes shrinkage stresses. It is important to distinguish between total shrinkage and the shrinkage that truly causes stresses, called the ‘‘post-gel shrinkage”. The percentage of polymerization shrinkage is influenced by the amount of organic content of the composite and the percentage of inorganic content. The change of a resin composite to a solid material, characterized by the development of the elastic modulus, during the polymerization results in rigid restorations and consequently residual shrinkage stresses by the effect of polymerization contraction. Polymerization shrinkage stress, which may result in clinical problems such as fractures, is affected by the composition and filler content of resin composites and their elastic modulus. The lower post-gel shrinkage value of SDR could be explained by the lower viscosity that results in more flexibility and also by the amount of inorganic filler content, an attribute of flowable composites. Additionally, the SDR resin has a polymerization modulator that acts at propagation of the linear and branched chains of the polymers of the resin, reducing the formation velocity of the polymer network, keeping its viscosity longer and providing lower stress compared with traditional composites. Inversely, SDR presented the highest total shrinkage value, probably due to the smaller amount of filler content. The total volumetric contraction depends on factors such as the size of the charge particles and also the type of the organic matrix and concentration of monomers. (40)

If the stress generated exceeds the adhesive strength, debonding can occur. On the other hand, if the adhesive is sufficiently strong, the tooth structure will suffer the consequences, leading to cusp flexure, crack formation and propagation, and fracture. These shrinkage stresses are also directly associated with the elastic modulus of the composite. The elastic modulus is a material property that expresses the inherent stiffness of a material and determines how much stress is generated when the material is deformed. Stresses created by polymerization shrinkage thus depend on both shrinkage and elastic modulus values. Composite resins with a higher elastic modulus (which increases, for example, with filler content) can generate higher residual shrinkage stresses in a restored tooth with the same amount of shrinkage.

It has often been claimed that the elastic modulus should be as similar as possible to the tooth structure so that the resin composite is able to flex with the tooth structure under mechanical load. The elastic moduli of the three resin composites investigated in the present study (4-5 GPa to 10-11 GPa)are much closer to that of dentin (13-19.0 GPa)than to that of enamel(80-94 GPa) the much bigger difference for enamel resulting in higher stress formation. (41)

According to the results of the present study, regardless of the type of prepared endodontic cavity, the fracture strength of the samples restored with SDR was higher than that of the samples restored using Filtek bulk fill ($P < .05$). Thus, the second null hypothesis of the present study was rejected. A previous study showed that the choice of restoration material had significant effects on the fracture strength of teeth after root canal treatment (42). In the present study, in contrast to previous studies, the fracture strength of teeth restored with Filtrek Bulk Fill was lower than that of teeth restored using Sdr. Moreover, during the restoration of teeth with CEC preparation, SDR Plus has a self-leveling feature that allows intimate adaptation to the prepared cavity walls resulting higher fracture strength.

The use of bulk-fill composite resins in posterior restorations reduces the cusp deformation, post-gel shrinkage, and shrinkage stress, and increases the fracture strength.

Rosatto CMet al. fracture resistance of molars restored with bulk-fill composites and incremental filling technique four bulk-fills-, Filtek Bulk Fill/Filtek Z350XT; VBF/CHA, Venus Bulk Fill/Charisma Diamond; SDR/EST-X, SDR/Esthet-X HD; TEC, TetricEvoCeram Bulk Fill, The FBF/Z350XT group had significantly lower fracture resistance than the other filling techniques that used bulk-fill composite resins. Atalay C,et al (3)compared fracture resistance of endodontically treated teeth restored with bulk fill resin composite/Filtek Bulk Fill (3M ESPE); bulk fill flowable resin composite + nanohybrid/SureFil SDR Flow + Ceram.X Mono (Dentsply); fiber-reinforced composite + posterior resin composite/GC everX posterior + G-aenial posterior (GC Corp.); and nanohybrid resin composite/Tetric N-Ceram (Ivoclar/Vivadent)Haugen HJ (44)also found similar result that sdr has better fracture strength than filtek bulk fill,on the other hand Al-Nahedh HN, et al (45)compared filtek bulk fill SDR and tetric n ceram,found that filtek bulk fill has better fracture strength.

The limitations of the present study are that a static rather than a dynamic force was applied to the samples, and intraoral factors, such as temperature and pH changes, were not simulated.

CONCLUSION

It can be concluded from this study that Group A (Intact teeth) showed significantly highest fracture strength when compared with all other groups (Group B, C, D, E) in this study.

While TEC and CEC prepared samples had no significant differences in their mean fracture strength, when SDR was used as the restorative material (Group D and group C) respectively.

CEC prepared samples had significantly higher mean fracture strength than TEC prepared samples when Filtek Bulk Fill was used as the restorative material (comparison of Group C and B respectively).

It can also be stated from this study that when a comparison was done only on samples prepared using TEC method a significantly higher mean fracture strength was found in samples restored using SDR as compared to Filtek Bulk Fill (Group D and B).

When only the samples prepared using CEC method were compared it was seen that the samples restored using SDR as the restorative material showed significantly high mean fracture strength as compared to samples restored using Filtek Bulk Fill (comparison between group E and group C).

REFERENCESS

1. Adams N, Tomson PL. Access cavity preparation.. Br Dent J. 2014 Mar;216(6):333-9.
2. Bürklein S, Schäfer E.0.3290/j.qi.a33047. PMID: 25500587. Minimally invasive endodontics. Quintessence Int. 2015 Feb;46(2):119-24.
3. Atalay, C., Yazici, A., Horuztepe, A., Nagas, E., Ertan, A., & Ozgunaltay, G. (2016). Fracture Resistance of Endodontically Treated Teeth Restored With Bulk Fill, Bulk Fill Flowable, Fiber-reinforced, and Conventional Resin Composite. Operative Dentistry, 41(5), E131–E140.
4. Mannan G, Smallwood ER, Gulabivala K. Effect of access cavity location and design on degree and distribution of instrumented root canal surface in maxillary anterior teeth. Int Endod J. 2001;34(3):176-183.
5. Tang W, Wu Y. Identifying and reducing risk for potential fracture in endodontically treated teeth. J Endod 2010;36:609-17. .
6. Krishna R, plaque F. Impacts of conservative Endodontic cavity on root canal instrumentation efficacy and resistance to fracture assessed in incisor, premolar, and molar. J Endod 2014;40:1160-66. .
7. Mannocci F, Cowie J. Restoration of endodontically treated teeth. Br Dent J. 2014;216(6):341-346.
8. Eaton JA, Clement DJ, Lloyd A, Marchesan MA. Micro-Computed Tomographic Evaluation of the Influence of Root Canal System Landmarks on Access Outline Forms and Canal Curvatures in Mandibular Molars. J Endod. 2015;41(11):1888-1891.
9. Moore B, Veredelis K, et Al. Impacts of contracted endodontic cavities on instrumentation efficacy and biomechanical response in maxillary molar. J Endod2016;42:1779-83.
10. Zehnder MS, Connert T, Weiger R, Krastl G, Kühl S. Guided endodontics: accuracy of a novel method for guided access cavity preparation and root canal location. Int Endod J. 2016;49(10):966-972.
11. Yuan K, Niu C, Xie Q, et al. Comparative evaluation of the impact of minimally invasive preparation vs. conventional straight-line preparation on tooth

biomechanics: a finite element analysis. Eur J Oral Sci. 2016;124(6):591-596. .

12. Plotino G, Grande NM, Isufi A, et al. Fracture Strength of Endodontically Treated Teeth with Different Access Cavity Designs. J Endod. 2017;43(6):995-1000.
13. Rover G, Belladonna FG, Bortoluzzi EA, De-Deus G, Silva EJNL, Teixeira CS. R Influence of Access Cavity Design on Root Canal Detection, Instrumentation Efficacy, and Fracture Resistance Assessed in Maxillary Molars. J Endod. 2017;43(10):1657-1662.
14. Taha NA, Maghaireh GA, Ghannam AS, Palamara JE. Effect of bulk-fill base material on fracture strength of root-filled teeth restored with laminate resin composite restorations. J Dent. 2017;63:60-64.
15. Özyürek T, Ülker Ö, Demiryürek EÖ, Yılmaz F. The Effects of Endodontic Access Cavity Preparation Design on the Fracture Strength of Endodontically Treated Teeth: Traditional Versus Conservative Preparation. J Endod. 2018;44(5):800-805. .
16. Allen C, Meyer CA, Yoo E, Vargas JA, Liu Y, Jalali P. Stress distribution in a tooth treated through minimally invasive access compared to one treated through traditional access: A finite element analysis study. J Conserv Dent. 2018;21(5):505-509. .
17. Corsentino G, Pedullà E, Castelli L, et al. Influence of Access Cavity Preparation and Remaining Tooth Substance on Fracture Strength of Endodontically Treated Teeth. J Endod. 2018;44(9):1416-1421.
18. Silva EJNL, Rover G, Belladonna FG, De-Deus G, da Silveira Teixeira C, da Silva Fidalgo TK. Impact of contracted endodontic cavities on fracture resistance of endodontically treated teeth: a systematic review of in vitro studies. Clin Oral Investig. 2018.
19. Sabeti M, Kazem M, Dianat O, et al. Impact of Access Cavity Design and Root Canal Taper on Fracture Resistance of Endodontically Treated Teeth: An Ex Vivo Investigation. J Endod. 2018;44(9):1402-1406.
20. Marchesan MA, Lloyd A, Clement DJ, McFarland JD, Friedman S. Impacts of Contracted Endodontic Cavities on Primary Root Canal Curvature Parameters in Mandibular Molars. J Endod. 2018;44(10):1558-1562.
21. Alovisi M, Pasqualini D, Musso E, Bobbio E, Giuliano C, Mancino D, Scotti N,

Berutti E. Influence of Contracted Endodontic Access on Root Canal Geometry: An In Vitro Study. J Endod. 2018 Apr;44(4):614-620.

22. Marchesan MA, Lloyd A, Clement DJ, McFarland JD, Friedman S. Impacts of Contracted Endodontic Cavities on Primary Root Canal Curvature Parameters in Mandibular Molars. J Endod. 2018 Oct;44(10):1558-1562.
23. Abou-Elnaga MY, Alkhawas MAM, Kim HC, Refai AS. Effect of Truss Access and Artificial Truss Restoration on the Fracture Resistance of Endodontically Treated Mandibular First Molars. J Endod. 2019;45(6):813-817.
24. Roperto R, Sousa YT, Dias T, et al. Biomechanical behavior of maxillary premolars with conservative and traditional endodontic cavities. Quintessence Int. 2019;50(5):350-356.
25. Zhang Y, Liu Y, She Y, Liang Y, Xu F, Fang C. The Effect of Endodontic Access Cavities on Fracture Resistance of First Maxillary Molar Using the Extended Finite Element Method. J Endod. 2019;45(3):316-321.
26. Saberi EA, Pirhaji A, Zabetiyan F. Effects of Endodontic Access Cavity Design and Thermocycling on Fracture Strength of Endodontically Treated Teeth. Clin Cosmet Investig Dent. 2020;12:149-156. Published 2020 Apr 23.
27. Barbosa AFA, Lima CO, Coelho BP, Ferreira CM, Sassone LM, Silva EJNL. The influence of endodontic access cavity design on the efficacy of canal instrumentation, microbial reduction, root canal filling and fracture resistance in mandibular molars. Int Endod J. 2020;10.1111/iej.13383.
28. Saber SM, Hayaty DM, Nawar NN, Kim HC. The Effect of Access Cavity Designs and Sizes of Root Canal Preparations on the Biomechanical Behavior of an Endodontically Treated Mandibular First Molar: A Finite Element Analysis. J Endod. 2020;S0099-2399(20)30451-9.
29. Silva EJNL, Oliveira VB, Silva AA, et al. Effect of access cavity designs on gaps and void formation in resin composite restorations following root canal treatment on extracted teeth. Int Endod J. 2020;10.1111.
30. Isufi A PGGNTLGG. Standardization of Endodontic Access Cavities Based on 3-dimensional Quantitative Analysis of Dentin and Enamel Removed. J Endod. 2020;S0099-2399(20)3.
31. Barbosa AFA, Lima CO, Coelho BP, Ferreira CM, Sassone LM, Silva EJNL. The

influence of endodontic access cavity design on the efficacy of canal instrumentation, microbial reduction, root canal filling and fracture resistance in mandibular molars. Int Endod J. 2020;10.1111/iej.13383.

32. Wang Q, Liu Y, Wang Z, et al. Effect of Access Cavities and Canal Enlargement on Biomechanics of Endodontically Treated Teeth: A Finite Element Analysis. J Endod. 2020;S0099-2399(20)30424-6.
33. Tüfenkçi P, Yılmaz K, Adigüzel M. Effects of the endodontic access cavity on apical debris extrusion during root canal preparation using different single-file systems. Restorative dentistry & endodontics, 4.
34. Touré B FBKALCNBBY. Analysis of reasons for extraction of endodontically treated teeth: a prospective study. J Endod. 2011;37(11):1512-1515.
35. Panitvisai P MH. Cuspal deflection in molars in relation to endodontic and restorative procedures. J Endod. 1995;21(2):57-61.
36. Rocca GT SCCLMFASSKI. f endodontically treated molars restored with CAD/CAM resin composite overlay resto. J Dent. 2015;43(9):1106-1115.
37. Jiang W BHYGLN. Stress distribution in molars restored with inlays or onlays with or without endodontic treatment: a three-dimensional finite element analysis. J Prosthet Dent. 2010;103(1):6-12.
38. Pierrisnard L BFRPBM. Corono-radicular reconstruction of pulpless teeth: a mechanical study using finite element analysis. J Prosthet Dent. 2002;88(4):442-448.
39. Kelić K, Matić S, Marović D, Klarić E, Tarle Z. Microhardness of Bulk-Fill Composite Materials. Kelić K, Matić S, Marović D, Klarić E, Tarle Z. M Acta Clin Croat. 2016 Dec;55(4):607-614.
40. da Silva Pereira RA, de Bragança GF, Vilela A, de Deus RA, Miranda RR, Veríssimo C, Soares CJMolars. Post-gel and Total Shrinkage Stress of Conventional and Bulk-fill Resin Composites in Endodontically-treated Molars. Oper Dent. 2020 Sep 1;45(5):E217-E226.
41. Peutzfeldt A, Mühlebach S, Lussi A, Flury S. Marginal Gap Formation in Approximal "Bulk Fill" Resin Composite Restorations After Artificial Ageing. Oper Dent. 2018 Mar/Apr;43(2):180-189.

42. Hachmeister KA, Dunn WJ, Murchison DF, Larsen RB. Fracture strength of amalgam crowns with repaired endodontic access.. Oper Dent. 2002 May-Jun;27(3):254-8.

43. Rosatto CM, Bicalho AA, Veríssimo C, Bragança GF, Rodrigues MP, Tantbirojn D, Versluis A, Soares CJ.. Mechanical properties, shrinkage stress, cuspal strain and fracture resistance of molars restored with bulk-fill composites and incremental filling technique. J Dent. 2015 Dec;43(12):1519-28.

44. Haugen HJ, Marovic D, Par M, Thieu MKL, Reseland JE, Johnsen GF. Bulk Fill Composites Have Similar Performance to Conventional Dental Composites.. Int J Mol Sci. 2020 Jul 20;21(14):5136.

45. Al-Nahedh HN, Alawami Z. Fracture Resistance and Marginal Adaptation of Capped and Uncapped Bulk-fill Resin-based Materials. Oper Dent. 2020 Mar/Apr;45(2):E43-E56.

46. Magaravalli SR, Patel SJ, Rangaswamy P, Ramachandra S, Govindappa K, Hiremath V.. Effect of Smart Dentin Replacement, Biodentine, and Its Combination for Dentin Replacement as Alternatives to Full-crown Coverage for Endodontically Treated Molars: An In Vitro Study. Magaravalli SR, Patel SJ, Rangaswamy P, Ramachandra S, Govindappa K, Hiremath V. Effect of Smart Dentin Replacement, Biodentine, and Its Combin fo J Int Soc Prev Community Dent. 2019 Nov 12;9(6).

47. AlSagob EI, Bardwell DN, Ali AO, Khayat SG, Stark PC.. Comparison of microleakage between bulk-fill flowable and nanofilled resin-based composites. Interv Med Appl Sci. 2018 Jun;10(2):102-109. doi: 10.1556/1646.10.2018.07. PMID: 30363354; PMCID: PMC6167621.

48. Ilie N, Hickel R. Investigations on a methacrylate-based flowable composite based on the SDR™ technology. Dent Mater. 2011 Apr;27(4):348-55.

49. 4. Patel S R. 4. A practical guide to Endodontic access cavity preparation in molar teeth. 4. Br Dent J 2007;203:133-40.

50. Abou-Elnaga MY AMKHRA. Effect of Truss Access and Artificial Truss Restoration on the Fracture Resistance of Endodontically Treated Mandibular First Molars. J Endod. 2019;45(6):813-817. doi:10.1016/j.joen.2019.02.007.

51. Reeh ES MHDW. Reduction in tooth stiffness as a result of endodontic and

restorative procedures. J Endod. 1989;15(11):512-516.

52. Adams N, Thomson P. Access cavity preparation. Br Dent J. 2014;216:333-39.
53. Gluskin A.H, Peter C, Peter O.A. Minimally invasive endodontics :challenging prevailing paradigms. Br Dent J. 2014;216:347-53.
54. Tzimpoulas NE, Alisafis MG, Tzanetakis GN, Kontakiotis EG.. A prospective study of the extraction and retention incidence of endodontically treated teeth with uncertain prognosis after endodontic referral. J Endod 2012; 38: 1326–9.
55. Clark D, Khademi J. Modern molar endodontic access and directed dentin conservation. Dent Clin North Am 2010; 54: 249–73.
56. Ikram OH, Patel S, Sauro S, Mannocci F. Micro-computed tomography of tooth tissue volume changes following endodontic procedures and post space preparation. Int Endod J 2009; 42: 1071–6.
57. Maske A, Weschenfelder VM, Soares Grecca Vilella F, Burnett Junior LH, de Melo TAF. Influence of access cavity design on fracture strength of endodontically treated lower molars. Aust Endod J. 2020 Sep 26.
58. Silva EJNL, Rover G, Belladonna FG, De-Deus G, da Silveira Teixeira C, da Silva Fidalgo TK. Impact of contracted endodontic cavities on fracture resistance of endodontically treated teeth: a systematic review of in vitro studies. Clin Oral Investig. 2018.
59. Özyürek T ÜÖDEYF. The Effects of Endodontic Access Cavity Preparation Design on the Fracture Strength of Endodontically Treated Teeth: Traditional Versus Conservative Preparation. J Endod. 2018;44(5):800-805.
60. Clark D, Khademi J. Modern molar endodontic access and directed Dentin conservation. Dent Clin North Am 2010;54:249-73.
61. Clark D, Khademi J.. Modern molar endodontic access and directed dentin conservation. Dent Clin North Am. 2010 Apr;54(2):249-73.

ANNEXURE I

RESEARCH COMMITTEE APPROVAL

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

INSTITUTIONAL RESEARCH COMMITTEE APPROVAL

The project titled **"Comparative Fracture Strength Evaluation of Endodontically Treated Teeth Having Different Access Cavity Design, Restored With SDR and Bulk Flow as a Dentin Replacement Composite: An *In-Vitro* Study."** submitted by **Dr Karishma Rao** 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.

10/12/18

Prof. Vandana A Pant
Co-Chairperson

Prof. B. Rajkumar
Chairperson

ANNEXURE II

ETHICS COMMITTEE APPROVAL

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: 22 **BBDCODS/01/2019**

Title of the Project: Comparative Fracture Strength Evaluation of Endodontically Treated Teeth Having Different Access Cavity Design, Restored With SDR and Bulk Flow as a Dentin Replacement Composite: An *In-Vitro* Study.

Principal Investigator: Dr. Karishma Rao **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. Karishma Rao,

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 University
Faizabad Road, Lucknow-226028

(Dr. B. Rajkumar)
PRINCIPAL
BBDCODS

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

ANNEXURE III

CIPET certificate

सिपेट : इंस्टीट्यूट ऑफ प्लास्टिक्स टेक्नोलॉजी (आई.पी.टी.)
रसायन एवं पेट्रोरसायन विभाग,
रसायन एवं उर्वरक मंत्रालय, भारत सरकार
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फोन : +९१-५२२-२४३६२२७, ७६०७१९४०१४
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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 – 011
Date: 20.11.2020

Issued to:

Dr. Karishma Rao
MDS Student in Department of Conservative Dentistry & Endodontics,
Babu Banarasi Das University,
BBD City, Faizabad Road,
Lucknow- 226 028 (U.P.), India

Page No 1 of 4

CERTIFICATE

PART-A

PARTICULARS OF SAMPLE SUBMITTED

Sample details	:	**Dental sample** as stated by the party Your Ref. No. : BBDCODS/Gen-Corres/2020/01 Date : 20.10.2020
Size/Class	:	--
Quantity of samples	:	100 Nos.group
Code No.	:	---
Date of Manufacturing	:	---
Condition of receipt of sample	:	---
Sealed or not	:	Not sealed
Date of sample received	:	05.11.2020
Any other details	:	Payment received on 11.11.2020

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

मुख्यालय : गिण्डी, चेन्नई - ६०० ०३२ Head Office : Guindy, Chennai - 600 032

सिपेट : इंस्टीट्यूट ऑफ प्लास्टिक्स टेक्नोलॉजी (आई.पी.टी.)
रसायन एवं पेट्रोरसायन विभाग,
रसायन एवं उर्वरक मंत्रालय, भारत सरकार
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Page No 2 of 4

CERTIFICATE

S. No		1	2	3	4	5
GROUPS		Group A	Group B	Group C	Group D	Group E
		Sample Control	TEC + FILTEK BULK FILL	CEC + FILTEK BULK FILL	TEC + SDR	CEC + SDR
Name Of the Test		Fracture strength	Fracture strength	Fracture strength	Fracture strength	Fracture strength
Test method		As per requisition	As per requisition	As per requisition	As per requisition	As per requisition
Unit		N	N	N	N	N
TEST VALUE OBTAINED	S. No	CONTROL	TEC + FILTEK BULK FILL	CEC + FILTEK BULK FILL	TEC + SDR	CEC + SDR
	1	1812	1935.7	1649.3	1929	2039.3
	2	1972.4	1269.2	1817.5	2036.2	1907.3
	3	2439	1788.1	1506.7	1897.7	2246.2
	4	2112	1808.1	1732.6	1987.5	1890.7
	5	2092	1564.9	1603.2	2109.6	2080.7

मुख्यालय : गिण्डी, चेन्नई - ६०० ०३२
Head Office : Guindy, Chennai - 600 032

ANNEXURE IV

MASTER CHART

सिपेट : इंस्टीट्यूट ऑफ प्लास्टिक्स टेक्नोलॉजी (आई.पी.टी.)
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Page No 3 of 4

	6	2097	1921.9	1517.9	2205.7	1968.9
	7	1990.3	1475.2	1852.7	1890.4	1967.2
	8	2255.7	1619.2	1962.3	1978.2	1967.4
	9	2173.7	1449.2	1608	1896.6	2205.7
	10	2206.8	1432.3	1809.9	2106.1	2198.7
TEST	11	2398.7	1239.1	1762.3	2019.2	2027.6
VALUE	12	2197.5	1474.4	1471.8	1865.9	2124.7
OBTAINED	13	1990.7	1828.3	1952.7	1994.8	1976.9
	14	2309.9	1752.6	1701.5	2012.1	1799.6
	15	2207.6	1606.8	1901.1	2101.6	2298.8
	16	2152.8	1713.2	1765.5	1872.9	1798.9
	17	1997.5	1468.8	1879.8	1975.9	2098.6
	18	2091.4	1502.6	1462.3	1972.2	1986.9

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रसायन एवं उर्वरक मंत्रालय, भारत सरकार
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Page No 4 of 4

TEST VALUE OBTAINED	19	2107.9	1656.7	1793.7	1810.1	1909.4
	20	2180.8	1542.7	1917.2	1990.3	2291.9

AUTHORIZED SIGNATORY
Dr. V. H. Sangeetha
Technical Officer

AUTHORIZED SIGNATORY
Vivek Kumar
Sr. Technical Officer

मुख्यालय : गिण्डी, चेन्नई - ६०० ०३२
Head Office : Guindy, Chennai - 600 032

ANNEXURE V

PLAGIARISM REPORT

URKUND

Urkund Analysis Result

Analysed Document: Thesis 6th july v4 (1).docx (D110208823)
Submitted: 7/6/2021 6:09:00 PM
Submitted By: 1180322003@bbdu.ac.in
Significance: 9 %

Sources included in the report:

A COMPARATIVE EVALUATION OF DIFFERENT RESTORATIVE MATERIALS AS AN ALTERNATIVE TO CROWN COVERAGE FOR ENDODONTICALLY TREATED MANDIBULAR MOLARS AN IN VITRO STUDY.docx (D60229113)
SHILPA D JAIN THESIS FINAL(ODS).pdf (D61323189)
thesis palagrism.docx (D110198936)
e0435e51-8889-49e7-8a34-2931824f66dc
https://glad.geog.umd.edu/Potapov/Primary_2000/www/index.html
https://assets.dentsplysirona.com/flagship/en/explore/restorative/sdr_flow_plus_eoc_version/SDR-Plus-Scientific-Manual.pdf
https://www.researchgate.net/publication/323894510_The_Effects_of_Endodontic_Access_Cavity_Preparation_Design_on_the_Fracture_Strength_of_Endodontically_Treated_Teeth_Traditional_Versus_Conservative_Preparation
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7185324/
https://www.dovepress.com/effects-of-endodontic-access-cavity-design-and-thermocycling-on-fractu-peer-reviewed-fulltext-article-CCIDE
http://saspjournals.com/wp-content/uploads/2018/10/SJDS-59-443-451-c.pdf
https://www.researchgate.net/publication/326552655_Impact_of_Access_Cavity_Design_and_Root_Canal_Taper_on_Fracture_Resistance_of_Endodontically_Treated_Teeth_An_Ex_Vivo_Investigation