

**“COMPARATIVE EVALUATION OF FRACTURE  
RESISTANCE OF ENDODONTICALLY TREATED  
TEETH RESTORED WITH FOUR DIFFERENT  
BULK FILL COMPOSITES: AN IN-VITRO STUDY”**

By

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**Dissertation**

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ENDODONTICS  
(BRANCH – IV)**

**Under the guidance of**

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*This Dissertation is dedicated*

*to*

*Almighty God,*

*My Parents,*

*&*

*My Family Members*

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**Date:**

**Dr Shrutika V. Salkar**

**Place:** Belagavi.

## LIST OF ABBREVIATIONS

NiTi	Nickel – Titanium
NaOCl	Sodium Hypochlorite
K file	Kerr file
EDTA	Ethylenediaminetetracetic acid
#15	Tip diameter - 0.15mm
#20	Tip diameter -0.20mm
%	Percentage
i.e	That is
MOD	Mesial-Occlusal-Distal
ETT	Endodontically treated teeth
PCD	Peri Cervical Dentin
N	Newton
PTU	ProTaper Universal File system
S	Seconds
BMP	Biomechanical preparation
LED	Light-emitting diode
Bis-EMA	Ethoxylated bisphenol-A-dimethacrylate
Bis-GMA	Bisphenol-A-glycidyl dimethacrylate
TEGDMA	Triethylene glycol dimethacrylate

UDMA	Urethane dimethacrylate
F3	ProTaper Universal Finishing file 3
GIC	Glass ionomer cement
WL	Working length
min	Minutes
hrs	Hours
yrs	Years
<	Less than
>	Greater than
=	Equal to
DC	Degree of Conversion
DOC	Depth of cure
vs.	versus
UTM	Universal testing machine

## **ABSTRACT:**

**Aim** :Comparative evaluation of fracture resistance of endodontically treated teeth restored with four different bulk-fill composites using the universal testing machine

**Materials and method**:120 permanent mandibular premolar which fulfilled inclusion and exclusion criteria were selected for the study. Mesio-occlusal-distal cavity preparation was done followed by access opening. WL determination was carried out with a 15 K file. Cleaning and shaping were done with ProTaper Universal files upto size F3. Irrigation was done with 3% of sodium hypochlorite between the successive files followed by the use of 17% EDTA and final flush with distilled water. The teeth were dried with paper points and obturated. Coronal 3mm of gutta-percha was removed and the canal orifices were sealed with resin-modified GIC. The teeth were then placed in an incubator for 7 days. The teeth were then randomly divided into 4 groups of 30 each and core build-up was done with 4 different types of bulk fill.

The four groups were as follows:

Group I:X-trafil (VOCO) bulk fill composite

Group II: Filtek (3M) bulk-fill composite

Group III: TetricEvoceram (Ivoclar) bulk-fill composite

Group IV: Aura (SDI) bulk-fill composite

The teeth were mounted in an acrylic resin. Fracture resistance testing was done using a universal testing machine.

**Results:** The fracture resistance of Group 2 (FILTEK BULK FILL) was significantly higher as compared to that of the Group 1 (X-TRA FILL), Group 3 (TETRIC EVOCERAM) and Group 4 (AURA) bulk-fill composites.

**Statistical analysis:** Statistical analysis was done using One-way ANOVA and Newman-Keuls multiple Post hoc test.

**Conclusion:** Under the limitations of current research, it was concluded that highest fracture resistance was exhibited by 'Filtek', followed by 'TetricEvoceram', 'X-trafil' and 'Aura bulk fill' composites.

**Keywords:** Bulk fill composites, fracture resistance, universal testing machine

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## **INTRODUCTION**

Post endodontic treatment has repeatedly been a matter of disquiet for the prolonged success of teeth treated endodontically. Poor post endodontic restoration would lead to loss of most of the endodontically treated teeth(ETT) rather than subsequent failure caused by inadequate endodontic therapy. Most endodontically treated teeth(ETT) are lost owing to poor restoration rather than subsequent endodontic failure. An acceptable coronal seal may be achieved by the use of restorative materials and techniques which, furthermore provide resistance to fracture so as to lower the possibility of an unsuccessful restoration and probable tooth loss.<sup>1</sup>

Tooth fracture has been described as a serious problem in dentistry and is the third most common explanation for tooth loss after decayed teeth and periodontal disease <sup>2</sup>. Several clinical data have revealed the interrelation of the history of endodontic treatment to the high prevalence of tooth fracture <sup>(3,4)</sup>. Teeth treated endodontically may fracture because of dehydration and privation of dentin following endodontic procedures which would induce the removal of important anatomic structures all of which gives much of the required brace for the natural teeth, hence making them prone to fracture <sup>5</sup>.

Endodontically treated teeth(ETT) become brittle resulting in a decrease in strength of the tooth leading to increased risk of fracture. Access cavity preparation along with chemo-mechanical debridement compromise the anatomic structures like the occlusal marginal ridges of endodontic ally treated teeth(ETT) which cause tooth fragility <sup>6</sup>. Increased tooth fragility could also be because of the effect of endodontic chemical products such as Sodium hypochlorite(NaOCl), Chelators and Calcium

hydroxide  $\text{Ca}(\text{OH})_2$  used during cleaning and shaping, which may have an effect on the dentin of the root canal & modify its characteristics.<sup>7</sup>

Dimitrui et al said that tissue conservation is the most crucial issue when handling the non-vital teeth. Enhancement of the biomechanical behaviour as well as conserving and perpetuating the intact structures of the restored teeth treated endodontically play a pivotal role to ameliorate the resistance to fracture of the teeth.<sup>13</sup> Traditionally placement of a crown following endodontic treatment was considered necessary, however as crown cutting requires an invasive tooth preparation and exposes the tooth to a higher risk of irreversible fractures, therefore there is a paradigm shift from traditional crown preparation to a more conservative approach of minimally invasive dentistry.<sup>14</sup>

The dentin extending 4mm coronally and 4 mm apically to the alveolar crestal bone known as the Peri-Cervical Dentin(PCD) along with Biodome, in which the enamel acts as a compression dome, allowing the transfer and transformation of load via the dentinoenamel complex are irreplaceable and can be lost due to their removal during crown cutting procedures followed by replacement of the crown prosthetically<sup>15</sup>. Hence the main target has shifted to the preservation of Peri-Cervical Dentin in teeth treated endodontically by undergoing minimally invasive dentistry which may enhance their resistance to fracture.<sup>(16, 17)</sup> Studies have revealed that the structural integrity of the ETT is often increased by preserving the Peri-Cervical Dentin(PCD).<sup>17</sup>

The minimally invasive options for teeth treated endodontically are direct/indirect restorations like amalgam restorations, gold restorations, resin-based

composite restorations or partial coverage restorations like inlays, onlays/overlays, endocrowns etc.<sup>18</sup>.

Lately, it has been propounded that, minimal to moderate tooth structure loss seen in endodontically treated posterior teeth could also be affluently restored with resin composite restoration<sup>19</sup>. Rehabilitation of endodontically treated premolars with crown & resin composite restorations have exhibited comparable clinical success results<sup>20</sup>. However, the clinical consequence of this idea remains controversial.

A systematic review by Sukaphar et al concluded that “Posterior ETT with minimal to moderate loss of tooth structure, restored with either crowns or direct resin composite restorations had no significant difference in their survival rates against fracture within the different groups of teeth.<sup>21</sup>”

Therefore, the ultimate goal of endodontic treatment is often maintaining the functional pulpless teeth by means of an adequate restoration which can increase the fracture strength of the teeth.

Resin-based composite restorations have drawn attention owing to its various advantages like minimal tooth preparation which preserves the Peri-Cervical dentine and Biodome, better stress distribution, increased surface for adhesion, bank tooth structure, less time consuming & cost-effectiveness<sup>22</sup>. However, the disadvantages of the resin-based composites are its polymerization shrinkage, the incremental layering technique which is time-consuming & results in an increased risk of contaminated layers & inclusion of voids within the restoration<sup>(23,24)</sup>. Several manufacturers have recently initiated and established newer sorts of resin composites so-called “Bulk fill” composites to beat the disadvantages of resin-based composites.

Earlier the Bulk-fill materials were available as flowable or low viscosity composites. Subsequently, bulk-fill composites with high viscosity were introduced having higher filler loading and enhanced mechanical properties. Bulk fill composites are often applied in increments upto 4mm thick, thus making them less time consuming, having improved self-levelling ability, decreased polymerization shrinkage stress, reduced cuspal deflection & good bond strength irrespective of the filling technique.<sup>(25,26)</sup>

Bulk-fill composites have been extensively researched ever since their introduction in the market, however, there is a paucity of promulgated data regarding their use as post endodontic restoration(core-buildup materials)<sup>1</sup>.

Large differences could be noticed in the properties of existing bulk-fill composites given by different manufacturers. Moreover, on account of large variations in the composition, which are usually not entirely disclosed by the manufacturer, correct classification of composition related properties among the commercially available materials is impractical<sup>27</sup>.

Hence there is a necessity to research regarding the mechanical properties of varied bulk-fill composites available within the market for successful leads to our clinical practice.

Therefore, the aim of this study is to, “Evaluate & compare the fracture resistance of endodontically treated teeth restored with 4 different restorative bulk-fill composites”.

X-trafil (VOCO), Filtek (3M), TetricEvoceram (Ivoclar) and Aura (SDI).

## **AIM AND OBJECTIVES**

- To comparatively evaluate the fracture resistance of four bulk-fill composite used as post- endodontic restorations using the universal testing machine.

Group1: 'X-trafil' bulk fill (VOCO)

Group2: 'Filtek' bulk fill (3M ESPE)

Group3: 'TetricEvoceram' bulk fill (IvoclarVivadent)

Group 4: 'Aura 'bulk fill (SDI)

### **OBJECTIVES OF THE STUDY: -**

1. "To evaluate the fracture resistance of the four Bulk fill composites (X-trafil, Filtek, TetricEvoceram& Aura) as post-endodontic restoration by using the universal testing machine (UTM)"
2. "To compare the fracture resistance of the four Bulk fill composites (X-trafil, Filtek, TetricEvoceram& Aura) as post-endodontic restoration by using the universal testing machine (UTM)"

## **HYPOTHESIS**

- **“NULL HYPOTHESIS”-**

- There will be no difference in the fracture resistance of the four Bulk fill composite restorations (‘X-trafil’, ‘Filtek’, ‘TetricEvoceram’ & ‘Aura’).

- **“ALTERNATIVE HYPOTHESIS”-**

- There will be a difference in the fracture resistance of the four Bulk fill composite restorations (‘X-trafil’, ‘Filtek’, ‘TetricEvoceram’ & ‘Aura’).

## **REVIEW OF LITERATURE**

1. An in vitro examination was carried out to assess resistance to fracture of the teeth restored with 'Filtek Bulk fill posterior', 'GC Ever posterior', and 'Tokuyama Estelite sigma' composites. The examination concluded that 'Estelite sigma quick' composite showed significantly higher fracture strength.<sup>45</sup>
2. An in vitro investigation was performed to ascertain the fracture toughness of teeth restored with Filtek bulk-fill (3M), Sonicfill bulk-fill (Kerr), and EverX bulk-fill (GC). The study concluded that EverX bulk-fill (GC) had a higher fracture resistance in comparison to the other two groups.<sup>34</sup>
3. An in vitro examination was carried out to evaluate the microleakage and fracture resistance of root canal treated teeth restored with (Group 1) 'TetricEvoFlow' Bulk Fill – TEFBF overlaid with 'TetricEvoCeram' Bulk Fill – TECBF, (Group 2) 'TECBF' restorative resin, (Group 3) 'TetricEvoFlow' – TEF overlaid with 'TetricEvoCeram' & (Group4) 'conventional nanohybrid' composite (TEV) with incremental technique. (Groups I) & (Group II) showed highly significant fracture resistance and the restoration with bulk-fill composites enhanced the fracture toughness of teeth treated endodontically.<sup>65</sup>
4. An examination was performed to evaluate the fracture toughness of Silorane-based composite, Nanohybrid resin composite, Microfibers reinforced resin composite, and short fibres reinforced resin composite. The investigation reasoned that among the study groups, the highest resistance to fracture was shown by FRC group.<sup>29</sup>

5. An in vitro examination assessed the fracture toughness of teeth treated endodontically restored with 'Tetric n Ceram' condensable bulk-fill, 'Beautiful' bulk-fill flowable resin composite, 'EverX posterior' fibre-reinforced composite & 'Filtek conventional' resin-based composite. The study concluded that the resistance to fracture in 'root canal-treated' teeth with 'EverX Posterior' composite was the highest.<sup>33</sup>
6. An examination was conducted to compare the resistance to fracture between 'EsthetX' conventional composite & with an 'SDR' bulk-fill flowable composite used along with 'EsthetX' to restore the occlusal surface layer of the in endodontically treated teeth. Molars restored with 'SDR' bulk composite had no significant difference in comparison to those restored with 'EsthetX' composite.<sup>66</sup>
7. The investigation gauged the kinetics of polymerization shrinkage stress using five different 'bulk-fill resin composites': 'Surefil SDR flow', 'TetricEvoCeramBulkfil', 'Venus Bulk Fill', 'x-trafil' (XF, Voco), and 'Filtek Z250' (FZ, 3M ESPE) as a control. The study concluded that VB exhibited lowest shrinkage stress, however, highest shrinkage stress was seen with x-tra fill group among the bulk-fill composites used.<sup>22</sup>
8. An in vitro examination compared the shrinkage during polymerization of 'EverX Posterior' (EXP), 'Filtek' (FBP), 'SonicFill 2' (SF2), 'Tetric N-Ceram' (TNB), 'X-trafil' (XF) bulk-fill composites with 'Filtek Z250' conventional composite. The polymerization shrinkage of tested bulk-fill & conventional composite was found to be kindred.<sup>67</sup>

9. An in vitro investigation examined fracture toughness of teeth with post endodontic restorations done with 'Filtek Z250 XT', 'SDR' bulk-fill flowable composite and 'Filtek P90' composite. The study concluded that the percentage of increase in strength was the highest for teeth restored with 'SDR' bulk-fill composites in comparison to the other groups.<sup>68</sup>
  
10. An examination assessed the fracture strength of teeth treated endodontically using 'Tetric N Ceram' bulk fill, 'Filtek' bulk fill, 'Smart Dentin Replacement' bulk fill and Packable composite 'Filtek P60' & the study revealed that the highest fracture resistance was recorded in 'Filtek' bulk fill group compared to the other groups of composites.<sup>46</sup>
  
11. An in vitro examination analyzed the fracture toughness of primary anterior teeth restored bulk-fill & conventional composite. The composites used were, 'Filtek Z250' conventional composite (group 1), 'Sonic-Fill' bulk-fill composite (group 2) and 'Sonic-Fill' with a single layer of 'Filtek Z250' as the veneering (group 3) & the study concluded that there was significantly no difference seen among the three groups the mean fracture resistance.<sup>69</sup>
  
12. An In Vitro examination evaluated the resistance to fatigue of teeth restored with 'Tetric N Ceram' Bulk Fill versus 'Tetric N Ceram' Conventional Composite Resin following MOD cavity preparation. The study concluded that fatigue resistance values were indistinguishable in both techniques used.<sup>70</sup>
  
13. An investigation gauged the fracture toughness & cuspal deflection of endodontically treated premolars restored with bulk-fill flowable composites. The teeth were restored with G1: 'Clearfil Majesty Flow' & 'Clearfil Majesty Posterior'; G 2: 'Venus Bulk Fill' & 'Clearfil Majesty Posterior'; G3:

‘ClearfilMajesty Posterior’: G 4: ‘Vertise Flow’ & ‘Clearfil Majesty Posterior’; G 5: ‘SDR’ & ‘Clearfil Majesty Posterior’; & G 6: ‘x-tra base’ and ‘Clearfil Majesty Posterior’. The study revealed that the deflection of cusp or resistance to fracture of teeth treated endodontically, restored with Bulk-fill flowable composite bases and with ‘Conventional flowable’ base and ‘Conventional resin’ composite showed similar results with statistically no significant difference.<sup>71</sup>

14. An in vitro examination the fracture resistance of ‘Smart Dentin Replacement’ bulk fill, ‘Biodentine,’ and Combination of ‘Dentin Replacement’ and ‘Biodentine’ as alternatives to the crown for molars treated endodontically. The study concluded that the mean fracture resistance of the group restored with ‘Smart Dentin Replacement’ was highest whereas group restored with ‘biodentine’ alone was the lowest compared to the other two groups.<sup>72</sup>
15. An examination assessed the resistance to fracture of teeth treated endodontically restored with bulk-fill composites such as; ‘Filtek 3M’, ‘Preheated Filtek 3M’, ‘Beautiful –Bulk’, ‘Preheated Beautiful’ –Bulk’, ‘TetricEvo Ceram’ & ‘Preheated TetricEvoCeram’. The study concluded that “Teeth restored with ‘Beautiful-Bulk’ composite recorded the highest fracture toughness compared with all other restored groups, the teeth restored with ‘Filtek’ & with ‘TetricEvo Ceram’ Bulk-Fill showed same fracture resistances & ‘preheated beautiful’ bulk fill recorded the highest fracture resistance compared to other two preheated bulk fill composites, however lowest fracture resistance among the preheated composites was seen in the teeth restored with preheated Filtek3M bulk fill posterior restoration”.<sup>47</sup>

## **MATERIALS AND METHOD**

### **SOURCE OF DATA:**

The study was carried out in the “Department of Conservative Dentistry and Endodontics, KLE VK Institute of Dental Sciences, KLE Academy of Higher Education & Research (KLE University), Belagavi.”

Extracted human mandibular premolar teeth were collected from “Department of Oral and Maxillofacial Surgery, KLE VK Institute of Dental Sciences, KLE Academy of Higher Education & Research, (KLE University) Belagavi”.

The fracture resistance test of the 120 extracted human mandibular premolars was carried out at KLE Society’s Dr M.S. Sheshgiri College of Engineering and Technology, Belagavi.

### **INCLUSION CRITERIA**

- Human mandibular premolars with a single straight canal with closed apex.
- Teeth with initial apical width corresponding to #20K file size or less.

### **EXCLUSION CRITERIA:**

- Teeth with radicular resorption, cracks or fracture line.
- Root canal treated teeth.
- Teeth with calcified canals.
- Teeth with caries.
- Teeth with multiple canals/Anatomic variation.
- Teeth with initial apical width more than #20k- file size.

**MATERIALS**

- Human mandibular premolars
- Distilled water (Nice Life Care, New Delhi)
- 0.1% thymol solution (S D Fine-Chemicals Limited, Mumbai)
- 3% Sodium Hypochlorite (Vishal Dentocare, Ahmedabad)
- 17% Ethylenediaminetetraacetic Acid; EDTA (Canalarge, Ammdent)
- Paper points (Diadent Group International)
- AH Plus sealer (Dentsply, Germany)
- Applicator tips (Addler)
- Etchant (IvoclarVivadent)
- Gutta-percha points (Diadent Group International)
- Light cured resin-modified GIC (GC)
- Matrix bands (Samit)
- Single bond universal adhesive (3M ESPE)
- ‘Polyvinyl siloxane impression material’ (3M ESPE)
- X-trafil bulk-fill composite (VOCO)
- Filtek bulk-fill composite (3M)
- ‘TetricEvoceram bulk-fill composite’ (Ivoclar)
- Aura Bulk fill composite (SDI)
- Acrylic resin

**ARMAMENTARIUM**

- Airotor (NSK, Japan)
- Endomotor (Coltene)
- 245 Tungsten carbide bur (SS White)
- Round high-speed Endo access Diamond Bur (Dentsply)
- 5 ml 27 gauge syringes (Dispo Van)
- Ball burnisher (GDC)
- Obturation pen system (Woodpecker)
- Diamond finishing bur (SS White)
- Mini Polishing kit (Shofu)
- 15 K File (MANI)
- Tofflemire Retainer (GDC)
- Plastic filling instrument (Waldent)
- Composite filling instrument (GDC)
- LED curing light (Woodpecker)
- ‘ProTaper Universal’ nickel-titanium files (‘DentsplyMaillefer’, Switzerland)
- Universal testing machine

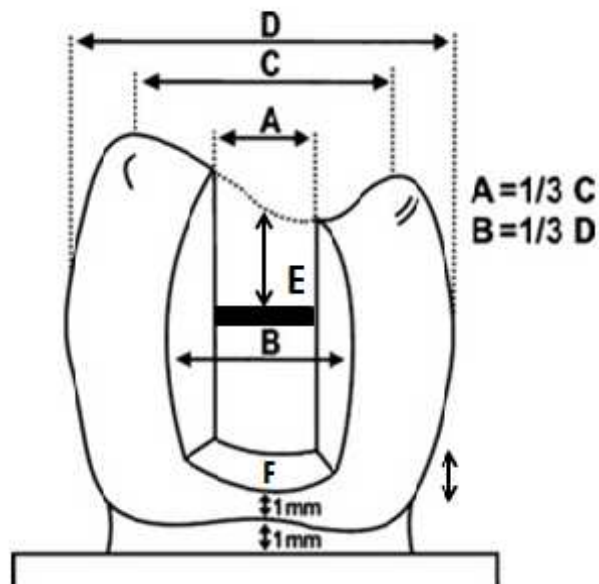
**Methodology**

Total of 120 extracted human single-rooted and single canal permanent mandibular premolars were used for the study. They were cleaned of soft tissue & calculus followed by storage in a solution of 0.1% thymol until their use. All teeth were radiographed and were selected as per the inclusion & exclusion criteria. The

teeth were then embedded in polyvinyl siloxane material (putty) for support & stability while undergoing the endodontic procedure.

**MOD cavity preparation of teeth specimens**

MOD (Mesial-Occlusal-Distal) cavities were prepared using number 245 tungsten carbide bur in a high-speed handpiece so that the buccolingual width of the occlusal isthmus (A) was 1/3<sup>rd</sup> the intercuspals distance(C). The buccolingual width of the proximal preparation (B) was 1/3<sup>rd</sup> of the buccolingual width of the crown (D) & the depth of the pulpal floor (E) was kept 2.7mm i.e. approximately the full length of the bur head. The facial & lingual walls of the occlusal segment were maintained parallel to one another. The gingival floor (F) was kept 1.0mm above the Cementoenamel Junction [ref. Figure 1A].<sup>29</sup>



**FIGURE 1A: Dimensions of MOD cavity preparation**

**Preparation of the access cavity:**

Endodontic access cavities were prepared through the pulpal floor using number 2 round Endo access diamond bur & an Airotorhandpiece. The teeth were then removed from the putty mould and working length was determined using size 15K file till it was just seen at the root tip and then 1mm was subtracted from the recorded length. The teeth were then placed back in the putty and chemo-mechanical debridement of the root canals was done using 'ProTaper' Universal Ni-Ti rotary instruments, in a sequential order starting from SX, S1, S2, F1, F2 upto the master apical size of F3(#30) by avoiding excessive apical pressure as per the manufacturer's instruction.

The canals were irrigated with 2ml of 3% sodium hypochlorite (NaOCl) irrigant advocated between successive instrumentation followed by 5ml of 17% ethylenediaminetetraacetic acid (EDTA) & the final flush was performed using 5ml of distilled water.

The root canals were dried using sterile paper points. The root canals were obturated with 'Pro Taper F3 Gutta-Percha' (Diadent group international) & 'AH-Plus' epoxy resin-based sealer (Dentsply). Excess gutta-percha was sheared off with a hot ball burnisher. Coronal 3mm of gutta-percha was removed using an obturation pen system (Fi-P woodpecker). The canal orifices were sealed with resin-modified glass ionomer cement upto the canal orifices & the samples were placed in the incubator for 7 days at 100% humidity to allow the sealer to set.

The teeth were then randomly divided into 4 groups (30 each) & the core build-up was done with 4 different types of bulk-fill composites.

The 4 groups were as follows:

Group I: X-trafil (VOCO) bulk fill composite.

Group II: Filtek (3M) bulk-fill composite.

Group III: Tetric Evoceram (Ivoclar) bulk-fill composite.

Group IV: Aura (SDI) bulk-fill composite.

**Adhesive Procedure:**

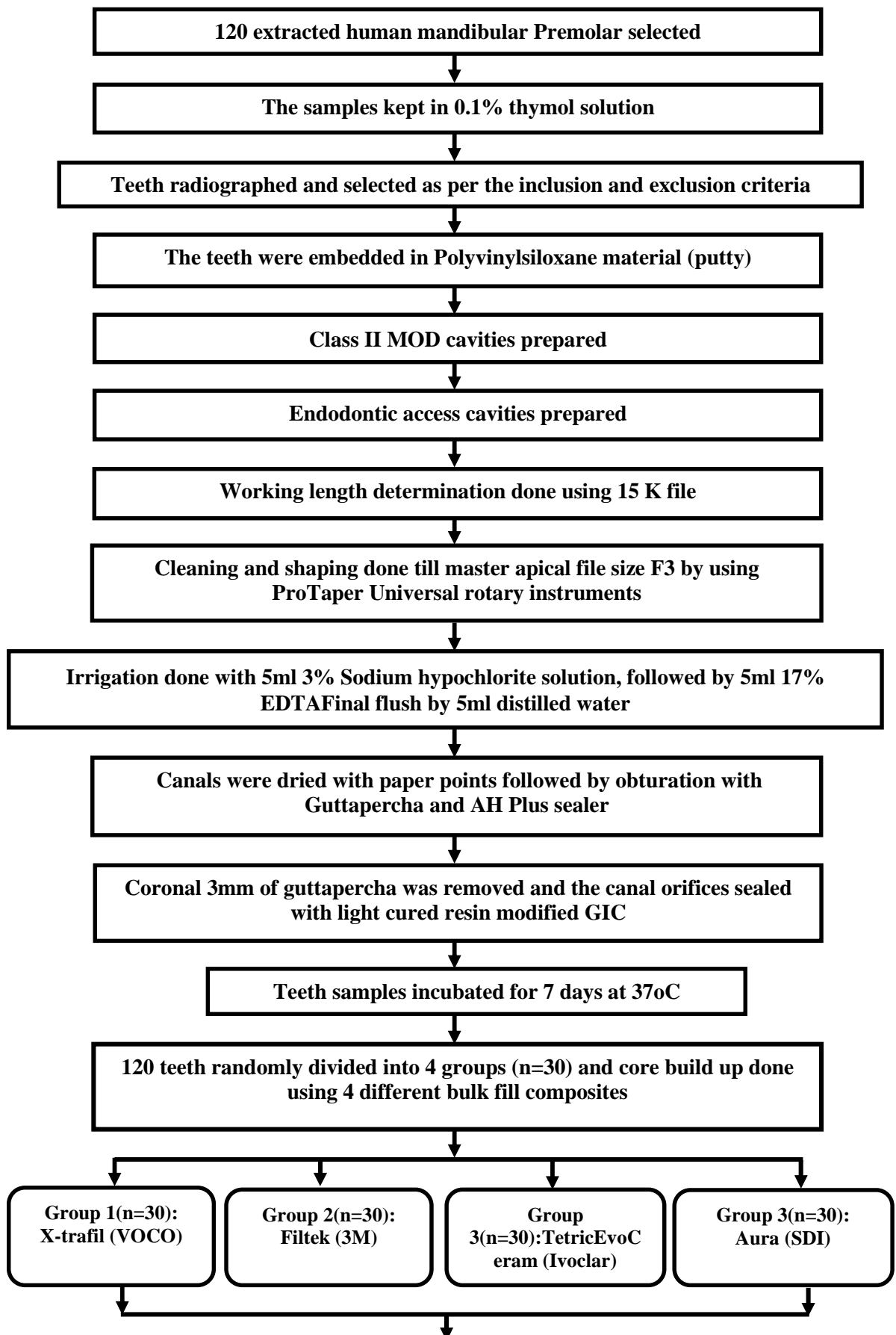
The prepared cavities were etched using '37% phosphoric acid' for 15 secs and were rinsed and dried. A Tofflemire retainer was placed around the prepared tooth. 'Single Bond Universal Adhesive' (3M ESPE) was applied using an applicator tip. The cavities were filled with a single increment & the final contour of the restoration was achieved followed by which light-curing of each specimen was done using light-emitting diode (Woodpecker) as per the manufacturer's instructions.

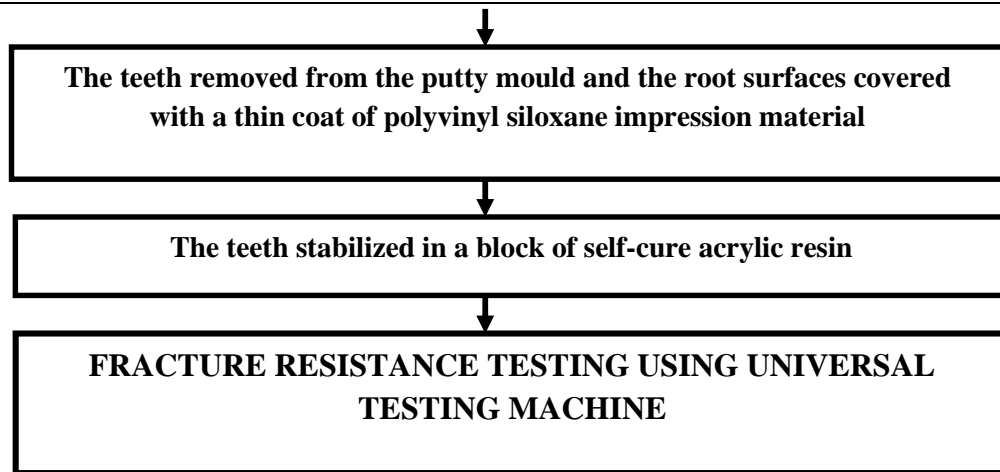
Final finishing was achieved under air/water spray using diamond finishing burs (SS white) at high speeds. Subsequently, Super-Snap Disk Green (fine) by 'Shofu Mini' was used for polishing & the specimens were stored in distilled water for 24 hours. The teeth were then removed from the putty mould & the root surfaces were covered with a thin coat of polyvinyl siloxane impression material to replicate the Periodontal Ligament (PDL). The teeth were then stabilized in a block of self-cure acrylic resin.

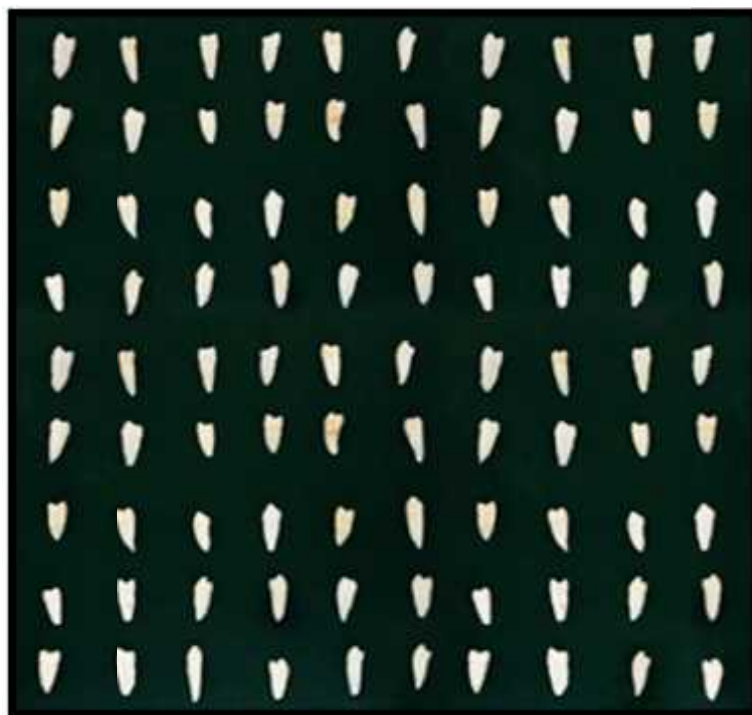
**Fracture resistance testing:**

The fracture resistance was evaluated by the placement of the self-cure acrylic resin blocks under the 'Universal Testing Machine'. A constant compressive force was applied at a crosshead speed of 1mm per min with a 6mm diameter metal indenter along the long axis of the tooth on the inclined planes of the buccal& lingual cusps beyond the margins of the restoration on the restorative material until the fracture of the teeth & the force at which the fracture took place was recorded in Newtons.

**METHODOLOGY FLOWCHART**







**FIGURE 1:** Human mandibular premolar selected for the study.



**FIGURE 2:** Preoperative radiograph of the mandibular premolar taken for the study.

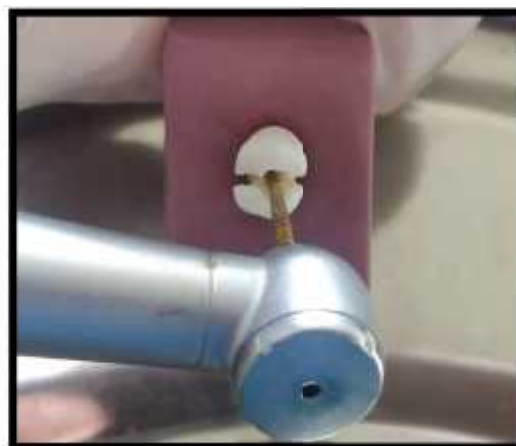




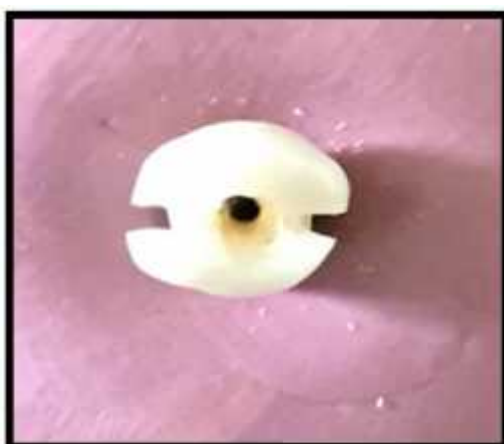
**FIGURE 5:** Armamentarium used for the study.



**FIGURE 6:** MOD cavity preparation



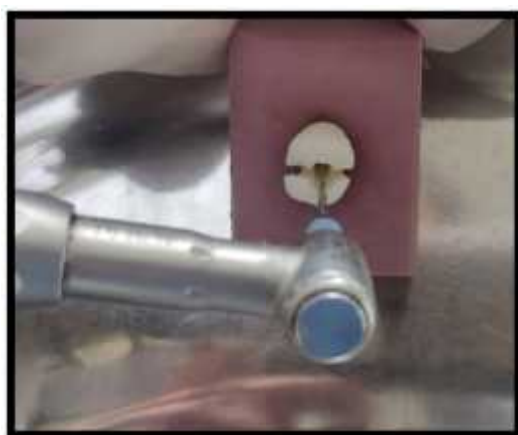
**FIGURE 7:** Access opening



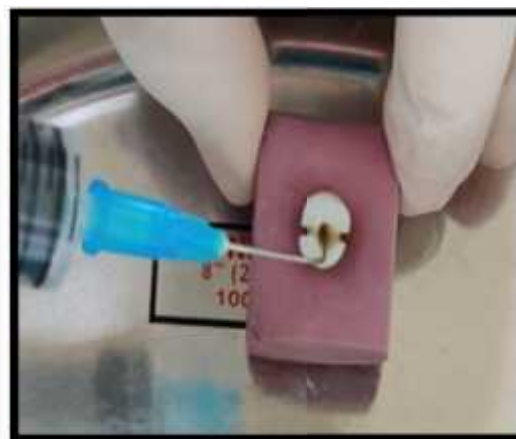
**FIGURE 8:** MOD cavity preparation and access opening of mandibular premolar



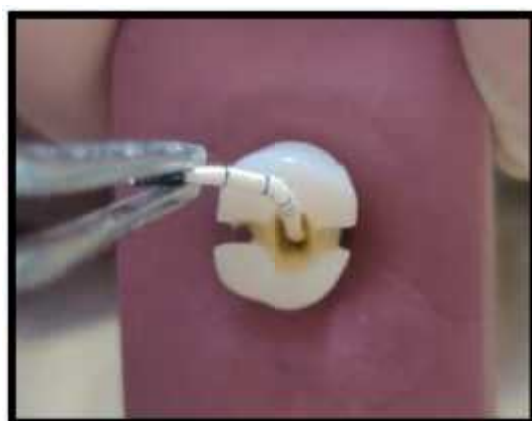
**FIGURE 9:** WL determination



**FIGURE 10:** Cleaning and shaping



**FIGURE 11:** Irrigation



**FIGURE 12:** Canal dried using paper point



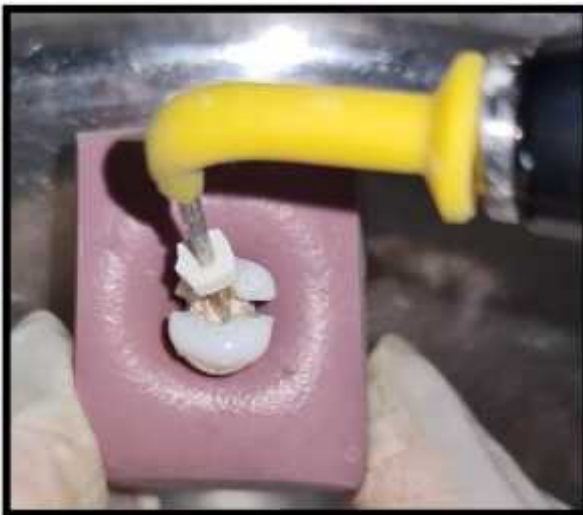
**FIGURE 13:** Obturation



**FIGURE 14:** Shearing of Guttapercha



**FIGURE 15:** Post obturation radiograph



**FIGURE 16:** Removal of 3 mm of Guttapercha



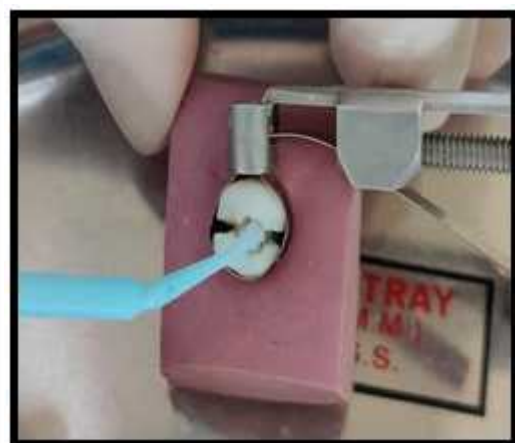
**FIGURE 17:** Placement of Resin modified GIC



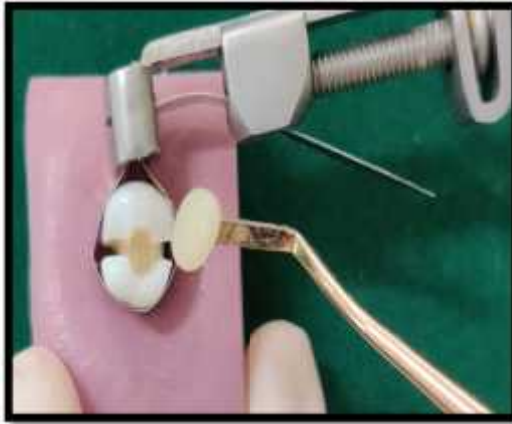
**FIGURE 18:** Incubator



**FIGURE 19:** Etching



**FIGURE 20:** Bonding



**FIGURE 21:** Placement of single increment of bulk fill composite



**FIGURE 22:** light curing using LED



**FIGURE 23:** Polishing of the restoration



**FIGURE 24:** Root covered with a layer of putty



**FIGURE 25:** Tooth specimen embedded in the acrylic disc



**FIGURE 26:** Fracture resistance testing using universal testing machine

## **RESULTS**

The results of this study show that the mean fracture resistance of Group 1 (X-TRA FIL), Group 2 (FILTEK BULK FILL), Group 3 (TETRIC EVOCERAM) & Group 4 (AURA) bulk-fill composites was 761.4 N, 900 N, 777 N and 754.40 N respectively.

The fracture resistance of Group-2 (FILTEK BULK FILL) was significantly higher as compared to that of the Group-1 (X-TRA FILL), Group-3 (TETRIC EVOCERAM) & Group-4 (AURA) bulk-fill composites. However, there was no statistically significant difference seen between 'X-trafil', 'TetricEvoceram' & 'Aura' bulk-fill composites.

The following order of fracture resistance was observed in different groups in the following order: **group-2 > group-3 > group-1 > group-4**

Hence, the null hypothesis in this study was rejected.

TABLE 1

	<b>X-trafil (Group 1)</b>	<b>Filtek (Group 1)</b>	<b>TetricEvoce ram(Group 2)</b>	<b>Aura (Group 4)</b>
<b>Bulk fill composites (N)</b>	<b>594</b>	<b>898</b>	<b>700</b>	<b>740</b>
	<b>876</b>	<b>912</b>	<b>694</b>	<b>736</b>
	<b>832</b>	<b>894</b>	<b>578</b>	<b>800</b>
	<b>752</b>	<b>906</b>	<b>872</b>	<b>802</b>
	<b>700</b>	<b>868</b>	<b>800</b>	<b>752</b>
	<b>750</b>	<b>846</b>	<b>850</b>	<b>760</b>
	<b>850</b>	<b>920</b>	<b>750</b>	<b>780</b>
	<b>800</b>	<b>852</b>	<b>690</b>	<b>800</b>
	<b>600</b>	<b>850</b>	<b>720</b>	<b>766</b>
	<b>876</b>	<b>900</b>	<b>800</b>	<b>780</b>
	<b>832</b>	<b>880</b>	<b>850</b>	<b>800</b>
	<b>830</b>	<b>898</b>	<b>800</b>	<b>650</b>
	<b>750</b>	<b>940</b>	<b>900</b>	<b>660</b>
	<b>700</b>	<b>960</b>	<b>694</b>	<b>800</b>
	<b>700</b>	<b>880</b>	<b>820</b>	<b>750</b>
	<b>650</b>	<b>920</b>	<b>700</b>	<b>732</b>
	<b>594</b>	<b>860</b>	<b>872</b>	<b>680</b>
	<b>870</b>	<b>950</b>	<b>850</b>	<b>650</b>
	<b>832</b>	<b>930</b>	<b>750</b>	<b>850</b>
	<b>840</b>	<b>950</b>	<b>850</b>	<b>800</b>
<b>Mean</b>	<b>761.4 N</b>	<b>900.7 N</b>	<b>777 N</b>	<b>754.4 N</b>

**Table 1:** Mean fracture resistance of the four bulk-fill composites in Newtons

**TABLE 2**

Materials	Mean(N)	SD	SE	95% CI for mean	
				Lower Bound	Upper Bound
Xtrafil	761.4	97.17	21.73	715.92	806.88
Filtek	900.70	34.99	7.82	884.33	917.07
TetricEvoCeram	777.00	84.43	18.88	737.49	816.52
Aura	754.40	56.47	12.63	727.97	780.83

**Table 2:** Shows summary of fracture resistance , standard deviation and standard error of bulk-fill composites in four groups containing 30 samples each.

**TABLE 3**

Sources of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F-value	p-value
Between restorations	3	284564.95	94854.98	18.0812	<0.001
Within restorations	76	398699.80	5246.05		
Total	79	683264.75			

**Table 3:** Shows Comparison of four bulk-fill composite restorations (X-trafil, Filtek, TetricEvoceram and Aura) with mean fracture resistance by one-way ANOVA

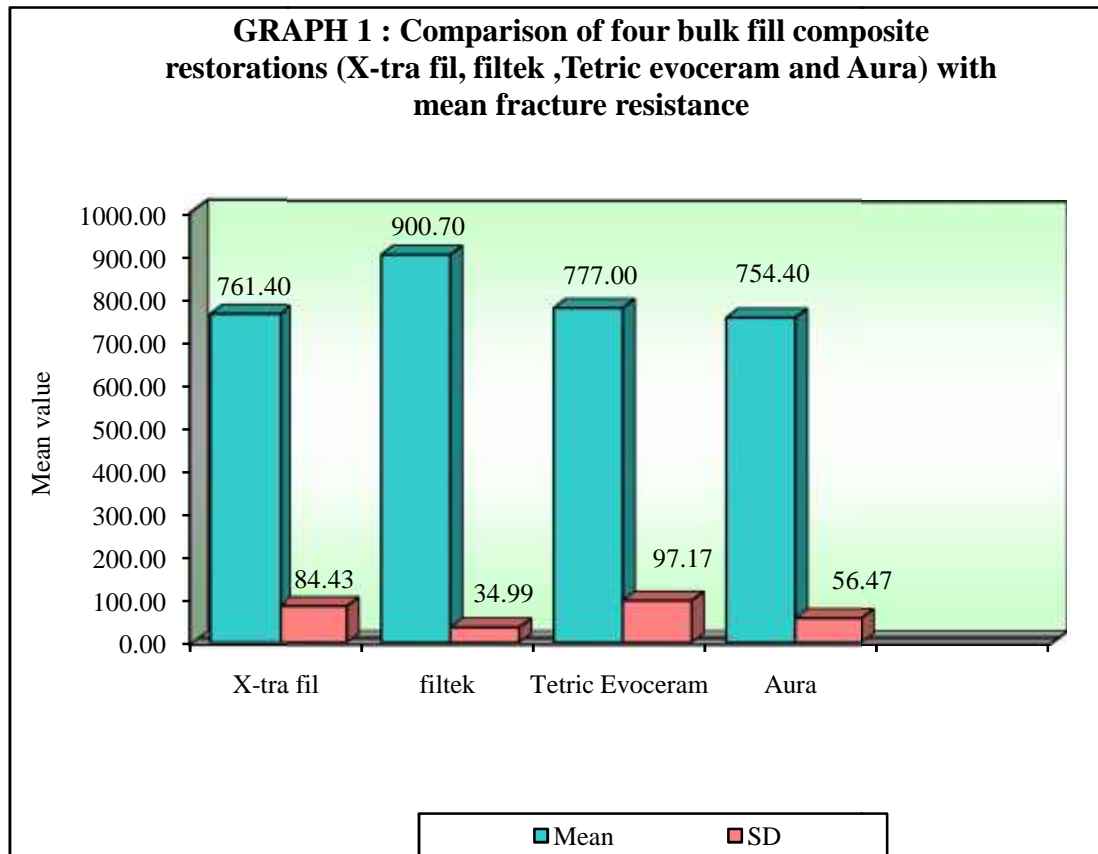
**TABLE 4**

Groups	X-trafil	Filtek	TetricEvoceram	Aura
Mean	761.40	900.70	777.00	754.40
SD	97.17	34.99	84.43	56.47
X-trafil	-	p=0.0001*	p=0.4980	p=0.7609
Filtek	p=0.0001*	-	p=0.0001*	p=0.0001*
TetricEvoCeram	p=0.4980	p=0.0001*	-	p=0.5876
Aura	0.7609	p=0.0001*	p=0.5876	-

\*p<0.05

**Table 4:** Shows pairwise comparison of four bulk-fill composite restorations (Filtek, TetricEvoceram, Aura & X-trafil) with mean fracture resistance using Newman-Keuls multiple posthoc. This table illustrates that the fracture resistance of Group 2 was statistically significant compared to group 1, 3 & 4. No statistically significant difference was seen between the following groups: group 1, group 3 & group 4.

## GRAPH 1



**Graph 1:** Shows graphical representation of mean and standard deviation for fracture resistance in each group. Group 2 exhibited the highest fracture resistance i.e. 900.70 Newton followed by Group 1 i.e. 761.4 Newton, Group 3 i.e. 777 Newton and least fracture resistance was exhibited by Group 4 i.e. 754.40 Newton.

## **DISCUSSION**

The success of teeth treated endodontically is determined by a satisfactory root canal therapy along with a sound coronal restoration. The final coronal restoration should not only provide satisfactory coronal seal but also enhanced fracture resistance for the long-term success of post endodontic restoration and reduce the prospect of possible loss of tooth<sup>29</sup>. Several clinical data have revealed the association of endodontically treated teeth (ETT) to a high prevalence of tooth fracture. Most of the fractures that occur after root canal treatment of the teeth are frequently attributed to noticeable loss of dental tissues<sup>30</sup>.

An approximately 4.6%–7.5% of teeth treated endodontically, predominantly molars and premolars, are extracted within 4–5 years post-treatment with coronal fractures, giving rise to 47% of post-treatment extractions [31,32]. The relative rigidity of teeth treated endodontically is reduced by 5% by access opening alone. In contrast, approximately 46% of reduction in tooth rigidity is seen due to loss of marginal ridge and decrease in 63% of relative cuspal rigidity due to MOD preparation.

Teeth having moderate remaining tooth structure following endodontic treatment can be restored with recently used more conservative approaches and with marked attention given to the probable utilization of bulk-fill restorative materials<sup>1</sup>. Bulk fill composites were introduced due to its superiority over the resin-based composites such as greater depth of cure, placement of upto 5mm increments, reduced polymerization shrinkage, less laborious and improved mechanical properties<sup>33</sup>.

Moreover, variation in the fracture toughness of available bulk-fill composites may be seen due to huge compositional variations, which may not completely be revealed by the manufacturer<sup>1</sup>. Hence, fracture resistance of different types of composites when used core build-up material is a crucial factor that determines the choice of bulk-fill composite used for long term clinical success post root canal treatment.

In literature, very less number of studies have been documented on fracture resistance of different bulk-fill composites, till date to the best of our understanding, none compares the resistance to fracture of four different bulk-fill composites used in the current investigation as post endodontic restoration.

Thus, the current study investigated, The fracture resistance of four different bulk-fill composites i.e. X-trafil (VOCO), Filtek (3M), TetricEvoceram (Ivoclar) and Aura (SDI) using the universal testing machine.

Mandibular premolar teeth were selected because they are easily available (being extracted for orthodontic reasons) and have a single root. Secondly, the location of the teeth in the arch and their deep cuspal inclination makes them prone to masticatory loading and highly susceptible to fracture that may require placement of a prosthesis<sup>36</sup>. Teeth were stored in 0.1% thymol solution in the current research to prohibit fungal growth. 120 teeth were chosen and the specimens were radiographed in two planes to inspect the presence of any calcifications, cracks, fractures, resorption and to determine the number of canals. The teeth were then included in the study on basis of inclusion and exclusion criteria. Mesio-occlusal-distal (MOD) cavities were prepared on the premolars as these are well-considered to be poor in

terms of resistance to fracture and secondly, they simulate the condition often found clinically. <sup>(36,37)</sup>

Root canal treatment(RCT) for samples was accomplished using ProTaper universal rotary NiTi instruments by following standardized protocol as recommended by the manufacturer. NiTiProTaper instruments provide an advantage over stainless steel instruments by covering the whole range of treatment with lesser files, furthermore providing superior flexibility, unparalleled efficiency, and enhanced safety.

In the current examination, 2ml of 3% NaOCl was advocated between successive file, being a potent antimicrobial agent, lubricant along with helping in dissolving both vital and non-vital tissue. Existence of smear layer obstructs sealers from penetrating inside tubules. Subsequently, the smear layer was eliminated by use of 17 % EDTA followed by a flush with distilled water, to oust the impact of remaining oxygen released from NaOCl on polymerization of sealers. <sup>[56,58]</sup>

Single-cone obturation of root canals using ProTaper Universal F3 GuttaPercha(Diament group international) was done as it is said to minimize the sealer component through the gutta-percha cones as the geometry of these gutta-percha cones nearly matches the nickel-titanium instrumentation systems<sup>58</sup>. These cones ensure 3-dimensional obturation of the root canal without the need for lateral condensation and requirement of accessory cones rendering it less laborious.

The intra-orifice barrier used was 'Resin modified Glass ionomercement'(GC) as studies have manifested that intra-orifice barrier will avert coronal microleakage and have resistance against root fracture.<sup>38</sup>

In the present research, all samples were placed in an incubator for a period of 7 days at 37°C in humidified conditions. This was done to achieve the total setting of the sealer along with complete polymerization & to simulate the oral condition

The specimens were then randomly divided into 4 groups of 30 each and core build-up was done with 4 different types of bulk-fill composites as per manufacturer's instructions.

Single bond universal adhesive (3M ESPE) was used in all 4 groups for standardization. Total etch system was used for the adhesive procedure in which the cavities were etched for 15 seconds using 37% phosphoric acid and rinsed followed by application of Single Bond Universal Adhesive. Light curing was done using a light-emitting diode unit (i LED, woodpecker) for 20 seconds according to the instructions given by the manufacturer.

Self-etch system was not used for bonding, as studies have revealed that they would compromise the enamel bonding due to high hydrophilic nature of acidic monomers. The etch-and-rinse adhesive system was used, as phosphoric acid etching would make the bonding of resin to enamel surfaces an everlasting and infallible clinical procedure<sup>57</sup>. The cavities were restored with a single increment to obtain the final contour of restoration and light-cured for 20 secs each from all the directions (buccal, lingual & occlusal) using LED as recommended by the manufacturers.

The roots of the samples were coated with an elastomeric material to replicate the Periodontal Ligament (PDL) which would distribute the load of the occlusal forces to the alveolar bone equally<sup>29</sup>. The samples were stabilized in a block of self-cure acrylic resin & fracture resistance was tested using Universal Testing

Machine(UTM) under a constant compressive force at a crosshead speed of 1mm/min with a 6-millimetre metal indenter placed along the long axis of the tooth on the inclined planes of buccal and lingual cusps beyond the margins of restoration on the restorative material.

The results of this study reveal that ‘Filtek’ (GROUP 2) had significantly higher fracture resistance as compared to that of the ‘X-trafil’ (GROUP1), ‘TetricEvoceram’ (GROUP 3) and ‘Aura’ (GROUP 4) bulk-fill composites. Thus, the current study data disagreed with the null hypothesis that fracture resistance of the four experimental bulk-fill composites would not differ.

Fracture of the restoration mainly depends on various factors such as the matrix composition and distribution, filler content/filler size of resin composites and their modulus of elasticity. Different types of composites may delineate variation within their strength due to the differences seen in these properties as can be seen in [Table 5] <sup>(39,40)</sup>. Thus, an increase in compressive strength & surface hardness of restoration is directly proportional to the reduction in size and increase in the volume of the fillers. <sup>(38,39)</sup>

Filler content plays a remarkable role in the Polymerization Shrinkage (PS) and Depth of Cure (DOC) possible with the bulk-fill composites. An increase in the filler content would increase the curing depth which in turn, decreases the volume of resin matrix for polymerization which would reduce shrinkage caused during polymerization of the restoration and also increase its hardness. <sup>(42,43)</sup>

Polymerization shrinkage is an inherent property of composite resin which is inversely proportional to the fracture toughness & if not controlled may result in gap formation at the tooth-restoration interface, subsequent microleakage & decrease in the resistance to fracture of the restoration<sup>42</sup>. The shrinkage caused during polymerization leads to the formation of stress within the restoration resulting in undesirable clinical consequences such as fractures. This polymerization shrinkage stress is affected by the composition and filler content of resin composites & their elastic modulus.<sup>44</sup>

**Table 5:** The following table shows the factors affecting the fracture resistance of the 4 different bulk fill composites used in this study. (Filler percentage, Filler type & composition)

Bulk fill composites	Filler (wt.%/ vol %)	Filler type	Composition
X-trafil	86/70.1	Inorganic filler particle size is between 0.04um and 3 um. Barium-boron-alumino-silicate glass (2-3 um)	Bis-GMA, UDMA, TEGDMA Barium-boron-aluminosilicate glass filler
Filtek	76.5/58.4	'20 nm' silica filler, '4 to 11 nm' zirconia particles	AUDMA and AFM, UDMA, DDDMA Non agglomerated/non-aggregated silica filler, zirconia filler, aggregated zirconia/silica cluster and ytterbium trifluoride filler
TetricEvo ceramic	78/61	Ba glass, silicate, SiO <sub>2</sub> , mixed oxide with particle size 40nm-3000nm	Matrix: Bis-GMA, Bis-EMA, UDMA, additives, initiators, stabilizers, pigments Filler: Barium alumino silicate glass, prepolymer (isofillers), ytterbium
Aura	-/65	-	Bis-GMA, UDMA & TEGDMA Fillers: Silica & Silanized barium glass

**Abbreviations:** ['Bis-EMA': ethoxylatedbisphenol-A-dimethacrylate, 'Bis-GMA': bisphenol-A-glycidyl dimethacrylate, 'TEGDMA': triethylene glycol dimethacrylate, 'UDMA': urethane dimethacrylate, 'AUDMA': aromatic dimethacrylate & 'DDDMA': 1, 12-Dodecanediol dimethacrylate]

In the current investigation, intergroup comparison which was done by 'Newman-Keuls multiple posthoc test' revealed Filtek bulk-fill (GROUP 2) had significantly higher resistance to fracture in comparison to the other three groups of bulk-fill composites i.e. Xtra-fil (GROUP 1), TetricEvoceram (GROUP 3) and Aura (GROUP 4). There was no statistically significant difference seen between X-tra fill, TetricEvoceram and Aura bulk-fill composites. The following sequence of fracture resistance was observed in 4 study groups: Group-2 > Group -3 >Group -1>Group- 4.

The better outcome of Filtek bulk-fill could be attributed to the presence of two novel methacrylate monomers that, in combination, act to lower polymerization stress. The number of reactive groups in the resin is decreased along with the moderation of the volumetric shrinkage due to the existing high molecular weight aromatic urethanedimethacrylate(AUDMA) [Table 5].

Secondly, the presence of addition-fragmentation monomers(AFM) containing a third reactive site severs through a fragmentation process during polymerization. This process allows a channel for stress relief due to the relaxation of the developing network along with the retained capability of the fragments to react with each other or with the developing polymer <sup>45</sup>. In this mode, stress relief is attainable while preserving the physico-mechanical properties of the polymer.

The filler system uses the nanofiller technology as silane-treated nanocluster& individual silane-treated nanosilica/nanozirconia with average filler size of 20 nm for silica and 4 - 11 nm for zirconia<sup>46</sup>. [Table 5]

Farahanny et al has previously compared fracture resistance of 'Tetric N Ceram' bulk fill, 'Filtek' bulk fill, 'Smart Dentin Replacement' bulk fill and 'Filtek P 60' resin composites when used as post endodontic restorations<sup>34</sup>. This investigation has shown that higher fracture resistance was seen with 'Filtek' bulk fill followed by 'Tetric N Ceram' bulk-fill composite which was significant and is consistent with the present study. The reason for this was attributed to the higher compressive strength of Filtek bulk fill and presence of nanoclusters having better mechanical properties compared to fillers with a spheroidal or irregular shape. Al-Nahedh et al compared Fracture Resistance & Marginal Adaptation of Capped & Uncapped 'SureFil SDR', 'Filtek' Bulk-Fill Posterior, 'Tetric N-Ceram' Bulk-Fill, 'Filtek Z350 XT' & revealed that fracture resistance of 'Filtek' Bulk-Fill was consistently higher under all conditions, this result was attributed to the higher filler loading in 'Filtek' bulk fill (filler volume 58.4%)<sup>35</sup>.

Significantly lower fracture resistance of GROUP 3(TetricEvoceram), when compared to GROUP 2 (Filtek), was seen, despite having the filler content of 58.4% (Filtek) &61%( TetricEvoceram) by volume which is comparable [Table 5]. This variation maybe because of the presence of pre polymerized fillers in TetricEvoceram which are usually added to increase filler loading<sup>(48,49,50)</sup>. Studies have shown that the inclusion of pre polymerized fillers in the filler count is believed to overestimate the actual inorganic filler content<sup>49</sup>. Randolph et al and Al-Nahedh et al have reported lower mechanical properties with composites containing pre polymerized fillers<sup>51</sup>.

However, GROUP3 (TetricEvoceram) had higher fracture resistance value compared to GROUP 1(X-trafil) and GROUP 4 (Aura) bulk fill though the values were not statistically significant. The reason for this may be due to the addition of a

highly reactive photo-initiator “Ivocerin” and presence of shrinkage stress reliever which helps in enhancing its mechanical properties.

Results of a study conducted by Abdulhamed et al opposed the results of the present investigation, in which teeth restored with ‘Filtek’ & ‘TetricEvoceram’ bulk fill have shown to have similar resistance to fracture between them whereas, teeth restored with preheated ‘TetricEvoceram’ bulk-fill showed higher resistance to fracture compared to preheated ‘Filtek’ bulk fill, this difference could be due to the changes in the methodology. Unlike the current study, the fracture toughness was checked following MOD cavity preparation without the endodontic therapy of the tooth specimens & secondly preheating the bulk-fill composites which may have led to the changes in their mechanical & physical properties.<sup>47</sup>

In the current investigation GROUP 1(X-trafil) and GROUP 4 (Aura) showed lower resistance to fracture compared to the other two groups i.e. GROUP 2 (Filtek) and GROUP 3 (TetricEvoceram) despite having a higher filler volume fraction of 70.1% and 64% respectively.<sup>52</sup>[Table 5].The reason may be attributed due to the increase in the elastic modulus seen with the two bulk-fill composites leading to lower mechanical properties.

A former study by Y. Li et al indicated, “A strong association between compressive strength & filler volume fraction in dental composites, it stated that increase in the filler volume would increase the mechanical properties of the composites”.<sup>54</sup>However the results obtained in this study do not confirm this finding.

Kim et al, recently stated that “The threshold of filler loading was 55% (by volume) in composite resins having highest fracture resistance values”. Kindred

findings were demonstrated by Garoushi et al. reveal that, “The non-existence of a direct relationship between volumetric content of inorganic particles & fracture resistance parameters”.<sup>55</sup>

Ikejima et al. and Hara R et al. revealed that “The shear strength & flexural strength were not increased further by increasing the filler levels (>60% of volume fraction). However, elastic modulus continued to increase with more incorporation of filler”. High elastic modulus denotes inelasticity resulting in an increase in the shrinkage stress, cuspal deflection and decrease in the fracture toughness.<sup>53</sup>

It can be considered that the matrix type and arrangement, type and size of the filler particle [Table 5] in X-trafil and Aura bulk fill may be the cause for their inferior fracture resistance.

Filler type and size plays an important role in the mechanical property of the composites. In accordance with Rafaela A. Melo et al; Aura bulk-fill resin had particle size which was smaller, some spherical and some with irregular shapes. It was observed that Filtek conventional composite had greater regularity in comparison to the Aura composites. The Filtek bulk-fill comprises of nanocluster particles which have dissimilar physico-mechanical properties unlike the filler particles possessing a spheroidal or irregular morphology’.<sup>59</sup>

The physio-mechanical properties of dental composites are also influenced by the Degree of conversion(DC). The minimum percentage of DC for clinically sustainable restoration has not yet been acknowledged<sup>60</sup>. Soares et al. reported that “No less than 55% of DC values are needed for the occlusal restorative layers”.

The mechanical properties and wear performance of composites can be jeopardized due to insufficient levels of conversion during polymerization. The composition of Aura bulk fill has not been entirely revealed by the manufacturer, however, a study by Carmona et al mentioned the presence of TEGDMA in the monomer matrix along with other monomers such as 'UDMA', 'Bis-EMA' & 'Bis-GMA'.<sup>61</sup> Presence of TEGDMA has also been reported in 'X-trafil' bulk fill, unlike the other two groups i.e. GROUP 2 (Filtek) and GROUP 3 (Tetric Evoceram); [Table 5]

TEGDMA is more hydrophilic and has increased mobility than the base monomers, it has the tendency to leach out from resin composites stored in aqueous environments. This may contribute to a gradual decline in polymer mechanical properties. Therefore, a high degree of conversion (DC) is desirable in bulk-fill composites containing 'TEGDMA' for polymer stability.<sup>62</sup>

However, J.W. Stansbury et al stated that if the conversion is optimized to reduce these problems, then alternative complications such as polymerization shrinkage and brittle fracture of the composite become more crucial. Increased degree of conversion may lead to more crosslinking of polymer matrix increasing the elastic modulus, polymerization shrinkage and stress on the restoration rendering it brittle.<sup>63</sup>

A study given by Rodrigo Lins et al stated that "Presence of TEGDMA in bulk fill composite may be responsible for the increase in the polymerization shrinkage, reduction in its strength and fracture resistance".<sup>52</sup> TEGDMA increases the molecular mobility during polymerization, thereby increasing their degree of conversion (DC) which may be responsible for the rise in linear polymerization shrinkage'.

It may be inferred that increase in the polymerization shrinkage stress in the Aura and X-trafil resulted in increased cuspal deflection and brittleness which may predispose to lower fracture resistance .<sup>2</sup>

The difference in fracture resistance values among the experimental composite resins depends not only on the filler loading of the composite but also on various other properties (i.e.; chemical composition of their matrix, filler content/ size and monomer distribution) .<sup>45</sup> [Table 5]

The different types of failure modes seen in restorations such as “adhesive”, “mixed”, “cohesive in dentin”, and “cohesive in resin composite” may be responsible for the fractures caused in the various groups. However, this study failed to inspect the different modes of fracture seen in each group as mentioned previously by Kumar et al and Atalay et al.<sup>64</sup>

The detailed composition of bulk-fill composites is a trade secret, however accessible information shows that they all have a different composition, whether at the level of components used or their proportions. These variations influence the behavior of materials. Hence, further research can be done to assess the various modes of fractures and other mechanical properties of these bulk-fill composites. Further in vivo studies should be conducted to support the findings of the present study where the teeth are subjected to functional chewing movements and failure under fatigue.

## **CONCLUSION**

Under the limitations of the current in-vitro study, the following conclusions, could be made:

1. All experimental bulk-fill composites exhibited clinically acceptable fracture resistance.
2. Highest fracture resistance was exhibited by 'Filtek', followed by 'TetricEvoceram', 'X-trafil' and 'Aura bulk fill' composites.
3. Fracture resistance of 'X-trafil' and 'Aura' bulk-fill composites were comparable.

## **SUMMARY**

The success of endodontically treated teeth(ETT) depends on appropriate chemo-mechanical debridement & obturation along with an adequate post endodontic restoration. Post endodontic restoration has been considered to be a matter of concern for the prolonged success of endodontically treated teeth.

Lately, there has been a shift in the pattern to a more conservative approach such as resin-based composite restoration rather than the regular procedure of crown cutting which leads to excessive tooth structure loss.

Conventional resin-based composites used as a post endodontic restoration had various disadvantages such as polymerization shrinkage, incremental layering technique which is time-consuming and results in increased chances of contaminated layers within the restoration and inclusion of voids within the restoration.

Therefore, “bulk-fill materials” have been recently developed and introduced by several manufacturers, which have various advantages over conventional composites.

Large variations in the composition and differences in the properties of existing bulk-fill composites have been seen that are usually not entirely revealed by the manufacturer which may contribute to changes their mechanical properties. Hence there is a requirement to research regarding the mechanical properties of varied bulk-fill composites available within the market for a successful clinical practice.

In the current investigation evaluation and comparison of resistance to fracture of teeth with post endodontic restoration using four different restorative bulk-fill composites has been attempted.

Human mandibular premolar teeth were used for current research, Mesio-distal-occlusal cavity preparation was done followed by access opening. WL determination was done with a 15 K file. Cleaning and shaping were done with ProTaper Universal files upto size F3 in conjunction with 3% of sodium hypochlorite between the successive files followed by the use of 17% EDTA & final flush with distilled water. The teeth were dried with paper points & obturated. Coronal 3mm of gutta-percha(GP) was removed & the canal orifices were sealed with resin-modified GIC. The teeth were then placed in an incubator for 7 days. Teeth were restored using the bulk-fill composites & were mounted in an acrylic resin. The fracture resistance was tested using a universal testing machine(UTM).

Results obtained indicated a highly significant difference seen with (group 2) Filtek bulk-fill composite compared to (group 1) X-trafil, (group 2) Tetric Evoceram and (group 4) Aura bulk fill (p-value <0.05). Highest fracture resistance was seen with 'Filtek bulk-fill' & lowest fracture resistance was seen with 'Aura bulk fill' composite.

Therefore, the null hypothesis that the fracture resistance of four bulk fill experimental composites will not differ is rejected.

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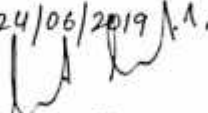

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## ANNEXURE – I

## ETHICAL CLEARANCE CERTIFICATE

 <p><b>Research and Ethics Committee</b>  <b>KLE V K INSTITUTE OF DENTAL SCIENCES</b>  <b>KLE University</b>          Accredited 'A' Grade by RAAC      Placed in Category 'A' by MHRD (Govt)          Nehru Nagar, Belagavi - 590 010, Karnataka State          ☎: 0831-2470362      Web: <a href="http://www.kledental-bgm.edu.in">http://www.kledental-bgm.edu.in</a>          FAX: 0831-2470640      E-mail: <a href="mailto:principal@kledental-bgm.edu.in">principal@kledental-bgm.edu.in</a></p>	
Sl. No. : 1220	
<div style="border: 1px solid black; padding: 5px; display: inline-block;"><b>CERTIFICATE</b></div>	
<p><i>This is to Certify that the synopsis titled</i></p> <p><i>Comparative evaluation of fracture resistance of</i>  <i>endodontically treated teeth restored with four</i>  <i>different bulk fill composites - An in vitro</i> Submitted by  <i>study</i>  <i>Dr. <u>Shrutika V. Salkar</u> P. G. Student /</i>  <i>Staff, Guided by <u>Dr. Preeti Doddwad</u> from Department of</i>  <i>Conservative dentistry &amp; Endodontics has been critically evaluated by</i>  <i>committee members and granted ethical clearance to conduct the above</i>  <i>mentioned study</i></p>	
<p><b>Date :</b> 24/06/2019 A.M.</p>	
 <b>Member Secretary</b> Research and Ethical Committee KLEVK Institute of Dental Sciences Belagavi	 <b>Chairman</b> Research and Ethical Committee KLEVK Institute of Dental Sciences Belagavi KLE V K Institute of Dental Sciences

## ANNEXURE – II

## BIOSTATISTIC CLEARANCE CERTIFICATE

**KLE V.K. Institute of Dental Sciences**

(A Constituent unit of KLE Academy of Higher Education & Research  
Deemed-to-be-University u/s 3 of the UGC Act, 1956)  
Nehru Nagar, Belagavi-590 010 INDIA

Re-Accredited 'A' grade by NAAC (2<sup>nd</sup> Cycle) & Placed in Category 'A' by MHRD (GoI)

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### Biostatistics Clearance Certificate




This is to certify that the Biostatistics aspect of the Dissertation / Research work of Dr. Shrutika V. Salkar entitled Comparative Evaluation of fracture resistance of endodontically treated teeth restored with four different Bulk fill composites (An *in vitro* study) has been done under my guidance and considered satisfactory.

Place : Belagavi  
Date : 18/09/2020

  
 Name & Signature of Biostatistician  
 (Dr. S. B. Javali)

## ANNEXURE – III

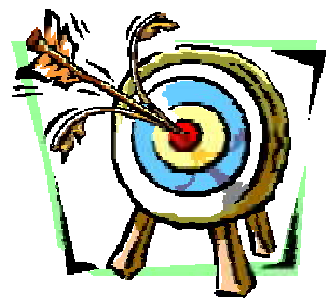
## PLAGIARISM CHECK CERTIFICATE

<b>Scientific Correspondence and Review Committee</b>	
<b>KLE VK Institute of Dental Sciences</b>	
A Constituent Unit of KLE Academy of Higher Education and Research (Deemed-to-be-University u/s 3 of the UGC Act, 1956) Nehru Nagar, Belagavi - 590 010, Karnataka State	
	Accredited 'A' Grade by NAAC (2nd Cycle)      Placed in Category 'A' by MHRD (GoI)
☎: 0831-2470362 FAX: 0831-2470640	Web: <a href="http://www.kledental-bgm.edu.in">http://www.kledental-bgm.edu.in</a> E-mail: <a href="mailto:principal@kledental-bgm.edu.in">principal@kledental-bgm.edu.in</a>
Date : 28-9-2020	Serial No. : 048
<b>PLAGIARISM CHECK REPORT</b>	
Name of the Applicant : <i>Dr. Shrutika Salgar</i>	
UG / PG / Ph.D / Staff : <i>Post graduate</i>	
Batch & Year : <i>2018-2021</i>	
Department : <i>Conservative dentistry &amp; Endodontics</i>	
The soft copy of Research Work / Manuscript by <i>Dr. Shrutika</i> ..... entitled " <i>Comparative evaluation of fracture resistance of</i> <i>endodontically treated teeth restored with four</i> <i>different bulk fill composites - An in vitro study</i> ....." under the guidance of .....has been submitted for Anti-Plagiarism check to the Scientific Correspondence & Review Committee of KLE VK Institute of Dental Sciences using "Turn-it-in" software.	
The scan has been carried out and the scanned output reveals a Similarity Index of ..... <i>9</i> .....%, which is <b>within / not within</b> the acceptable limits of 10% as per the UGC guidelines.	
 <b>Member Secretary</b> Scientific Correspondence and Review Committee KLEVK Institute of Dental Sciences KAHER-Belagavi	 <b>Chairman</b> Scientific Correspondence and Review Committee KLEVK Institute of Dental Sciences KAHER - Belagavi



# *Introduction*

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# *Aim and Objectives*

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# *Research Hypothesis*

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# *Review of Literature*

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# *Methodology*

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*Results*

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# *Discussion*

---



*Conclusion*

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# *Summary*

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# *Bibliography*

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# *Annexures*

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