FRACTURE STRENGTH OF AN ENDODONTICALLY TREATED TEETH WITH DIFFERENT ACCESS CAVITY DESIGNS

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CHENNAI

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation titled **"FRACTURE STRENGTH OF AN ENDODONTICALLY TREATED TEETH WITH DIFFERENT ACCESS CAVITY DESIGNS "** is a bonafide and genuine research work carried out by me under the guidance of **Dr. P. SHANKAR M.D.S,** Professor, Department of Conservative Dentistry and Endodontics, Ragas Dental College and Hospital, Chennai.

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This is to certify that this dissertation titled **"FRACTURE STRENGTH OF AN ENDODONTICALLY TREATED TEETH WITH DIFFERENT ACCESS CAVITY DESIGNS"** is a bonafide record work done by **DR. GAYATHRI.V** under our guidance during her post graduate study period between **2017-2020.**

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LIST OF ABBREVIATIONS

SL.NO	ABBREVIATIONS	DESCRIPTION
1	TEA	Traditional Endodontic Access
2	CEA	Conservative Endodontic Access
3	NEA	Ninja Endodontic Access
4	MIE	Minimally InvasiveEndodontics
5	CBCT	Cone Beam Computed Tomography
6	CEJ	Cemento-enamel Junction
7	PEAC	Point Endodontic Access Cavity
8	MIA	Minimally Invasive Access
9	PCD	Pericervical Dentin
10	MB Canal	MesioBuccalCanal
11	DG-16	David Green Explorer
12	WL	Working Length
13	NaOCL	Sodium Hypochlorite
14	Hyflex EDM	Hyflex Electrical Discharge Machining
15	TEC Technique	Traditional Endodontic Access Cavity Technique
16	CECTechique	Conservative Endodontic Access Cavity Technique
17	NEC Technique	Ultra Conservative Endodontic Access Cavity Technique

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Introduction

INTRODUCTION

Endodontic treatment consists of three equally important phases including canal preparation, microbiological control, and three-dimensional obturation[1]. Access cavity preparation is a first phase in endodontic therapy which not only eliminate infection but also protect the entire root canal system from future microbial invasion. It should provide an adequate access to remove obstruction in the pulp chamber, to locate canal orifices, to debride the entire root canal and to conserve sound tooth structure as much as possible so as to avoid a weakening of remaining tooth structure. Improper access preparation can lead to procedural errors and root canal failure.

The tooth being treated should be analysed before initiating access cavity preparation that includes physical identification of the position and shape of the CEJ, pulp chamber and root canal system followed by radiographic investigation to assess the angulation, to measure the distance from the cusp tip to furcation area, finally confirming the morphological aberrations (presence of fused roots and canals, any bifurcation and trifurcation in the canal system, pulp stones ,sclerosed canals, canal curvature root resorption) using CBCT analysis. Specific laws suggested by krasner and Rankow in 2004[2] can be used as a guideline to initiate access cavity preparation.

Clinically, the steps involved in access cavity preparation includes the removal of carious dentin and defective restorations followed by deroofing the pulp chamber to locate the canal orifices and underlying the root canal space. The most commonly used technique in access cavity preparations is traditional endodontic access (TEA) cavity and less commonly used technique are conservative endodontic access (CEA) and ultraconservative endodontic access(NINJA) cavity preparation.

The endodontic access cavity should aim to provide straight line access to the apical foramen, to remove the organic debris completely, and offer a appropriate space for dense permanent root canal filling material (Schilder 1967)[3]. In order to achieve this goal, the concept of "straight line access" was adopted in endodontics and is the foundation for the traditional endodontic access (TEA).

Straight line access involves removal of sufficient amount of tooth structure that provides a straight line access to the apical foramen or the first point of canal curvature that helps to achieve better cleaning and shaping ,provides a space for irrigants, intracanal medicament and reduce the risk of file distortion and eventual separation due to cyclic fatigue [4,5].

The traditional access cavity preparation for endodontic therapy is directed along the long axis of the tooth and forms a straight line from the occlusal point of access into the pulp chamber leading towards the apical foramen. The bur penetrates the roof of the pulp chamber, then the deroofing of the entire pulp chamber is done with a divergent wall towards occlusal surface. This is done based on G.V.Blacks concept of "extension of prevention" where additional tooth structure is sacrificed to achieve best results and prevent iatrogenic complications[6].

Conservative endodontic access cavity (CEA) preparation was proposed by Giacomo Corsentino[7]. Essentially the concept is to preserve tooth structure maximally. Similarly to the concept of “minimally invasive dentistry" MIE which preserves healthy coronal, cervical and radicular tooth structure[6]. This technique emphazises in preserving the tooth structure including the pericervical dentin, as against traditional endodontic cavities where the emphasis is on straight line pathway into the root canal to increase efficient biomechanical preparation and also prevent or minimise procedural errors[8].

A new concept of root canal access cavity preparation has been proposed by David Clark and Khademi.It emphasizes on pericervical dentin preservation and some amount of the pulp chamber roof termed "Soffit"[6].

CEA, as it conserves more tooth structure, is becoming popular. Another advantage of CEA preparation over TEA preparation, as reported by Alovisi et al in 2017[9], is that it has been shown to provide a greater resistance to fracture. However, with CEA preparation the examination of pulp chamber becomes limited and there is difficulty to debride the area under the roof of the pulp chamber which is not exposed[10].

Another CEA technique is Point endodontic access cavity, also known as NINJA cavities (NEC).

An NEC preparation consist of creating a small hole using a round ended tapering fissure bur on the occlusal surface and projecting it obliquely towards the central fossa of the root orifices in the occlusal plane. This is done to facilitate easier access to locate the root canal orifices from different angulations[11]. Although there is not much of information in literature about this type of access cavity preparation , some use PEAC technique nowadays, which uses microscope to remove minimal amount of hard tissue[12]. The major advantage of NINJA access cavity is preservation of pericervical dentin and some of the part of the pulp chamber roof (Soffit) as mentioned earlier[13].This reduces the need for preparing complex and more expensive post endodontic restorations, thereby improving fracture resistance of root canal treated teeth[14].

Previous studies reported that Pericervical dentin is located 4 mm above the crestal bone and extending 4 mm apical to the crestal bone. It acts as the “neck” of the tooth. It is important for two reasons: for ferrule and to improve fracture resistance, whereas soffit is a small piece of roof around entire coronal portion of the pulp chamber. The soffit behaves like metal band surrounding barrel. It must be maintained to avoid the collateral damage that usually occurs, namely, the gouging of lateral walls[6,7,16].

Cone Beam Computed Tomography (CBCT) is an extra-oral imaging system specifically designed for three dimensional imaging of the oral and maxillofacial structures. Most of the limitations associated with conventional radiography like compression of a three dimensional object into a two dimensional image, image distortion, anatomic superimposition, are overcome with cone beam computed tomography (CBCT)[15].

CBCT technology enhances the access cavity preparation especially in CEA technique as it provides more relevant and consistent information prior to initiating the access cavity. CBCT provides knowledge of the number of root canals present , and to their orientation within the tooth and relative to each other. This aids in preparing more precise access cavity thereby preserving more dentin.

The fracture predilection of endodontically treated teeth is governed by biomaterial and biomechanical considerations as well as specific risk factors: 1) chemical (effects of endodontic irrigants and medicaments on dentin), 2) microbial (effects of bacteria-dentin interaction), 3) dentin (effects of tooth structural loss), 4) restorative (effects of post and core restorations) and 5) age (effects of age changes in dentin). The tooth type is also important, as intact pulpless anterior teeth that have not lost further tooth structure beyond the endodontic cavity are at minimal risk for fracture, while posterior teeth that are subject to larger occlusal loads during function are at greater risk (anil kishen 2006)[17].

The universal testing instrument (Instron, Canton) was selected as it is a highly accurate and versatile material testing instrument used for the precise measurement of the properties and behaviour of materials in tension, compression, flexure and torsion. The use of the instron testing machine has been well-validated in dentistry for a variety of procedural testing including load-at-fracture under a constantly increasing compressive force, to provide an estimate of fracture resistance. The diameter of the sphere head was selected to allow adequate contact with the cuspal inclines during testing, additionally these conditions are similar to those of molars [87]. A complicating variable is the fact that the presence of various permanent restorative materials such as posts, resins, amalgam, porcelain and metals may affect the fracture resistance under test conditions and may obscure the direct effect of dentin loss on specific fracture resistance of the tooth being tested.

Conservative (CEC) and ultraconservative (NEC) access cavity preparations preserve more tooth structure in comparing with traditional access cavity (TEC)preparations, thereby does not require the placement of a pre-fabricated post to reinforce the tooth following root canal treatment. In vitro study done by Plotino et al in 2017 concluded that the fracture resistance of endodontically treated teeth was similar to non endodontically treated teeth, when CEA and ultra CEA preparations were made and restored with direct composite resins. However, root canal treated teeth done with TEA preparations and restored only with composite resins showed a decrease in resistance to fracture.

This necessitated a study to be conducted on the impact of various designs of access cavity preparations and restoration with direct composite resins and subjecting them to an occlusal load. So the aim of this present study was to compare the fracture resistance in endodontically treated mandibular first molars and premolars and in maxillary first molars and premolars which were subjected to one of the three access cavity designs namely traditional (TEC), conservative(CEC) and ultraconservative Ninja (NEC) designs. Following restoration with direct composite resin, the teeth were subjected to an occlusal load using instron universal testing machine. The value at which fracture occurred was noted (in Newtons), recorded and compared with intact natural teeth.

Aim and Objectives

AIM AND OBJECTIVES

AIM:

The aim of this study was to compare the fracture resistance of endodontically treated teeth with different access cavity designs in premolars and molars and compared with intact teeth.

OBJECTIVES:

- This study was designed to compare the fracture resistance in extracted endodontically treated upper and lower first molars and premolars with intact normal teeth .
- The study was designed to compare the fracture resistance following preparing the root canal access using traditional endodontic cavities(TEC), conservative endodontic cavities(CEC) and ultra conservative endodontic cavities(NEC) in upper and lower first molars and premolars.
- The fracture resistance was compared after 24 hours, following restoration of the access cavity with visible light cure composite resin 3M ESPE, after acid etching with 37% phosphoric acid (Actino gel) and using a single coating of two step 7th generation bonding agent (tetric N bond).

- The resistance to fracture for each specimen was evaluated using universal testing machine (Instron) with a sharp pointer having a ball ended tip with a diameter of 6mm. The ball end was directed towards the central fossa of each specimen irrespective of the type of the teeth .The force at which the fracture occurred was noted in Newtons .
- The resistance to fracture (in newtons) for each type of tooth and each technique of access cavity preparation was recorded and the results were analysed and compared using SPSS software.
- From the results conclusions were elucidated for the maximum resistance to fracture for upper and lower first molars and premolars following different access cavity preparations and restoring them with visible light cure composite resin and compared with extracted natural intact teeth.

Review of Literature

REVIEW OF LITERATURE

Panitvisai and Messer et al (1995)[18] determined the extent to which cusps of molars are weakened by progressively larger restorative preparations and endodontic access. 13 extracted, intact human mandibular molars was measured under controlled occlusal loading. A ramped load of 100 N was applied to the mesial cusps via a steel sphere, using a closed-loop servohydraulic testing machine. Lateral cuspal displacement was recorded by linear measuring devices accurate to 1 µm. Increasingly extensive MO or MOD cavity preparations followed by endodontic access were cut in each tooth. Cuspal deflection increased with increasing cavity size and was greatest following endodontic access. Cuspal deflections of more than 10 µm was observed. He concluded that cuspal coverage is necessary inorder to minimize the risk of marginal leakage and cuspal fracture in endodontically treated teeth.

Heling et al(1996)[19] investigated four root canal sealers Pulp Canal Sealer EWT, Sealapex, AH26, and Ketac-Endomolar for their antibacterial effects within dentinal tubules and concluded that all sealers showed antibacterial activity at 24 h, except Ketac-Endo. The activity of Pulp Canal Sealer EWT was similar at 24 h and 7 days. Sealapex had greater antibacterial effect at 7 days than it did at 24 h.

Silva et al (1997)[20] conducted a study with four root canal sealers (Sealapex, CRCS, Sealer 26, and Apexit) by measuring conductivity and pH and by conducting atomic absorption spectrophotometry and concluded that Sealapex (root canal sealer) showed the highest pH, ionic calcium and total calcium values throughout the experimental period, followed by CRCS, Apexit and Sealer 26.

Duarte et al (2000)[21] assessed the pH and calcium ion release of three root canal sealers-Sealapex, Sealer 26, and Apexit at 24, 8 and 7 hrs respectively and after 30 days of spatulation concluded that Sealapex presented the highest calcium and hydroxyl release, especially after longer time intervals, whereas Sealer 26 showed highest release during the initial periods (i.e. during its setting time). Apexit presented the least satisfactory results.

Huang F.M et al (2002)[22] conducted a study and concluded that sensitivity of toxicity depended on the materials tested and the cell culture system used. Thus, the use of both permanent and primary cells is recommended for screening of the cytotoxic effects of root canal sealers. In addition, the results confirmed that root canal sealers constantly dissolve when exposed to an aqueous environment for extended periods, possibly causing moderate or severe cytotoxic reactions. Use of calcium hydroxide-based material as a root canal sealer initially may result in a more favourable response to periradicular tissues.

Assif et al (2003)[23] conducted a study to assess the resistance to fracture of endodontically treated molars with various degrees of tooth structure loss restored with amalgam under simulated occlusal load. He did a cavity preparation included a conservative endodontic access (group 1), removal of all cusps (group 2), a prepared mesial cavity (group 3), removal of the mesiolingual cusp and the mesial cavity (group 4), removal of the mesiobuccal cusp and the mesial cavity (group 5), removal of the mesiobuccal and mesiolingual cusps and the mesial cavity (group 6), preparation of the mesial and distal cavities (group 7), removal of the lingual cusps and the mesial and distal cavities (group 8), and removal of the buccal cusps and mesial and distal cavities (group9) and concluded that the endodontically treated molars with a conservative endodontic access or after removal of all cusps that were restored to their original contour with amalgam presented the highest resistance to fracture under a simulated occlusal load.

Krasner P et al (2004)[2] reviewed that locating the number and position of orifices on pulp-chamber floors can be difficult. This is especially true when the tooth being treated is heavily restored, malposed, or calcified. After evaluating 500 pulp chambers of extracted teeth, new laws for finding pulp chambers and root-canal orifices are proposed. The use of these laws can aid in the determination of the pulp-chamber position and the exact location and number of root canals in any individual tooth.

Soares CJ et al (2005)[24] evaluated the influence of the embedment material and periodontal ligament simulation on fracture resistance of bovine teeth eighty bovine incisor teeth were randomized into 8 groups (n = 10), embedded in acrylic or polystyrene resin using 4 types of periodontal ligament simulation: 1 - absence of the ligament; 2 - polyether impression material; 3 - polysulfide impression material; 4 - polyurethane elastomeric material. The specimens were stored at 37°C and 100% humidity for 24 hours. Specimens were submitted to tangential load on the palatal surface at 0.5 mm/minute crosshead speed until fracture. The fracture modes were analyzed as follows: 1 - coronal fracture; 2 - cemento-enamel junction fracture; 3 - partial root fracture; 4 - total root fracture and concluded that root embedment method and periodontal ligament simulation have a significant effect on fracture resistance. Artificial periodontal ligament modified the fracture modes.

Nagasiri et al (2005)[25] conducted a cohort study to evaluate the survival rate for endodontically treated molars without crown coverage and to identify possible related factors. 220 endodontically treated permanent molar teeth in 203 subjects were included. Follow-up data were derived from a clinical examination and review of the dental record and radiographs and Overall survival rates of endodontically treated molars without crowns at 1, 2, and 5 years were 96%, 88%, and 36%, respectively. With greater amounts of coronal tooth structure remaining, the survival probability increased. Molar teeth with maximum tooth structure remaining after endodontic treatment had a survival rate of 78% at 5 years. Restorations with direct composite had a better survival rate than conventional amalgam and reinforced zinc oxide and eugenol with polymethacrylate restorations and hence concluded that the amount of remaining tooth structure and types of restorative material have significant association with the longevity of endodontically treated molars without crown coverage.

Matherne et al (2008)[26] demonstrated the superiority of CBCT over Conventional Radiographic Examination in identifying the supplemental root canals.

Liang et al (2011)[27] reported a success rate of 87% when the 2 years follow-up evaluation was based on conventional radiographic examination compared to 74% when CBCT was used. This is in accordance with the results obtained, as significant more root canals in molars was identified in CBCT scans and also it identified periapical lesions in 51.85% of the cases compared to 25.92% by conventional radiographic examination.

Faria et al (2013)[28] evaluated antibiofilm activity against Enterococcus faecalis, pH and solubility of AH Plus, Sealer 26, Epiphany SE, Sealapex, Activ GP, MTA Fillapex (MTA-F) and an experimental MTA-based Sealer (MTA-S) and concluded that Sealapex and MTA-F were associated with a reduction in the number of bacteria in biofilms and had greater solubility. The high solubility and pH may be related to the antibacterial activity of these materials.

Meena and Kowsky et al (2014)[15] reviewed to provide comprehensive information related to the principles of Cone beam computed tomography and its potential applications in the management of various endodontic conditions. CBCT has established itself as a highly useful tool in visualizing the exact root and canal anatomy, pathologic alterations, assessment or dentoalveolar trauma surgical assessment, assessment of root resorptions. Knowledge about CBCT will help clinicians to make the full use of this excellent three dimensional imaging system, starting from diagnosis to treatment outcome evaluation.

Krishan et al (2014)[29] conducted a study that Conservative endodontic cavity (CEC) may improve fracture resistance of teeth but compromise the instrumentation of canals and assessed the impacts of CEC on maxillary incisors, mandibular premolars, and molars and then specimens were tested using universal loading machine, after which it has been concluded that CEC was associated with the risk of compromised canal instrumentation only in the molar distal canals, it conserved coronal dentin in the 3 tooth types and conveyed a benefit of increased fracture resistance in mandibular molars and premolars.

Srivastava.S et al (2014)[30] evaluated an in-vitro study of the pH and calcium ion diffusion from MTA Fillapex and Sealapex through simulated external root resorption and concluded that sealapex provided highest pH and calcium release as compared to other groups.

Abella et al (2015)[31] compared the efficacy of six imaging methods (CBCT, modified canal staining and clearing, spiral CT, peripheral quantitative CT, contrast medium-enhanced radiography and digital radiography) in the ability to identify the complete root canal system of 95 teeth. The best results were obtained with the CBCT and therefore considered it as the gold standard.

Patel et al (2015)[32] found that CBCT is superior to periapical radiography for the detection and evaluation of periapical lesions, which can be discovered sooner, in true size, extend and nature.

Rezende GC et al (2016)[33] compared the antimicrobial activity of Acroseal, Sealapex and AH Plus endodontic sealers in an in-vitro biofilm model. Bovine dentin specimens (144) were prepared, and twelve blocks for each sealer and each experimental time point (2, 7 and 14 days) were placed and left in contact with plates containing inoculum of E. faecalis (ATCC 51299), to induce biofilm formation. After 14 days, the samples were transferred to another plate with test sealers and kept at 37°C and 5% CO2 for 2, 7 and 14 days. The specimens without sealers were used as a control for each period. The samples were agitated in a sonicator after each experiment. The suspensions were agitated in a vortex mixer, serially diluted in saline, and triple plated onto m-Entero coccus agar and concluded that Sealapex showed significant differences at all the experimental time points, in comparison with all the other groups. AH Plus and Acroseal showed antimicrobial activity only on the 14th experimental day. Neither of the sealers tested were able to completely eliminate the biofilm. Sealapex showed the highest antimicrobial activity in all the experimental periods. The antimicrobial activity of all the sealers analyzed increased over time.

Gaikwad et al (2016)[34] conducted a study to evaluate the strength of an endodontically treated tooth after preservation of peri-cervical dentin and soffit with Clark - Khademi Style access preparation. He divided the samples into three groups. In group. A, Clark- Khademi access was made and endodontic treatment was carried out with 2% NiTi K-files, in group. B, Straight line access was made and endodontic treatment was carried out with 2% NiTi K-files and in group. C, Straight line access was made and endodontic treatment was carried out with 6% Protaper Universal files. The samples were then tested with a universal testing machine, set to deliver an increasing load until failure and concluded that the teeth after preservation of pericervical dentin and soffit were found to be structurally reinforced as compared to the teeth with straight line access. Clark-

Khademi access preparation was found to be more effective at dentin preservation and strengthening the tooth when compared to straight line access.

Niemi et al (2016)[35] compared that the effectiveness of TRUshape (TS) instruments with ProFile Vortex Blue (VB) instruments for the removal of obturation materials during retreatment of singlecanal mandibular premolars performed through 2 access outlines (TEC and CEC) and concluded that neither retreatment protocol was able to completely eliminate all obturation materials from the root canal surface of mandibular premolars. However, in the presence of a CEC access design, using TS instruments removed more obturating material in single-rooted, oval-shaped canals.

Moore et al(2016)[36] assessed the impacts of CECs on instrumentation efficacy and axial strain responses in maxillary molars and concluded that CECs did not impact instrumentation efficacy and biomechanical responses compared with TECs.

Pirani C et al (2016)[37] conducted a study to evaluate the surface and microstructural alterations of new and used HyFlex EDM prototypes and to test their fatigue resistance and concluded that Spark-machined peculiar surface is the main feature of HyFlex EDM. Low degradation was observed after multiple canal instrumentations. Prototypes exhibited surprising high values of cyclic fatigue resistance and a safe in vitro use in severely curved canals.

Jozef Mincik et al (2016)[38] compared the effect of various restorative materials on fracture resistance in maxillary premolars. The specimens were randomly divided into 8 groups, 8 specimens each: *group A* intact teeth, *group B* unfilled cavity, *group C* composite made by oblique layering technique, *group D* composite with 2mmcusp coverage, *group E* bulk filled posterior composite, *group F* glass-ionomer, *group G* amalgam, and *group H* composite with proximal boxes The specimens were subjected to to fracture in the Instron Universal Testing Machine and then concluded that composite restoration with cusp coverage is the most ideal nonprosthetic solution for endodontically treated teeth. Cusp coverage increases the fracture resistance compared to the conventional cavity design.

Venino P M et al (2016)[39] conducted a study to compare the shaping ability of ProTaper Next (PTN) and the novel HyFlex EDM (HFEDM) instruments by means of micro–computed tomography imaging and concluded that HFEDM and PTN files were similarly effective, and both safely prepared the root canals, respecting their original anatomies. HFEDM files performed better in terms of bucco-lingual canal transportation and centering ratio at the section between the middle and coronal thirds.

Pedullà E et al(2016)[40] conducted a study to evaluate the torsional and cyclic fatigue resistance of the new Hyflex EDM, OneFile manufactured by electrical discharge machining and compared the findings with the ones of Reciproc R2 and Wave One Primary after which it has been concluded that the new Hyflex EDM instruments (controlled memory wire) have higher cyclic fatigue resistance and angle of rotation to fracture but lower torque to failure than Reciproc R25 and Wave One Primary files (M-wire for both files).

Kaval ME et al (2016)[41] conducted a study to evaluate the cyclic fatigue and torsional resistance of Hyflex EDM, ProTaper Gold (PTG), and ProTaper Universal (PTU) instruments and concluded that Hyflex EDM files demonstrated significantly higher cyclic fatigue resistance. Although PTG and PTU have similar cross-sectional design, PTG instruments presented higher cyclic fatigue and torsional resistance than PTU instruments. The enhanced alloy properties of PTG might be considered as the main reason for those differences.

Rover et al (2017)[13] conducted a study to assess the influence of contracted endodontic cavities (CECs) on root canal detection, instrumentation efficacy, and fracture resistance assessed in maxillary molars. He used Traditional endodontic cavities (TECs) as a reference for comparison and analyse the hard tissue debris accumulation, canal transportation, non instrumented canal area, and centering ratio. The samples were subjected to the fracture resistance test and then concluded that CECs access modality in maxillary molars resulted in less root canal detection when no ultrasonic troughing associated to an OM was used and did not increase fracture resistance.

Bayram et al (2017)[42] evaluated the frequency of dentinal microcracks observed after root canal preparation with HyFlex CM, HyFlex EDM, Vortex Blue , and TRUShape systems using micro-computed tomographic (micro-CT) analysis and concluded that root canal preparation with the HyFlex CM, HyFlex EDM, Vortex Blue, and TRUShape systems did not induce the formation of new dentinal microcracks on straight root canals of mandibular incisors.

Iacono et al (2017)[43] compared the phase transformation behaviour, the microstructure, the nano-hardness and the surface chemistry of electro-discharge machined HyFlex EDM instruments with conventionally manufactured HyFlex CM and concluded that HyFlex EDM revealed peculiar structural properties, such as increased phase transformation temperatures and hardness. Present results corroborated previous findings and shed light on the enhanced mechanical behaviour of these instruments.

Sankhe et al (2017)[44] evaluated the effect of HyFlex EDM, which is a new rotary system on root dentin during root canal preparation and concluded that HyFlex EDM showed lowest percentage of defects in root dentin. Thus HyFlex

EDM is more efficient in root canal preparation than that of Protaper Universal thereby preventing dentinal defects or microcracks leading to root fractures.

Alovisi et al (2017)[9] conducted a study to evaluate the influence of contracted endodontic cavities on the preservation of the original root canal anatomy after shaping with nickel-titanium rotary instruments and concluded that TECs may lead to a better preservation of the original canal anatomy during shaping procedures when compared with CECs, particularly at the apical level.

Gündoğar et al (2017)[45] compared the cyclic fatigue resistances of Reciproc Blue HyFlex EDM , WaveOne Gold ,OneShape single-file NiTi systems and concluded that cyclic fatigue resistance of HyFlex EDM files was higher than the cyclic fatigue resistances of OneShape, Reciproc Blue, and WaveOne Gold files**.**

Osman et al (2018)[46] evaluated that the fracture strength of conservative versus traditional access cavity design in molar teeth and concluded that mandibular molars after preservation of pericervical dentine and soffit were found to have higher fracture strength compared to teeth with traditional straight line access.

Kanchan Hegde et al (2018)[11] evaluated the endodontic access cavity designs.. The design of the traditional endodontic cavity (TEC) for different tooth types has been established several decades ago and has remained unchanged with only minor modifications. In TEC, it has a properly access cavity with straight line access. Whereas in conservative access cavity (CEC), there is preservation of the pericervical dentin and complete deroofing of the roof is avoided and concluded that Although traditional access cavity has been established several decades ago, the conservative access cavity designs mentioned in this article are also better options in order to preserve pericervical dentin to enhance the strength of endodontically treated teeth.

Corsentino et al (2018)[7] conducted a study to assess the impact of access cavity preparation and the remaining tooth substance on the fracture strength of endodontically treated teeth. Mandibular first and second molar teeth were prepared with traditional endodontic access cavity (TEC); group 2, teeth prepared with conservative endodontic access cavity (CEC); group 3, teeth prepared with truss endodontic access cavity (TREC) and tested using universal loading machine and then concluded that TRECs do not increase the fracture strength of endodontically treated teeth in comparison with CECs and TECs. Moreover, the loss of mesial and distal ridges reduced the fracture strength of teeth significantly

Neelakantan et al(2018)[47] investigated that the biological aspects of contracted endodontic access cavities . Mandibular molars were divided into 2 groups TEC ,DDC and histologic controls and specimens were processed for histologic evaluation, and the remaining pulp tissue (RPT) was measured from the pulp chamber, root canal, and isthmus at all root thirds and concluded that debridement of the pulp chamber was significantly compromised in DDC. The type of access cavity did not influence the amount of RPT in the root canals and isthmus.

Huynh et al (2018)[48] evaluated the impacts of bonding PCD with composite resin (CR) on radicular microstrain distribution and load at failure of root-filled maxillary premolars and concluded that CR bonding of PCD might impact the biomechanical responses in maxillary premolar roots at low-level continuous loads. The effect of this impact on root fracture loads when subjected to cyclic load warrants further investigation.

Das et al (2018)[49] compared the incidence of dentinal crack formation after root canal preparation using ProTaper Next, OneShape, and Hyflex electrodischarge machining (HEDM) and concluded that nickel–titanium instruments may cause cracks on the root surface. ProTaper Next and HEDM tend to produce less number of cracks as compared to OneShape.

Ozyurek et al (2018)[10] compared the fracture strengths of mandibular molar teeth prepared using traditional endodontic cavity (TEC) and conservative endodontic cavity (CEC) methods. Restored using SDR and EverX Posterior base composite materials and divided into 5 groups. In group 1 the control group. In group 2, TECs were prepared and the samples were restored with EverX Posterior and composite resin. In group 3, CECs were prepared and the samples were restored with EverX Posterior and composite resin. In group 4, TECs were prepared and the samples were restored with SDR and composite resin. In group 5, CECs were prepared and the samples were restored with SDR and composite resin and the samples were subjected to fracture test and then concluded that CEC preparation did not increase the fracture strength of teeth with class II cavities compared with TEC preparation. The fracture strength of teeth restored with the SDR bulk-fill composite was higher than that of teeth restored with EverX Posterior.

Allen et al (2018)[50] compared the stress distributions in the teeth treated through minimally invasive access (MIA) designs to those of the teeth treated through traditional straight‑line access and their relationship to the final restoration using three‑dimensional finite element analysis (FEA). Four FEA models of an extracted mandibular first molar were used and intact model served as the control, whereas the other three were prepared with either an MIA or traditional straight‑line access. Simulated composite access fillings with or without a simulated gold crown were applied to the models, followed by application of an occlusal load of 100 N. Von Mises stresses in the teeth were then calculated and analyzed and concluded that traditional endodontic access cavity may render a tooth more susceptible to fracture compared with an MIA design.

Marchesan et al (2018)[51] determined whether contracted endodontic cavities (CECs) will have an impact on angle, location and radius of the primary canal curvature (PCC) and 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.

K Suhas et al(2018)[8] to evaluate the fracture resistance of root canal treated tooth with different approaches of access cavity preparation and concluded that labial access preparation had better fracture resistance when compared to conventional palatal access preparation. Conventional access cavity preparation resulted in a significant loss of tooth structure as compared to labial access cavity.

Asadi et al(2018)[52] evaluated the canal transportation and centering ability of three nickel-titanium single file rotary systems by cone beam computed tomography (CBCT) and concluded that the three single rotary systems reported a degree in canal transportation and centric ratio but the Hyflex EDM reported the least one.

Shumilovich BR et al(2018)[53] compared the canal transportation and centering ability of three nickel-titanium rotary systems using HyFlex EDM, Protaper NEXT and Mtwo, using cone-beam computed tomography (CBCT) and concluded that HyFlex EDM showed minimum values for root canal transportation at all the three levels which may be attributed to its unique cross section design. Maximum canal transportation was observed with MTwo in the coronal and middle thirds.

Dalmia S (2018)[54] conducted an in vitro study to compare the antimicrobial efficacy of four different endodontic sealers against Enterococcus faecalis and concluded that antimicrobial efficacy of calcium hydroxide-based sealer was highest followed by resin-based sealer and was the least with MTA based sealer.

Altan et al (2018)[55] compared the short and long term apical sealing ability of different root canal sealers and concluded that Sealapex and AH Plus showed significantly better sealing abilities than MTA Fillapex in the long term.

Wang FF et al (2018)[56] compared the surface microstructures and cyclic fatigue resistance of HyFlex EDM with HyFlex CM and HyFlex NT and concluded that electro-discharge machining leads to peculiar melting appearance with micropores instead of machining grooves and irregularities on the surface of HyFlex EDM, which may be the reason, that HyFlex EDM exhibits significantly better cyclic fatigue resistance than HyFlex CM and HyFlex NT.

Giudice et al (2018)[57] conducted a study to evaluate the accuracy of CBCT in comparison with conventional intraoral radiographs used in endodontic procedures and concluded that the important radiological signs acquired using CBCT are not always visible in periapical X-ray. Furthermore, CBCT is used to solve diagnostic questions, essential to a proper management of the endodontic problems.

Saygilil et al (2018)[12] evaluated that the relationship between Endodontic Access Cavity (EAC) types with MB2 canal detection ratio in the upper first molars and concluded that in upper molars, CEAC seems reasonable in terms of detected the MB2 canal and removed hard tissue

Mamit et al (2019)[16] reviewed access cavity preparation from the occlusal table to the canal orifice. One of the common causes of failure in endodontics is missed/eluded canals which hold tissue, and at times bacteria and their related irritants. With the advent of modern endodontic techniques which includes dental operating microscope or loupes for better magnification, illumination and visualization of the ideal access cavity preparation" has evolved from being based on individual tooth type to the preparation based on the shape of the pulp chamber morphology of tooth being treated. This present review discussed the various aspects and trends in access cavity preparation focusing on both the traditional as well as the modern concepts.

Abou-Elnaga et al (2019)[14] evaluated the effects of traditional and truss access cavity preparations in addition to artificial truss restoration on the fracture resistance of endodontically treated mandibular molars. Specimens were divided into 4 groups of traditional access cavity, artificial truss restoration, truss access cavity and control groups and then samples were subjected to a vertical occlusal force until fracture occurred. After which it has been concluded that the truss access cavity preparation improved the fracture resistance of endodontically treated teeth with mesioocclusо- distal cavities whereas the artificial truss restoration did not improve it.

İnan et al (2019)[58] compared the torsional resistance of Pro Glider ,Hyflex EDM), and One G glide path instruments and concluded that Hyflex EDM and ProGlider instruments had significantly higher torsional fatigue resistance than One G instruments, whereas Hyflex EDM showed the highest angle of rotation values.

Turkistani AK et al (2019)[59] compared the shaping ability of HyFlex EDM (HFEDM) and ProTaper Next (PTN) rotary instruments in curved root canals by using micro-computed tomography (micro-CT) imaging and then concluded that HFEDM and PTN files were safe to use in curved canals and showed similar shaping ability, while respecting the original anatomies. HFEDM OneFile performed better at the vicinity of the danger zone in terms of mesiodistal canal transportation and centering ability.

Makati et al (2019)[6]compared the remaining dentin thickness (RDT) and fracture resistance of conventional and conservative access and biomechanical preparation in molars using cone‑ beam computed tomography (CBCT).Samples were randomly divided into two groups of conventional and conservative access preparation group (*n* = 30) and then subjected to pre‑ CBCT scan at the peri cervical region for the measurement of total dentin thickness. For the conventional group, samples were accessed and biomechanical preparation was done using K3 XF file. For conservative group, samples were accessed using CK micro endodontic burs using a dental operating microscope and biomechanical preparation was done using self‑ adjusting file. After obturation and post obturation with nano hybrid composite restoration, samples of both groups were subjected to post‑ CBCT scan at pericervical region for the measurement of RDT. The samples were then loaded to fracture in the Instron Universal Testing

Machine and observed that coronal dentin was conserved in molars when accessed through conservative than through conventional. The dentin conservation afforded an increased resistance to fracture in conservative group which is doubled the fracture resistance in conventional group.

Zhang Y et al (2019)[60] conducted a study to predict the fracture resistance of an endodontically treated first maxillary molar with diverse access cavities using the extended finite element model (XFEM) and 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.

Plotino et al(2017)[63] was to compare in vitro the fracture strength of root-filled and restored teeth with traditional endodontic cavity (TEC), conservative endodontic cavity (CEC), or ultraconservative "ninja" endodontic cavity (NEC) access and concluded that Teeth with TEC access showed lower fracture strength than the ones prepared with CEC or NEC. Ultraconservative "ninja" endodontic cavity access did not increase the fracture strength of teeth compared with the ones prepared with CEC. Intact teeth showed more restorable fractures than all the prepared ones.

Materials and Methods

MATERIALS AND METHODS

ARMAMENTARIUM

- 64 maxillary and mandibular premolars and molars with completely formed apices
- Airotor (NSK Handpiece)
- High speed Endo access burs
- Endomotor
- Hyflex EDM rotary files
- K-files(Mani size#10, 21mm)
- Normal saline
- 5.25%sodium hypochlorite solution (PRIME DENTAL PRODUCTS)
- 17%EDTA (Prime Dental)
- Glass slab and cement spatula
- Absorbent paper points (Meta Biomed)
- Gutta percha (.06 size #20,#25 Diadent)
- Gutta percha (.02 size#15,#20,#25,#30,#35,#40)
- Sealapex (Kerr Company)
- Actino gel(Dental Etching Gel Prevest Denpro)
- Tetric n-bond(Ivoclar Vivadent)
- A2 shade (3M ESPE)
- Light curing unit
- Self cure acrylic resin (DPI)

METHODOLOGY

SAMPLE COLLECTION

Freshly extracted sixty four permanent human single rooted mandibular premolars and double rooted maxillary premolars with separate roots ,maxillary molars with 3 roots and mandibular molars with 2 roots were selected and stored in normal saline until ready to be used.

INCLUSION CRITERIA

Maxillary and mandibular molars and premolars with completely formed apices were selected.

EXCLUSION CRITERIA

Teeth with presence of caries, previous restoration, and visible fracture lines or cracks, atypical crown morphology, previously root canal treated teeth.

SAMPLE PREPARATION

Sixty four maxillary and mandibular premolars and molars were selected for experimental procedure and debris, calculus were removed using ultrasonic scaler and polishing was done using pumice powder and rubber cup.

A total of sixty four extracted maxillary premolars, and molars and mandibular premolars and molars were mounted in a wax jig . Briefly, the wax material was melted and poured into preformed plastic wells. While unset, a given tooth sample was introduced to the level of the cemento-enamel junction (CEJ) and left for two minutes allowing the material to set. The jig was then removed from the well and labelled according to the sample number. The teeth were then removed from their corresponding jigs and re-stored in their labelled plastic vials.

Specimens were assigned into 4 types based on cavity design

- TYPE TEC- Traditional access cavity preparation (20 teeth)
- TYPE CEC- Conservative access cavity preparation (20 teeth)
- TYPE NEC- Ultra conservative access cavity preparation (20 teeth)
- CG-Control group (4 teeth)

And each type consists 5 specimens of lower molar (GROUP A), upper molar (GROUP B),upper premolar (GROUP C) and lower premolar (GROUP D). The groups were allocated based on the type of access preparation that would later be performed.

A separate cuboidal jig was made in which the molten wax was poured . Custom jigs for radiographic imaging were made such that four specimens were accommodated in each jig ,to facilitate CBCT scan.

The samples were initially scanned using a 3-D sirona (SIRONA DENTAL SYSTEMS, CHARLOTTE, NC, USA) CBCT scanner with spatial resolution of 200 µm.

Access preparations for type TEC specimens were performed with the goal of achieving straight line access resulting in either parallel or slightly divergent axial walls. All root canal orifice could be seen at a given occlusal view. The complete TEC preparation was also confirmed by inserting stainless steel hand files into the canals apical one-third with enough preparation as to enable the instrument handles to be oriented in a vertical fashion with minimal bending or flexing.

CEC and NEC access preparations were performed with the aim of preserving as much coronal dentin as possible. The strict adherence to “straight-line access” was not followed. Access to and identification of the largest canal (palatal canals of upper molars and distal canals of lower molars) was strategically performed first using round burs. From that given canal orifice, the remaining canal orifice were searched.

ENDODONTIC TREATMENT:

Root canals were instrumented initially with size 10 K-type files (MANI) till the major apical foramen, and later the canals were negotiated till working length with Hyflex EDM rotary instruments , up to the #20 tip size and 0.06 taper file except palatal and distal canals of upper and lower molars respectively. During procedure, 5.25% sodium hypochlorite was used for irrigation intermittently deposited using bivelled 26-G needles , and in between instrumentation, the root canals were coated with 17% EDTA gel. The palatal and distal canals were negotiated initially with #20k type files tip size upto 16mm working part and followed by apical preparation till #40 k type files and coronal preparation till #55 k type files using step back technique. All the canals were dried with paper points and filled with gutta-percha (single-cone size 20, 0.06 taper) and a calcium-based endodontic sealer (sealapex ,USA) for buccal and palatal canals for upper premolar and mesial canals for lower molars and the canals were obturated using lateral condensation technique in mandibular premolars and in palatal (upper molar) and distal canals (lower molar).

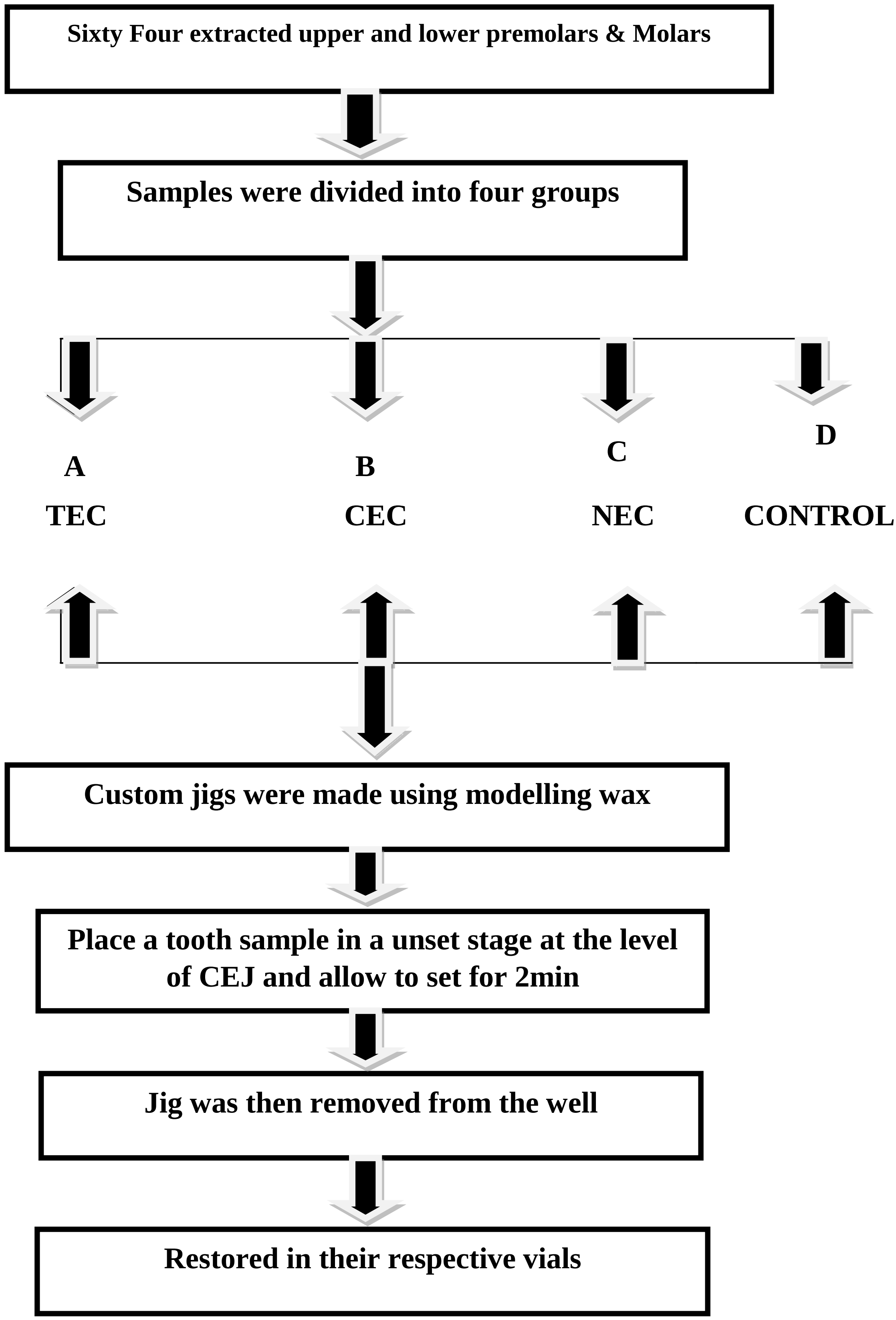
The gutta-percha is then sheared off at the canal orifice and the access cavity cleaned and etched with 37% phosphoric acid for 15 and 30 seconds, respectively; rinsed for 30 seconds with a water/air spray; and gently air dried. A light polymerizing primer bond adhesive (tetric -n bond)was applied and gently air dried , and exposed to light-emitting diode polymerization for 30 seconds. The access cavities in all specimens (60) were restored with direct composite resin (3 M ESPE) using incremental layering technique and polymerized for 40 seconds for each layer.

Post-operative CBCT scans were performed using the same custom jigs, scan groups, and parameters as the pre-operative scans described earlier. Pre-operative and post-operative CBCT images were analyzed using Galielio software.

Fracture Test:

The 60 teeth in the TEC, CEC, and NEC types and the four intact teeth were mounted on brass rings with the roots embedded in self-curing resin (DPI) up to 2 mm apical to the cemento-enamel junction . The 60 tooth specimens were placed in a custom-made water bath and mounted in a mechanical material testing machine (LR30 K; Lloyd Instruments Ltd, Fareham, UK) . The teeth were loaded at their central fossa at a 30^{o}angle from the long axis of the tooth. The continuous compressive force at a crosshead speed of 0.5 mm/min was applied using a 6-mm-diameter ball-ended steel compressive head. The loads at which the teeth were fractured, indicated by the software of the load testing machine, were recorded in newtons. The values were recorded , tabulated and compared with intact teeth.

FLOW CHART


Sixty Four extracted upper and lower premolars & Molars
Samples were divided into four groups
A
TEC
B
CEC
C
NEC
D
CONTROL
Custom jigs were made using modelling wax
Place a tooth sample in a unset stage at the level of CEJ and allow to set for 2min
Jig was then removed from the well
Restored in their respective vials

Teeth were removed from their corresponding jig

↓

Then, the samples were subjected to CBCT to locate canals, pulp stones.etc

↓

All the samples were prepared using endo access bur

↓

Canals orifices were located using an endodontic explore (DG -16)

↓

Canals were negotiated using 10 K -file in a watch winding motion full working length in all canals.

↓

Canals were instrumented initially using Hyflex EDM at 300rpm & 4Ncm

↓

Canals were then instrumented with K-files till size 35 using step back technique

↓

Canals were irrigated using 5.25% Naocl solution & 17%Endo prep Rc

Canals were dried with sterile paper points & obturation done using 6% GP & sealapex as a sealer in narrow canals

Canals were dried with sterile absorbent paper points & obturation was done using 2% GP & sealapex as a sealer using lateral condensation in wide canals

↓

Cavities restored with composite resin using incremental layering technique

↓

Post operative CBCT scans were taken to assess the completeness of obturation

↓

All specimens were stored in 0.9% saline solution at 4 degree C

↓

Samples were placed in universal testing machine

↓

Compressive force applied with 6mm stainless steel sphere on the central fossa of teeth

↓

Force necessary to fracture each tooth recorded in Newtons

↓

Data analyzed by SPSS software analysed

Figures

FIG 1 : SAMPLE 1 EXTRACTED MAXILLARY AND MANDIBULAR FIRST MOLARS AND PREMOLARS

FIG 2 : SAMPLE 2 EXTRACTED MAXILLARY AND MANDIBULAR FIRST MOLARS AND PREMOLARS

FIG 3 : SAMPLE 3 EXTRACTED MAXILLARY AND MANDIBULAR FIRST MOLARS AND PREMOLARS

FIG 4 : SAMPLE 4 EXTRACTED MAXILLARY AND MANDIBULAR FIRST MOLARS AND PREMOLARS

FIG 5 : SAMPLE 5 EXTRACTED MAXILLARY AND MANDIBULAR FIRST MOLARS AND PREMOLARS

FIG 6: CONTROL GROUP

ARMAMENTARIUM FOR ACCESS CAVITY PREPARATION

FIG 7 : NSK HANDPIECE AIROTOR

FIG 8 : ENDO ACCESS BUR

FIG 9: ACCESS CAVITY BEING PREPARED

FIG 10: ACCESS CAVITY

ARMAMENTARIUM FOR BIO MECHANICAL PREPARATION

FIG 11: ENDOMOTOR (X-Smart, Dentsply Maillefer)

FIG 12: SIZE 10 K FILE

FIG 13: NORMAL SALINE

FIG 14: 5% SODIUM HYPO CHLORITE

FIG 15 : EDTA SOLUTION

FIG 16: RC HELP

FIG 17 : HYFLEX EDM ROTARY FILES

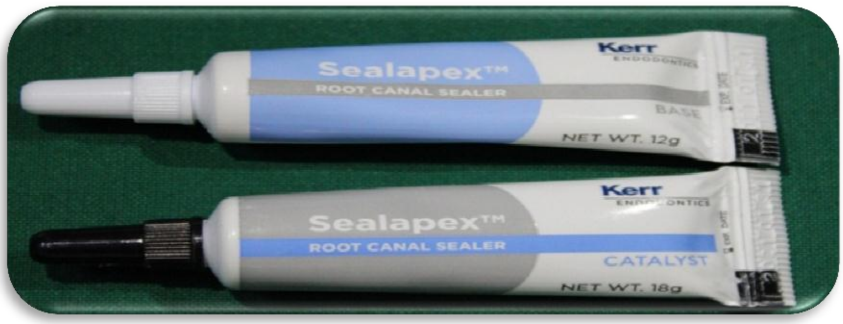


FIG 18 : SEALAPEX SEALER

ARMAMENTARIUM FOR OBTURATION

FIG 19 : GLASS SLAB AND CEMENT SPATULA

FIG 20 : PAPER POINTS

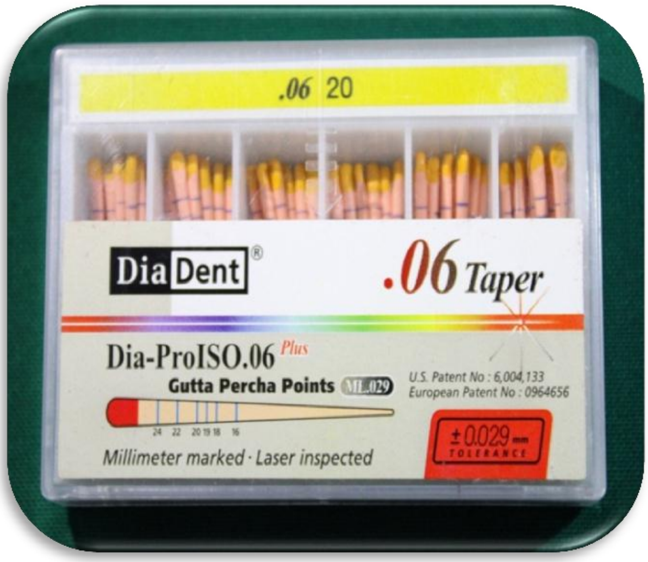


FIG 21 : 0.6% 20 SIZE GUTTA PERCHA

FIG 22 : 0.6% 25 SIZE GUTTA PERCHA

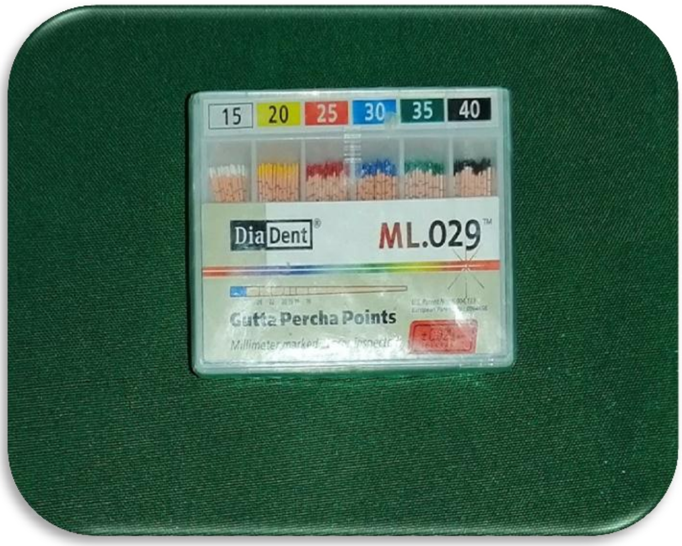


FIG 23 : 0.2% SIZE GUTTA PERCHA

FIG 24: ARMAMENTARIUM FOR POST ENDODONTIC RESTORATION

FIG 25: CBCT (3D SIRONA SYSTEMS)

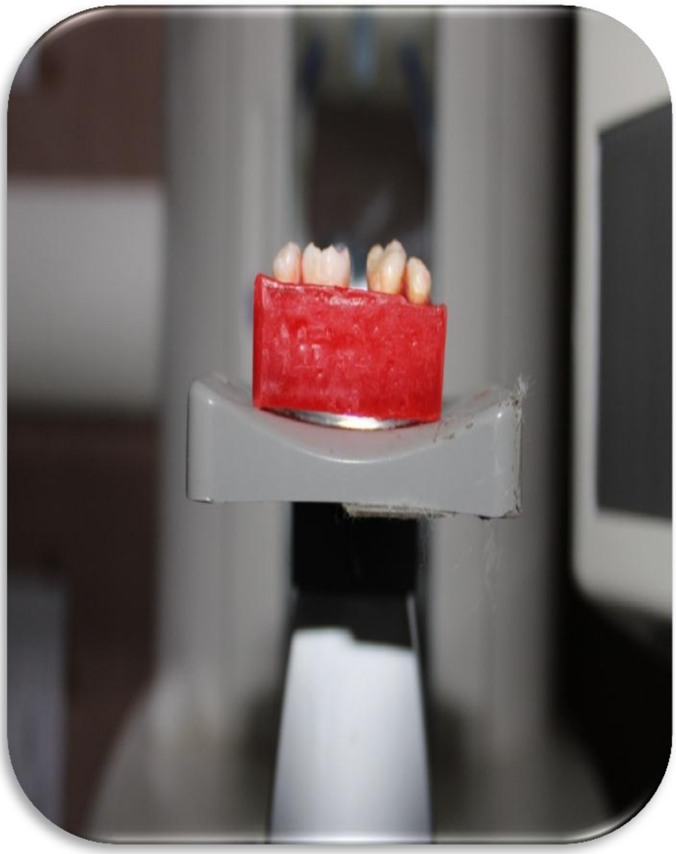


FIG 26 : PLACEMENT OF INTACT NATURAL TEETH

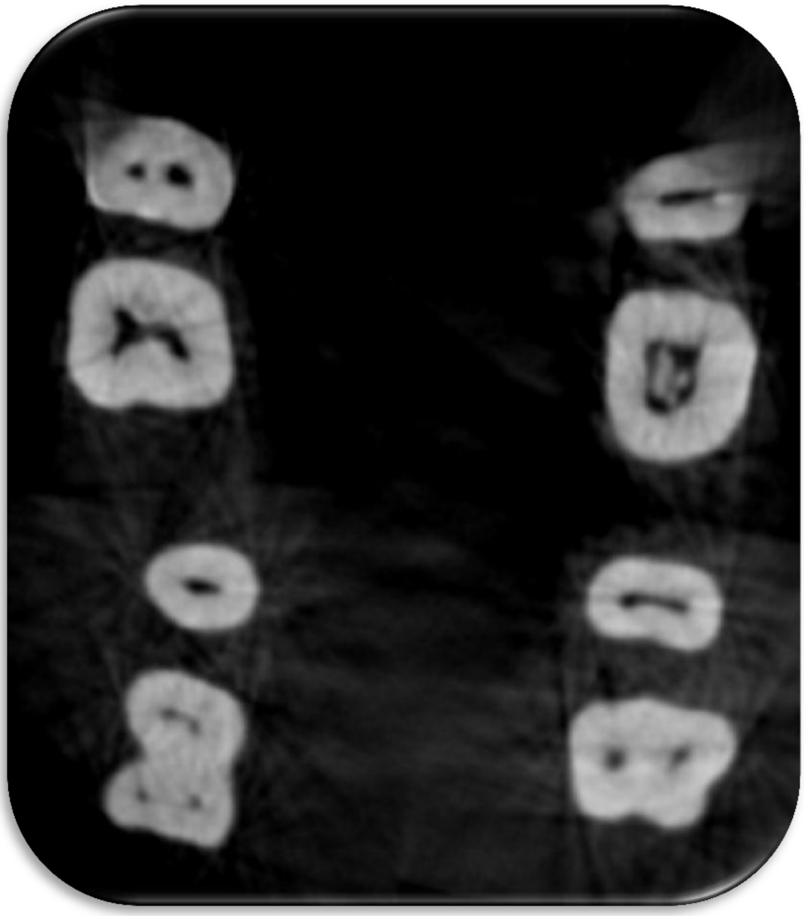


FIG 27 : PRE-OPERATIVE CBCT IMAGE

FIG 28 : INTACT NATURAL TEETH

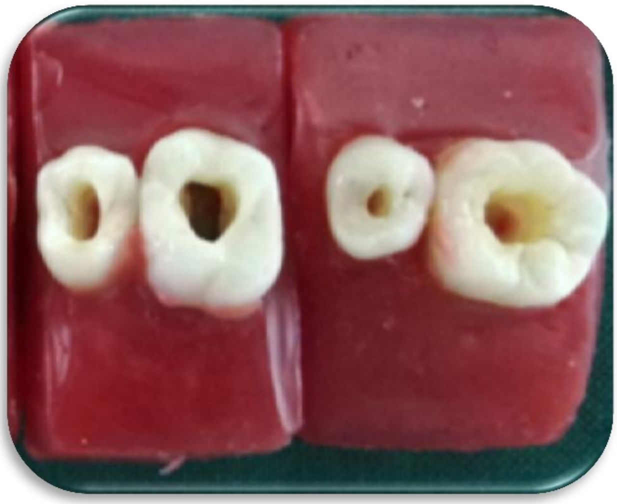


FIG 29 : TRADITIONAL ENDODONTIC ACCESS CAVITY

FIG 30 : CONSERVATIVE ENDODONTIC ACCESS CAVITY

FIG 31 : ULTRA CONSERVATIVE ENDODONTIC ACCESS CAVITY

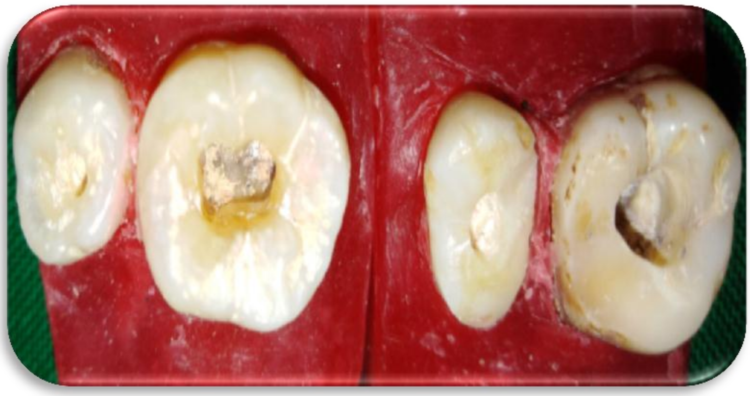


FIG 32 : OBTURATION (TEC) PREPARATION

FIG 33 : OBTURATION (CEC) PREPARATION

FIG 34 : OBTURATION (NEC) PREPARATION

FIG 35 : COMPOSITE RESTORATION (TEC) PREPARATION

FIG 36 : COMPOSITE RESTORATION (CEC) PREPARATION

FIG 37 : COMPOSITE RESTORATION (NEC) PREPARATION

FIG 38: POST OPERATIVE CBCT IMAGE

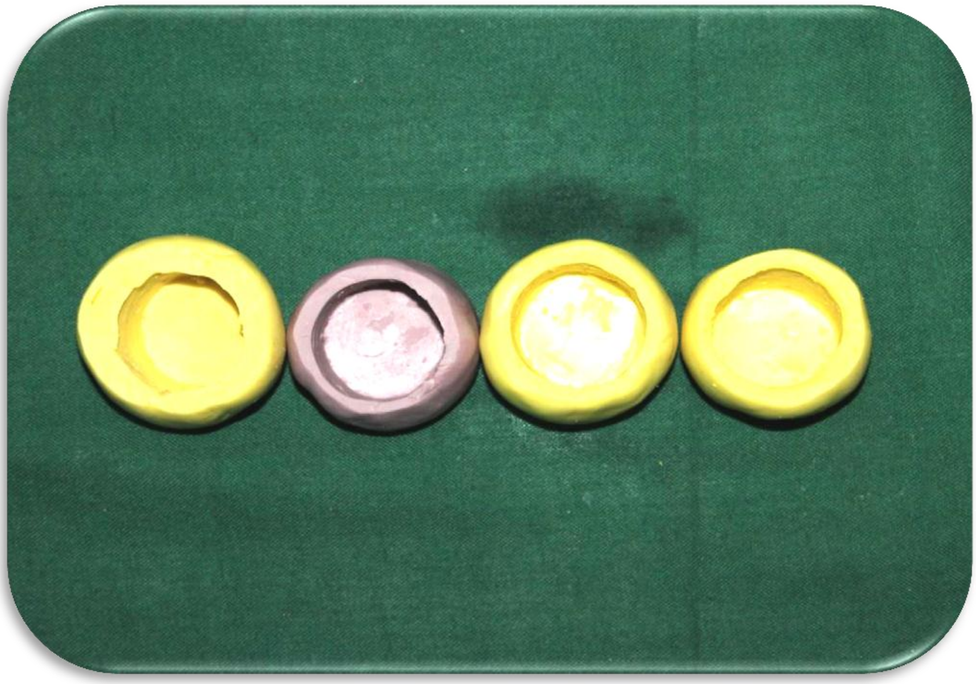


FIG 39 : SILICON RUBBER BASE CUSTOM MADE JIGS

FIG 40 : COLD CURE POWDER AND LIQUID

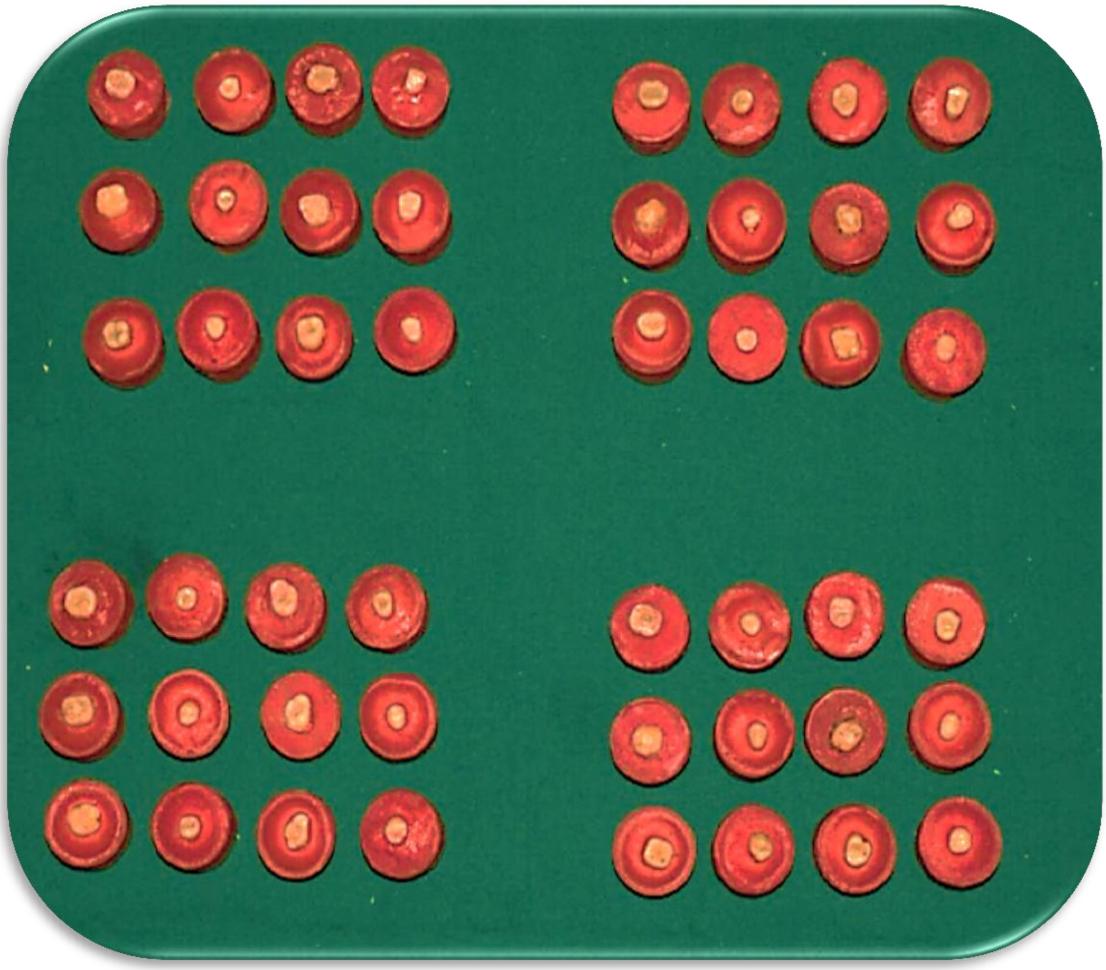


FIG 41 : TEETH WERE MOUNTED IN ACRYLIC RESIN

FIG 42: INSTRON TESTING MACHINE

FIG 43: SAMPLE BEING TESTED FOR FRACTURE RESISTANCE

FIG 44: MANDIBULAR MOLAR IN TEC TYPE

FIG 45: MANDIBULAR PRE MOLAR IN TEC TYPE

FIG 46: MAXILLARY MOLAR IN TEC TYPE

FIG 47 : MAXILLARY PRE MOLAR IN TEC TYPE

FIG 48 : MANDIBULAR MOLAR IN CEC TYPE

FIG 49 : MANDIBULAR PRE MOLAR IN CEC TYPE

FIG 50 : MAXILLARY MOLAR IN CEC TYPE

FIG 51 : MAXILLARY PRE MOLAR IN CEC TYPE

FIG 52 : MANDIBULAR MOLAR IN NEC TYPE

FIG 53 : MANDIBULAR PRE MOLAR IN NEC TYPE

FIG 54 : MAXILLARY MOLAR IN NEC TYPE

FIG 55 : MAXILLARY PRE MOLAR IN NEC TYPE

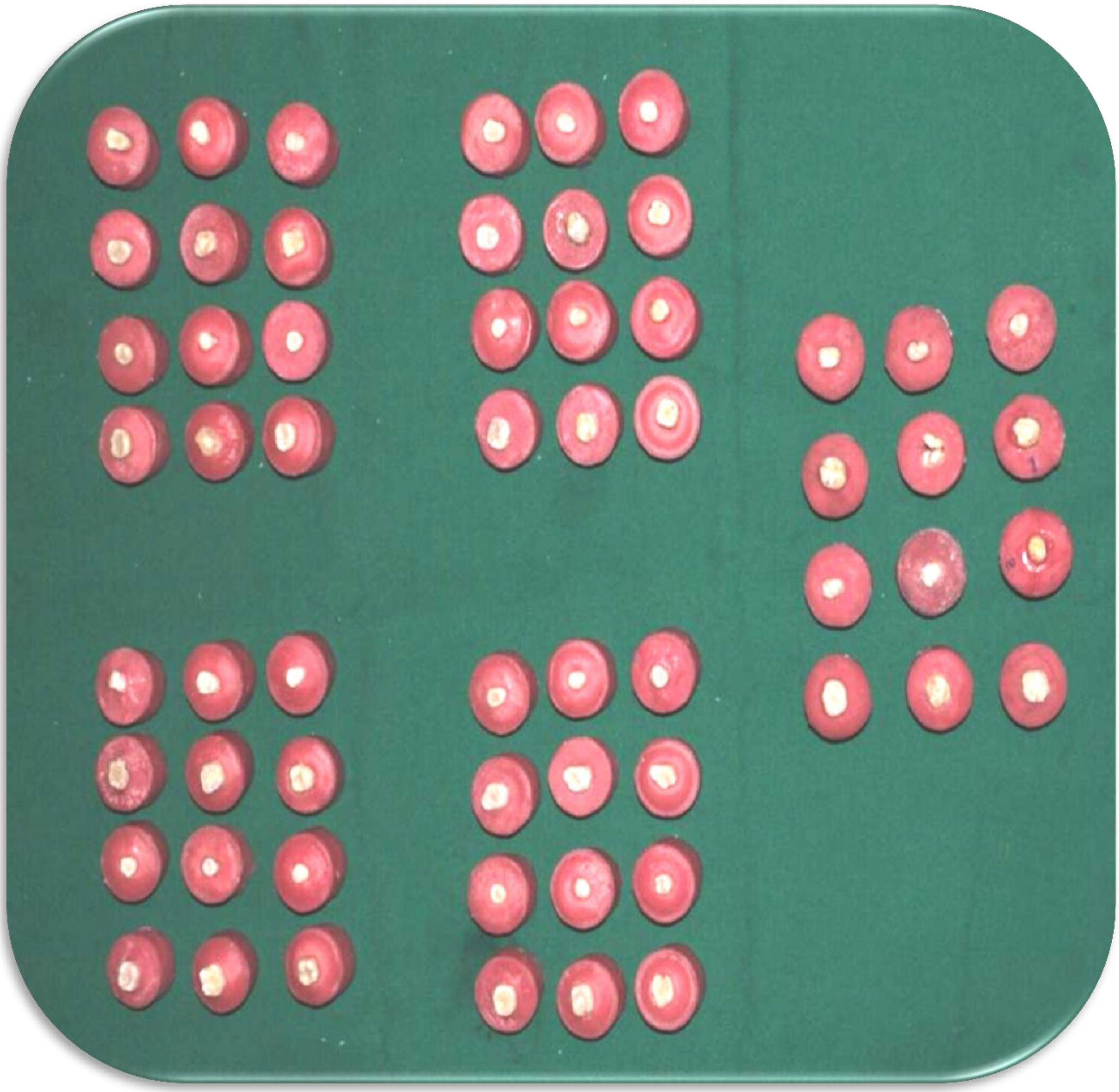


FIG 56 : SIXTY TESTED SAMPLES AFTER FRACTURE RESISTANCE

FIG 57 : CONTROL GROUP SAMPLES AFTER FRACTURE TEST

Result

RESULTS

The present study shown that ultra conservative endodontic access cavity preparation show higher resistant to fracture .The mean load necessary to fracture the samples in each group was measured in Newtons.

The loads necessary to fracture the teeth in all groups are shown in the following tables. The tables were statistically analyzed using SPSS V20 software.

STATISTICAL ANALYSIS:

Data obtained was entered in excel sheet and analysed using SPSS V20. Significance was set at $p \leq .05$. Normality was checked using Shapiro Wilks test and data was found to follow non normal distribution. Kruskal Wallis ANOVA was used to compare between three group and was followed by Mann Whitney U test for comparison between 2 groups.

The Kruskal-Wallis test is a *non-parametric test* of whether more than two independent groups differ. It is the non-parametric version of *one-way independent ANOVA*. That is, it tests whether the samples from which two independent samples are drawn have the same location. The Mann-Whitney U test is used to compare differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed.

Table 1 shows the descriptive statistics of the three techniques used with different tooth specimens. It can be seen from this table that the minimum force required to fracture a root canal treated tooth was 640 N in mandibular premolars and the maximum force was 1292 N in maxillary molar under the traditional technique of access cavity preparation (TEC). In the conservative technique (CEC) the least force that cause fracture was 1011 N seen in both upper and lower premolars and the highest recorded force was 2100 N in mandibular molars.

When NEC technique was used, the minimum resistance force 1600 N in Maxillary premolars and the maximum resistance recorded was 2900 N in mandibular molars.

On overall comparison of the recordings in this table (1) which shows that the force required to fracture a root canal treated tooth restored with composite resin varies between 640 N to 2450 N. Based on the results, it can be seen that the resistance to fracture was a least force when using the traditional technique (TEC) irrespective of the type of tooth (640-1292 N). Maximum force needed to fracture the specimens was seen in the ultraconservative technique group (NEC) [1600-2900 N].

On evaluation of the values from table 2, the following results were observed: In GROUP A mandibular molars while using the traditional technique type (TEC) values ranged between 930-961 N; with conservative technique type (CEC) values ranged between 1859-2100N; with ultraconservative technique type (NEC) the values ranged between 2320-2450 N;

In the maxillary molar (GROUP B), the values for the traditional technique (TEC) was between 1000-1292 N; the values for the conservative technique (CEC) was between 1800-1814 N; and the values for the ultraconservative (NEC) technique was between 2068-2900 N.

In the case of maxillary premolars (GROUP C), the traditional technique (TEC) preparation resisted the force between 750-1089 N; the conservative preparation (CEC) resisted from 1011-1047 N; and the ultraconservative (NEC)showed resistance values of 1908-2019 N.

In the case of mandibular premolars (GROUP D), when using the traditional technique (TEC), the resistance to fracture varies between 640-742 N; whilst using the conservative technique(CEC) the values vary between 1011-1075 N and with ultraconservative technique it varies between 1600-1842 N. Hence, the ultraconservative technique (NEC) resists the maximum and the traditional technique (TEC) resists the minimum.

Table 3, shows the comparison between individual techniques irrespective of the type of the teeth and this table shows comparison of traditional technique (TEC) versus conservative technique(CEC) preparation.

Table 4, compares the resistance to forces between traditional (TEC) technique group and ultraconservative (NEC) technique group. This value was statistically significant with all the types of the teeth.

Table 5, shows comparison between group (CEC) conservative technique with group ultraconservative technique (NEC). There is statistically significant increase on the resistance to forces in the ultraconservative technique (NEC) when compared with conservative technique (CEC).

Table 6, shows the comparison between three technique groups(TEC,CEC,NEC).

Table 7, shows the maximum resistance to the force applied (in newtons) in one specimen of all groups - control group (CG).

Tables and Graphs

TABLE 1: DESCRIPTIVE STATISTICS

Type	Group	N	Range	Minimum	Maximum	Mean	Std. Deviation
TRADITIONAL (TEC)	MAND MOLAR (A)	5	31	930	961	949.60	12.300
	MAX MOLAR (B)	5	292	1000	1292	1134.60	137.764
	MAX PREMOLAR (C)	5	374	715	1089	844.80	142.229
	MAND PREMOLAR (D)	5	102	640	742	698.40	36.923
CONSERVATIVE (CEC)	MAND MOLAR (A)	5	241	1859	2100	1927.40	98.259
	MAX MOLAR (B)	5	14	1800	1814	1803.00	6.164
	MAX PREMOLAR (C)	5	36	1011	1047	1031.80	15.547
	MAND PREMOLAR (D)	5	64	1011	1075	1052.40	25.215
ULTRA CONSERVATIVE (NEC)	MAND MOLAR (A)	5	130	2320	2450	2378.40	51.213
	MAX MOLAR (B)	5	832	2068	2900	2330.20	332.357
	MAX PREMOLAR (C)	5	111	1908	2019	1989.60	46.339
	MAND PREMOLAR (D)	5	242	1600	1842	1779.20	100.991

TABLE 2: MAXIMUM AND MINIMUM FORCES IN NEWTON'S

GROUP	TYPE	MINIMUM	MAXIMUM
MAN MOLAR (A)	TRADITIONAL (TEC)	930	961
	CONSERVATIVE (CEC)	1859	2100
	ULTRA CONSERVATIVE (NEC)	2320	2450
MAX MOLAR (B)	TRADITIONAL (TEC)	1000	1292
	CONSERVATIVE (CEC)	1800	1814
	ULTRA CONSERVATIVE (NEC)	2068	2900
MAX. PREMOLAR (C)	TRADITIONAL (TEC)	715	1089
	CONSERVATIVE (CEC)	1011	1047
	ULTRA CONSERVATIVE (NEC)	1908	2019
MAN. PREMOLAR (D)	TRADITIONAL (TEC)	640	742
	CONSERVATIVE (CEC)	1011	1075
	ULTRA CONSERVATIVE (NEC)	1600	1842

TABLE 3: COMPARISON BETWEEN INDIVIDUAL GROUPS TRADITIONAL VS CONSERVATIVE

Ranks

GROUP	TYPE	N	Mean Rank	Sum of Ranks	p-VALUE
MAND MOLAR (A)	TRADITIONAL (TEC)	5	3.00	15.00	
	CONSERVATIVE (CEC)	5	8.00	40.00	**.009***
MAX MOLAR (B)	TRADITIONAL (TEC)	5	3.00	15.00	
	CONSERVATIVE (CEC)	5	8.00	40.00	**.008***
MAX PREMOLAR (C)	TRADITIONAL (TEC)	5	4.00	20.00	
	CONSERVATIVE (CEC)	5	7.00	35.00	.117
MAND PREMOLAR (D)	TRADITIONAL (TEC)	5	3.00	15.00	
	CONSERVATIVE (CEC)	5	8.00	40.00	**.009***

*statistically significant, Mann Whitney U test.

TABLE 4: TRADITIONAL VS ULTRA CONSERVATIVE

Ranks

GROUP	TYPE	N	Mean Rank	Sum of Ranks	p-VALUE
MAND MOLAR (A)	TRADITIONAL (TEC)	5	3.00	15.00	**.009***
	ULTRA CONSERVATIVE (NEC)	5	8.00	40.00	
	Total	10			
MAX MOLAR (B)	TRADITIONAL (TEC)	5	3.00	15.00	**.009***
	ULTRA CONSERVATIVE (NEC)	5	8.00	40.00	
	Total	10			
MAX PREMOLAR (C)	TRADITIONAL (TEC)	5	3.00	15.00	**.009***
	ULTRA CONSERVATIVE (NEC)	5	8.00	40.00	
	Total	10			
MAND PREMOLAR (D)	TRADITIONAL (TEC)	5	3.00	15.00	**.009***
	ULTRA CONSERVATIVE (NEC)	5	8.00	40.00	
	Total	10			

*statistically significant, Mann Whitney U test

TABLE 5: CONSERVATIVE VS ULTRA CONSERVATIVE

Ranks

GROUP	TYPE	N	Mean Rank	Sum of Ranks	p-VALUE
MAND MOLAR (A)	CONSERVATIVE (CEC)	5	3.00	15.00	**.009***
	ULTRA CONSERVATIVE (NEC)	5	8.00	40.00	
	Total	10			
MAX MOLAR (B)	CONSERVATIVE (CEC)	5	3.00	15.00	**.008***
	ULTRA CONSERVATIVE (NEC)	5	8.00	40.00	
	Total	10			
MAX PREMOLAR (C)	CONSERVATIVE (CEC)	5	3.00	15.00	**.009***
	ULTRA CONSERVATIVE (NEC)	5	8.00	40.00	
	Total	10			
MAND PREMOLAR (D)	CONSERVATIVE (CEC)	5	3.00	15.00	**.009***
	ULTRA CONSERVATIVE (NEC)	5	8.00	40.00	
	Total	10			

*statistically significant, Mann Whitney U test

TABLE 6 : COMPARISON BETWEEN 3 GROUPS –TRADITIONAL, CONSERVATIVE AND ULTRA CONSERVATIVE

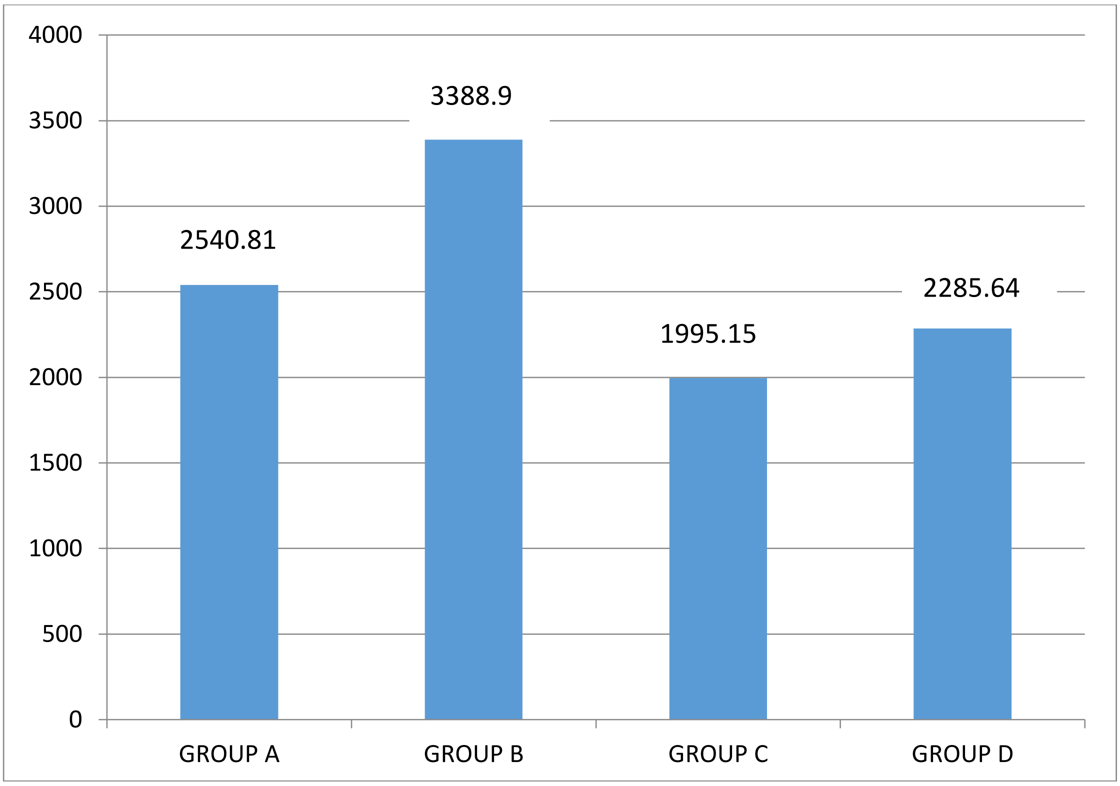
GROUP	TYPE	N	Mean Rank	p-VALUE
MAND MOLAR **(A)**	TRADITIONAL **(TEC)**	5	3.00	
	CONSERVATIVE **(CEC)**	5	8.00	
	ULTRA CONSERVATIVE **(NEC)**	5	13.00	**.002***
MAX MOLAR **(B)**	TRADITIONAL **(TEC)**	5	3.00	
	CONSERVATIVE **(CEC)**	5	8.00	
	ULTRA CONSERVATIVE **(NEC)**	5	13.00	**.002***
MAX PREMOLAR **(C)**	TRADITIONAL **(TEC)**	5	4.00	
	CONSERVATIVE **(CEC)**	5	7.00	
	ULTRA CONSERVATIVE **(NEC)**	5	13.00	**.005***
MAND PREMOLAR **(D)**	TRADITIONAL **(TEC)**	5	3.00	
	CONSERVATIVE **(CEC)**	5	8.00	
	ULTRA CONSERVATIVE **(NEC)**	5	13.00	**.002***

*statistically significant, Kruskal Wallis ANOVA

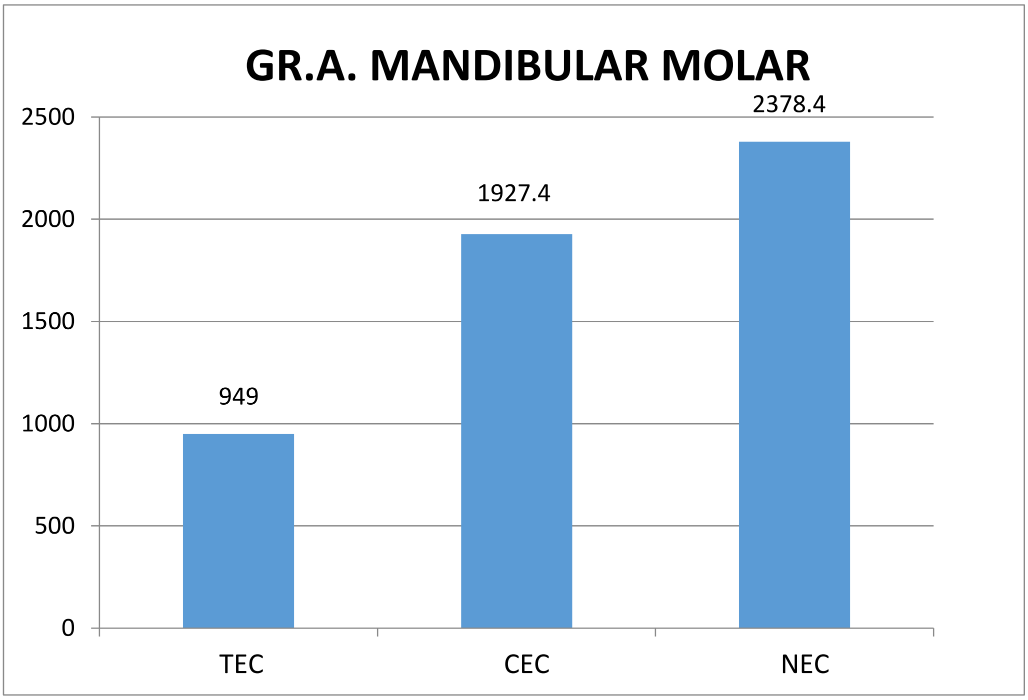
TABLE 7: CONTROL GROUP IN NEWTON'S

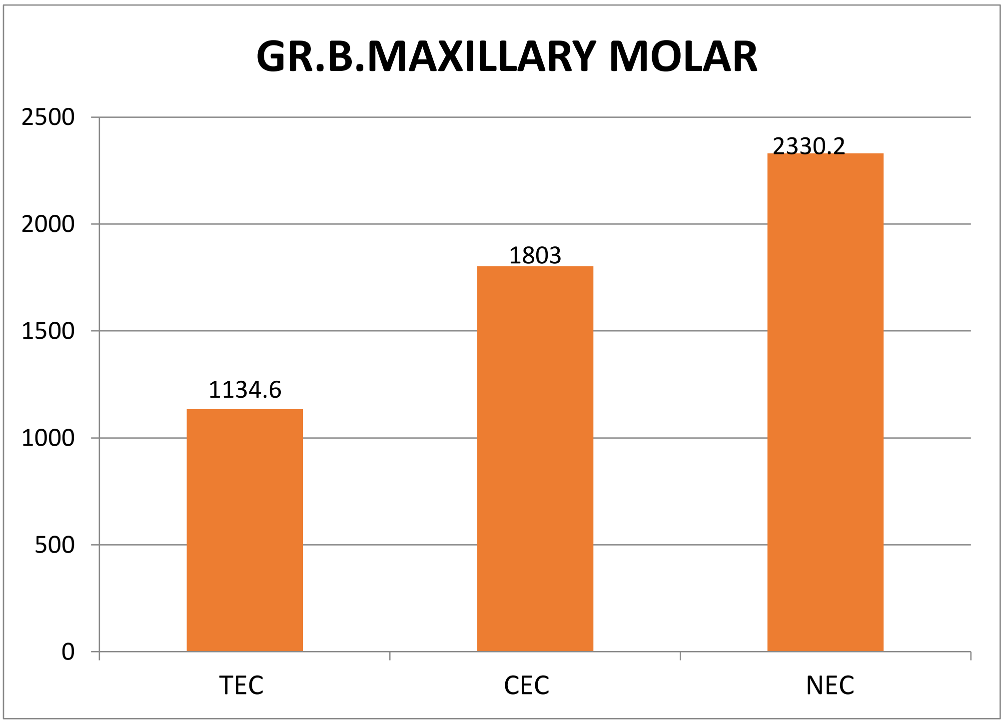
GROUP	NEWTON'S
MANDIBULAR MOLAR (A)	2540.81
MAXILLARY MOLAR (B)	3388.9
MAXILLARY PREMOLAR (C)	1995.15
MANDIBULAR PRE MOLAR (D)	2285.64

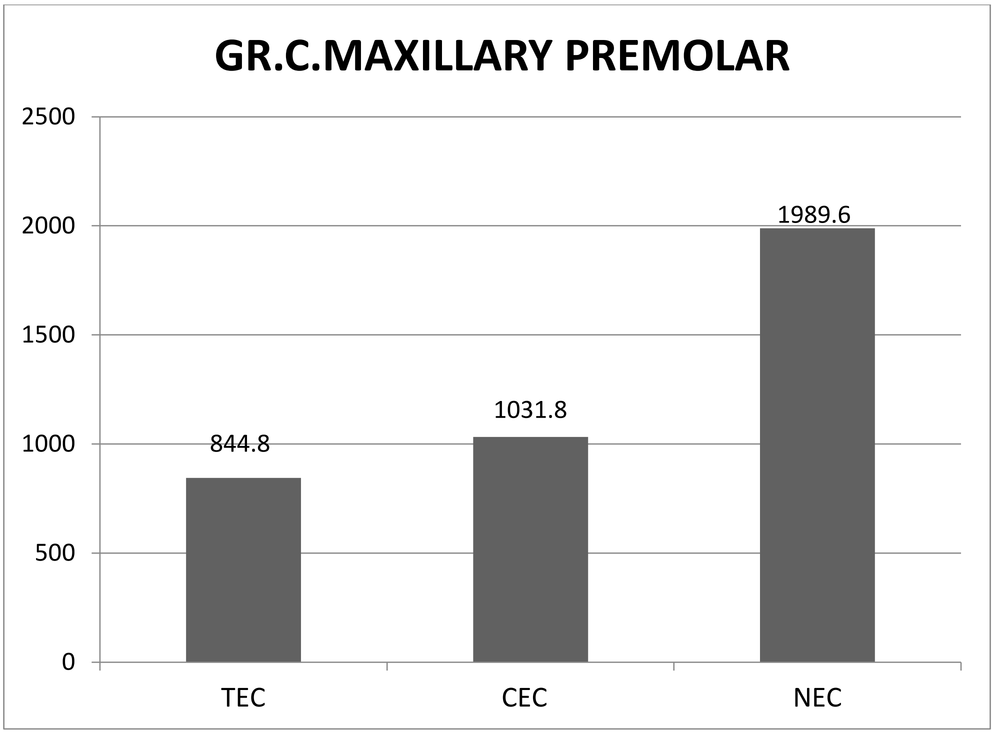
GRAPH 1: CONTROL GROUPS (CG)

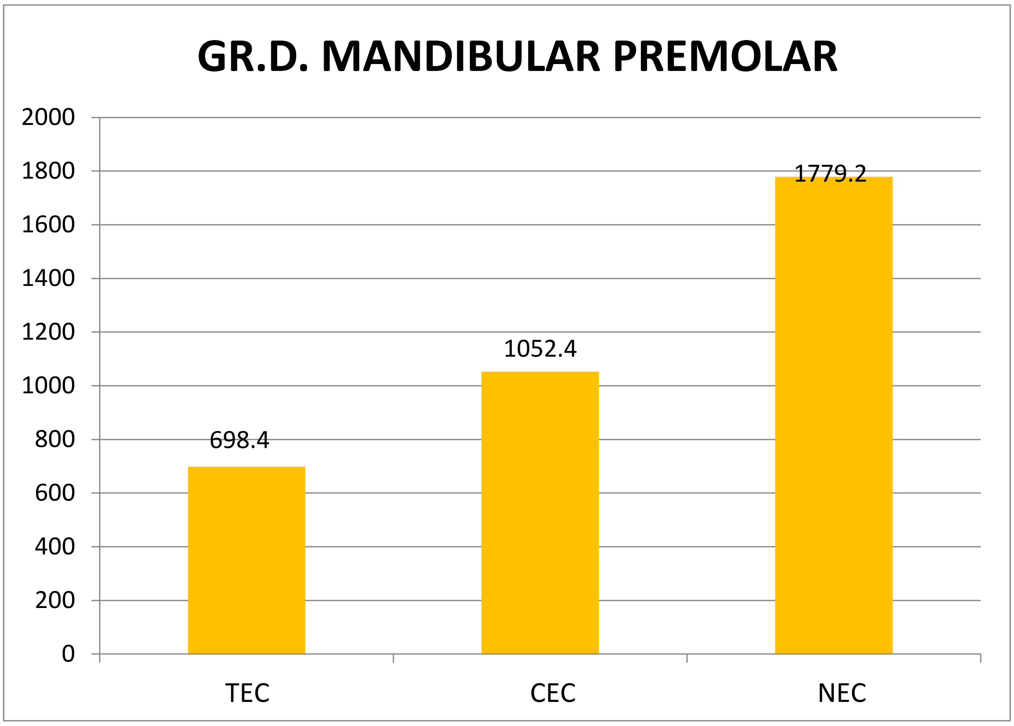


GRAPH 2: TESTED GROUPS

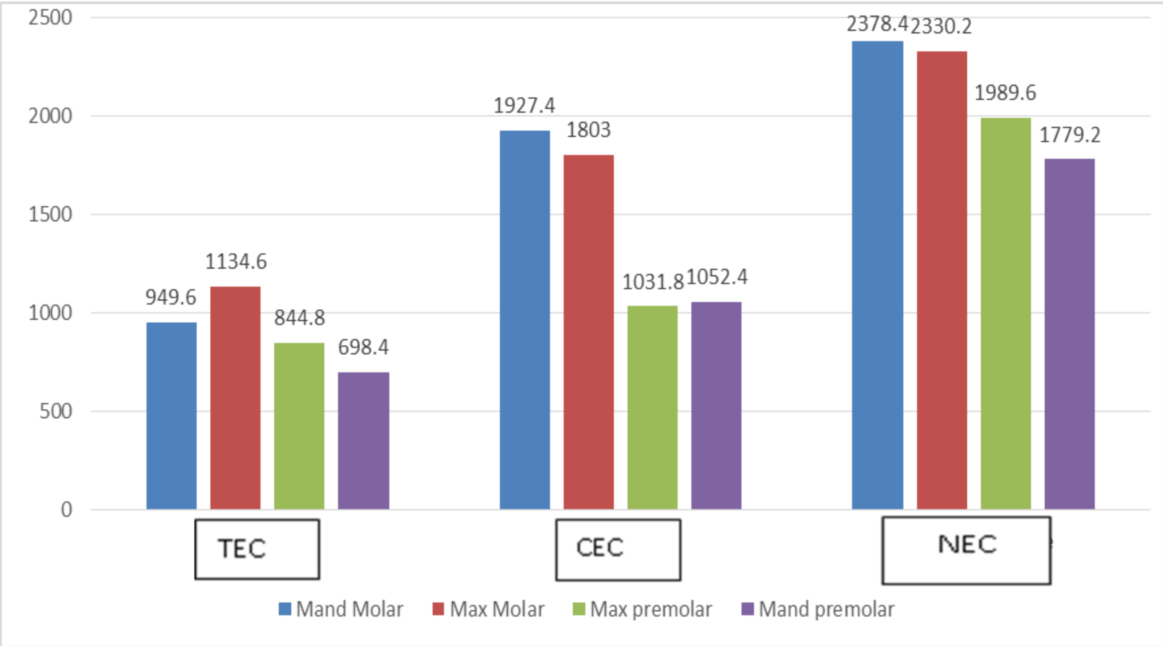




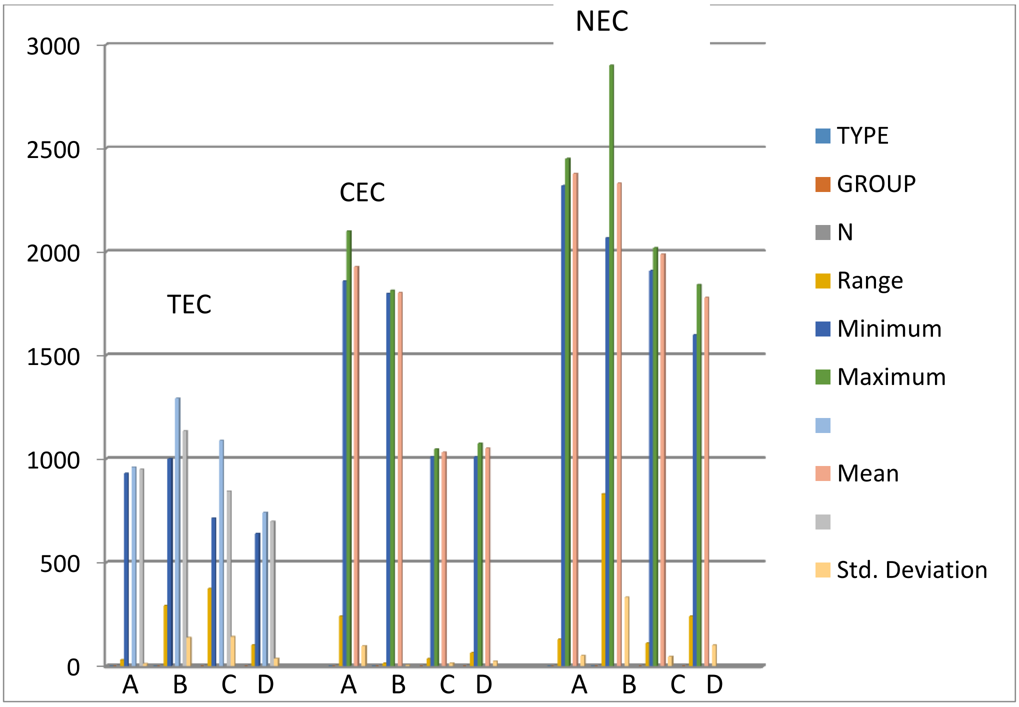

GR.C.MAXILLARY PREMOLAR
2500
2000
1500
1000
500
0
844.8
1031.8
1989.6
TEC
CEC
NEC


GR.D. MANDIBULAR PREMOLAR
2000
1800
1600
1400
1200
1000
800
600
400
200
0
698.4
1052.4
1779.2
TEC
CEC
NEC

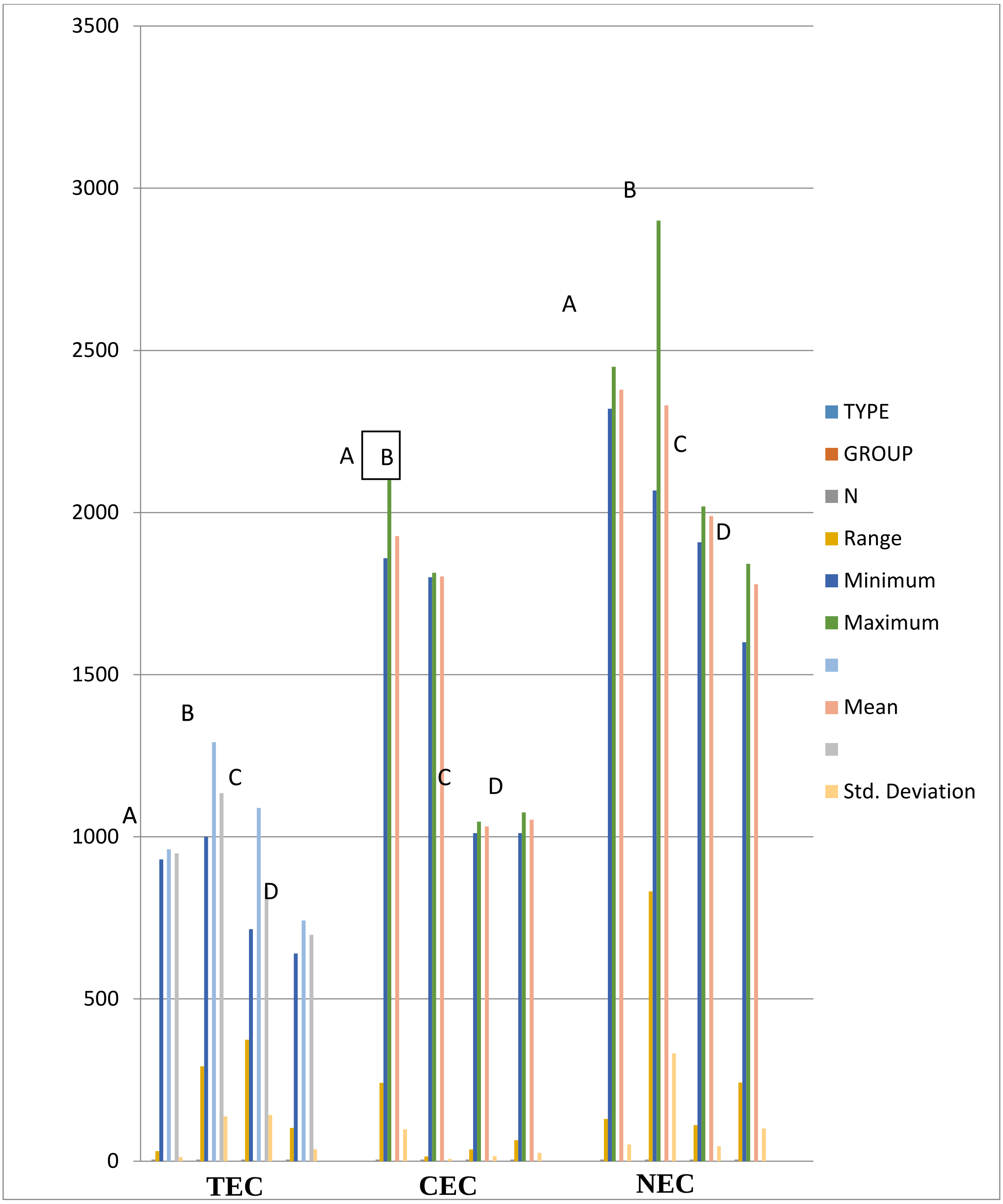
GRAPH 3 : DISTRIBUTION OF SAMPLES BASED ON FRACTURE RESISTANCE FOLLOWING 3 DIFFERENT ACCESS CAVITY PREPARATIONS



GRAPH 4 : DISTRIBUTION OF SAMPLES BASED ON TYPE OF FRACTURE RESISTANCE FOLLOWING 3 DIFFERENT ACCESS CAVITY PREPARATIONS



GRAPH 5 : DISTRIBUTION OF SAMPLES BASED ON GROUP OF FRACTURE RESISTANCE FOLLOWING 3 DIFFERENT ACCESS CAVITY PREPARATIONS



Discussion

DISCUSSION

The ultimate goal in endodontics is to retain the tooth following functional healing after root canal treatment. Root canal therapy involves a sequence of steps in the treatment of the infected pulp of a tooth which should not only result in the elimination of infection, but also on the protection from future microbial invasion. The endodontic access cavity forms the primary step in this sequence to achieve success. Preparing proper endodontic access cavity is the leading step in this series of procedures that can potentially lead to the three-dimensional obturation of the root canal system[61]. Good access cavity design is therefore imperative for quality endodontic treatment[6].

Access cavity design has undergone changes throughout the years[62]. The objectives of access cavity preparation includes creating a smooth, straight-line path beginning from the pulp horns to the apical foramina, facilitate debridement and disinfection of the entire space occupied by the pulp, reducing the risk of instrument breakage and also conserving the sound tooth structure, especially at the pericervical area of the tooth[34]. The traditional endodontic access cavity (TEC) design aims to achieve adequate or complete debridement of the coronal portion of the pulpal cavity by including the pulp horns and de-roofing the pulp chamber. In order to achieve these objectives, a large amount of tooth structure was compromised[34]. Traditional endodontic cavity (TEC) preparation involves controlled removal of the tooth structure and reduces complications that can occur during root canal treatment. However studies have shown that there is greater loss of dentin and anatomical structures like the cusps ,ridges and pulp chamber which can result in fracture of the tooth later[29]. Removal of hard tissue and the associated number of remaining cavity walls, increases cuspal flexure under occlusal load, thereby having an influence on the strength of the tooth resisting fracture. This would result in decrease in tooth strength following extended endodontic access cavity preparation. Studies have shown that the removal of even a millimeter of remaining dentin significantly decreases the fracture resistance of endodontically treated teeth[12]. To overcome this and improve the prognosis for an endodontically treated tooth, newer access cavity designs conserving more tooth structure have been suggested.

Conservative and minimally invasive access (MIA) cavities have been recently proposed to reduce the risk of fracture during endodontic access cavity preparation[50] . In contrast to TEC preparation, conservative endodontic cavity (CEC) preparation is aimed to preserve tooth structure like pericervical dentin and is a minimally invasive procedure[10] providing an alternative to traditional endodontic cavities .They are designed in an effort to preserve the mechanical stability of teeth [9]and there are no exact rules to prepare the CEC. The aim is to preserve as much of the tooth structure as possible and authors suggested that complete de-roofing of the pulp chamber is not necessary to locate the canal orifices[10,47].

Drs. Clark and Khademi have described the concept of conservative endodontic access preparations by preserving the peri-cervical dentin(PCD)and soffit [34]. According to them PCD is defined as the dentin near the alveolar crest. This critical zone, roughly 4 mm coronal to the crestal bone and extending 4 mm apical to crestal bone, is crucial to transferring load from the occlusal table to the root, and much of the PCD is irreplaceable. Soffit is a small piece of roof around the entire coronal portion of the pulp chamber. According to them," A Point endodontic access cavity consist of small hole on the occlusal surface in which the oblique projection is made towards the central fossa of the root orifices in the occlusal plane. It is easier to locate the root canal orifices even from different angulations".

According to Kanchan hegde et al[11],"This point endodontic access cavity was considered as an alternative to the traditional endodontic access cavity in maintaining the mechanical stability of the tooth. This mechanical stability helps in the long-term survival and the function of the endodontically treated teeth. This helps in preserving the pericervical dentin and they serve in distribution of functional stresses in teeth". So it is necessary to preserve this pericervical dentin in order to maintain the biomechanical response of the radicular dentin.

CBCT is the newer and well validated technique to evaluate during different stages of root canal treatment especially useful in locating root canal orifices, the most important advantage being non destructive in nature and quantitatively accurate. It is used to evaluate the exact dentin thickness in the specimens three dimensionally while analysing the images produced[6]. The use of CBCT during endodontic treatment not only provides with a three dimensional evaluation of the tooth being studied but also an appropriate resolution and analysis of images of the surrounding alveolar anatomy[57].

To design the access cavity preparation in this study, CBCT images of all the sixty specimens were made pre operatively.

For this purpose freshly extracted fifteen each of permanent human single rooted mandibular premolar and double rooted maxillary premolar with separate roots ,maxillary molars with 3 roots and mandibular molars with 2 roots with fully formed root apices were selected . The selected teeth were cleaned of calculus and soft tissue remnants using a hand curette. The teeth were disinfected using 5.25% sodium hypochlorite (PRIME DENTAL PRODUCTS) for 10 minutes and rinsed with distilled water. The teeth that had caries, deep cracks, attritions, fractures, or restorations were excluded. The selected teeth were stored in normal saline solution at room temperature until the time of use.

The total of sixty specimens were assigned into 3 types of access cavity designs. One tooth from each group (4 teeth)served as control and no access cavity preparation was done in these teeth .

- TYPE TEC - Traditional access cavity preparation (20 each)
- TYPE CEC - Conservative access cavity preparation (20 each)
- TYPE NEC- Ultra conservative access cavity preparation (20 each)
- CG- Control Group (4 teeth)

Each group consists of 5 lower molars(GROUP A), 5 upper molars(GROUP B), 5 upper premolars (GROUP C) and 5 lower premolars (GROUP D).

Custom jigs for radiographic imaging were made for each of the samples using modelling wax. Briefly, the wax material was melted and poured into preformed plastic wells. While unset, a given tooth sample was introduced to the level of the cement-enamel junction (CEJ) and left for two minutes allowing the material to set. The jig was then removed from the well and labelled according to the sample number. The teeth were then removed from their corresponding jigs and re-stored in their labeled plastic vials.

The samples were initially scanned using a 3-D SIRONA CBCT scanner with spatial resolution of 200 µm .The specimens were mounted in custom jigs and scanned in groups of four samples per scan.

Preoperative cone-beam computed tomographic scans (voxel size = 75 mmwith 90 kV and 12 mA) of the selected teeth were obtained. Anatomical complexities, such as additional root canals, can play an important role in the outcome of root canal treatments. CBCT has improved the ability to diagnose extra canals, because it allows image visualization from multiple orientations at very thin slices without disturbing the overlapping structures(Three dimensional, high-resolution images obtained with CBCT eliminate several limitations of conventional radiographs).In the present study, the combination of all axial, sagittal, and coronal slices of each tooth was examined.

Mandibular molars were selected as they normally have 2 roots and 3 canals. Maxillary molars normally have 3 roots with 3 or 4 canals. Since the location of the fourth canal (MB2) is not constant it was decided to eliminate MB2 canals in the study. Maxillary premolars normally show presence of two individual roots with single canals in each root. Mandibular premolars commonly presented with a single root.

As this study involve the forces acting on the occlusal surfaces 4 different types of occlusal pattern namely rhomboidal shape (maxillary first molar), wide rectangular shape (mandibular first molar), hexagonal shape (maxillary first premolar), pentagonal shape (mandibular first premolar) were used.

Traditional access cavity preparation(TEC) was done in 20 specimens (5 of each group) using Endo Access Bur mounted in a high speed handpiece with water cooling to gain straight line access . The canal orifices were detected with a modified endodontic explorer DG-16. Canal scouting and the initial glide path were performed in all specimens with a size 10 K-file with lubricant and should be gently used in a watch winding action to negotiate the canal till the working length (WL) except palatal canal of upper molars and distal canals of lower molars. The WL was established by subtracting 0.5 mm from the length at which the tip of the instrument was visible at the apical foramen. The pulp chamber was filled with 5% NaOCl throughout instrumentation. Mechanical glide path preparation was performed using Hyflex EDM glide path file and an endodontic engine with a 16:1 contra-angle at 300 rpm and 4 Ncm at the full WL. The palatal and distal canals were negotiated initially with #15k type files tip size upto 16mm working part and followed by apical preparation till #35 k type files and coronal preparation till #55 k type files using step back technique. Irrigation was performed with alternating 5.25% sodium hypochlorite and Endo prep RC (15% EDTA and 10% carbamide peroxide) followed by saline irrigation. Hand agitation, was done with 5.25% sodium hypochlorite to remove the pulpal tissue so as to have a proper disinfection of the root canals..

Conservative access cavity preparation (CEC) was done in 20 specimens (5 of each group) using Endo Access Bur mounted in a high speed handpiece with water cooling to preserve soffit and pericervical dentin with 1‑ mm anatomic flattening followed by entry at 45° penetration angle to reach the dentinal map. The use of round burs and GG burs should be strictly avoided as they are not self-centered, create gouging which leads to difficulties in negotiating the canals and are not minimally invasive as it cuts excessive pericervical dentin and soffit.

Ultra Conservative access cavity preparation(NEC) was done in 20 specimens (5 of each group)using Endo Access Bur mounted in a high speed handpiece with water cooling .The access ‘‘ninja’’ outline was derived from the oblique projection of the scan ,towards the central fossa of the root canal orifices on the occlusal plane. By doing this, localization of all the root canal orifices was possible even from different visual angulations because the endodontic access was parallel with the enamel cut at 90 degree or more to the occlusal table.

The canal orifices were detected with an modified endodontic explorer DG-16 and further scouting and canal preparation was done similar to TEC technique.

The canals in all the 60 specimens were dried with paper points and filled with gutta-percha (single-cone size 20, 0.06 taper) and a calcium-based endodontic sealer for buccal and palatal canals for upper premolar and mesial canal of lower molars ;the canals were obturated using 2% gutta percha by cold lateral condensation technique using finger spreaders for palatal canal in upper molars ,distal canal in lower molars and lower premolars . The gutta-percha is then sheared off at the canal orifice and the access cavity was cleaned for 30 seconds with water and etched with 37% phosphoric acid for 15 seconds, rinsed for 30 seconds with a water/air spray; and gently air dried. A light polymerizing primer bond adhesive was applied and gently air dried , and exposed to light-emitting diode polymerization for 30 seconds. The access cavities were restored with direct composite resin using incremental technique to the level of the occlusal surfaces with the preservation of the occlusal anatomy. Post-operative CBCT scans were performed using the same custom jigs, scan groups, and parameters as the pre-operative scans described earlier. Pre-operative and post-operative CBCT images were analyzed to check complete obturation of the root canals and the post endodontic restoration, as gaps in the restoration could act as weak points and may result in fracture of the tooth at lower forces.

Each tooth was embedded in a block of self-curing acrylic resin. To dissipate the heat generated from the polymerization reaction of the resin, the crowns were continuously moistened with air spray. The specimens were stored in 0.9% saline solution at 4ºC until they were used for static fracture resistance measurement; the storage time ranged from a minimum of 24 hours to a maximum of 36 hours. A universal loading machine was used for this purpose because of its ease of availability and low costs.

Each specimen was inserted into the holding device with an inclination of 90º in relation to the horizontal plane to allow adequate contact with the cuspal inclines during testing. A controlled load was applied by means of a stainless steel ball with a tip diameter of 6 mm at a 30º angle from the long axis of the tooth. The use of a 6-mm steel sphere for resistance to fracture testing by Dietschi, *et al* and Soares *et al* was shown to be ideal for molars, because, it contacts the functional and non-functional cusps in positions close to those found clinically. Pressure of the rod tip was applied in the central fossa. The load between 5 N and 50 N at 15 Hz simulates approximately 4 years of chewing function using forces within the physiological range. After this fatigue phase (36 hours), continuous compressive force was applied at a crosshead speed of 0.5 mm/min. All samples were loaded until fracture, and the maximum breaking loads were recorded in Newton's (N) by a computer connected to the loading machine. Values were recorded for each specimen, for each technique tabulated and compared with SPSS software .Values were recorded for one intact specimen in each group which acted as the control, to compare the fracture resistance of this intact tooth with the endodontically treated teeth.

Table 1 shows the descriptive statistics of the three techniques used with different tooth specimens. It can be seen from this table that the minimum force required to fracture a root canal treated tooth was 640 N in mandibular premolars and the maximum force was 1292 N in maxillary molar under the traditional technique of access cavity preparation (TEC). In the conservative technique (CEC), the least force that caused fracture was 1011 N seen in both upper and lower premolars and the highest recorded force was 2100 N in mandibular molars.

When Ultraconservative technique was used (NEC), the minimum resistance at which fracture occurred was at 1600 N in maxillary premolars and the maximum resistance recorded was 2900 N in mandibular molars.

On overall comparison of the recordings in this table (1), the force required to fracture a root canal treated tooth restored with composite resin varies between 640 N to 2900 N. Based on the results, it can be seen that the resistance to fracture was at a least force when using the traditional technique (TEC) irrespective of the type of tooth (640-1292 N). Maximum force needed to fracture the specimens was seen in the ultraconservative technique group (NEC) [1600-2900 N].

On evaluation of the values from table 2, the following results were observed: In GROUP A mandibular molars while using the traditional technique (TEC), values ranged between 930-961 N; with conservative technique (CEC),values ranged between 1859-2100N; with ultraconservative technique (NEC), the values ranged between 2320-2450.

As the Ultraconservative technique (NEC) involves the most minimal preparation of natural tooth structure and the amount of restoration after endodontic treatment is also less, then the resistance to fracture is maximum with this technique. Since, the traditional technique (TEC) involves maximum loss of tooth structure with maximum restorative material, the resistance to fracture remains the least. The conservative technique (CEC) shows the value in between the other 2 groups, which is probably due to greater conservation of the tooth structure.

In the maxillary molars (group B), the values for the traditional technique(TEC) were between 1000-1292 N; the values for the conservative technique(CEC) were between 1800-1814 N; and the values for the ultraconservative technique (NEC)were between 2068-2900 N. This reveals that the shape of the maxillary molar and the restoration placed resist maximum fracture with the NEC technique. Traditional technique (TEC) showed the least resistance than the conservative technique (CEC), which was better than that of traditional technique (TEC).

In the case of maxillary premolars (group C), the traditional technique (TEC) preparation resisted the force between 750-1089 N; the conservative preparation (CEC) resisted from 1011-1047 N; and the ultraconservative (NEC) showed resistance values of 1908-2019 N. Hence, it can be seen that the NEC technique resists the maximum and the traditional technique (TEC) resists the minimum, with the conservative techniques (CEC) in between. In fact ,ultraconservative technique(NEC) resists the forces slightly more than the intact tooth(1995 N), probably due to the morphology of the tooth(hexagonal shape), bifid roots, placing composite resin 2mm into both the buccal and palatal root canals and the direction of the force used in this study.

In the case of mandibular premolars(group D), which are pentagon in shape, when using the traditional technique(TEC), the resistance to fracture varies between 640-742 N; whilst using the conservative technique(CEC), the values are between 1011-1075 N and with the ultraconservative technique (NEC) the values are between 1600- 1842 N. The specimens prepared using ultraconservative technique (NEC) resists the maximum and the traditional technique (TEC) resist the minimum.

On overall comparison, irrespective of the type of the tooth, the specimens prepared with ultraconservative technique (NEC)resists maximum force and the specimens prepared with the traditional technique(TEC) shows the least resistance. The conservative technique preparation (CEC) shows higher values than the traditional technique (TEC), but less than the ultraconservative technique (NEC).

Table 3, shows the comparison between individual technique irrespective of the type of the teeth. On comparing traditional technique (TEC) versus conservative technique (CEC) preparation, the specimens prepared with the Conservative technique (CEC) resisted the forces significantly better than those prepared with traditional technique (TEC) and it was highly significant in maxillary premolar teeth. This could probably be related to the shape of the occlusal surface, which is hexagonal shape and also due to the presence of bifid roots. Hence, the forces acting on the hexagonal surface area of composite resin with more loss of tooth structure by the traditional preparation (TEC)would have weakened stress bearing areas on this teeth in comparison with conservative preparation(CEC) where more natural tooth structure was preserved.

Table 4, compares the resistance to forces between traditional (TEC) technique and ultraconservative (NEC) technique. Irrespective of the shape of the tooth all the specimens in the ultraconservative (NEC) showed more resistance to higher forces than with traditional technique (TEC). This value was statistically significant with all the types of the teeth. This suggests that preparation using ultraconservative technique (NEC) preserves more natural tooth structure, thereby showing statistically significant resistance in comparison with traditional technique (TEC), where more tooth structure is removed and replaced with composite resin material. The amount of tooth per se resisted the forces at higher values in comparison to the restorative material except in group C (maxillary premolar) with ultraconservative technique (NEC), which may be due to the hexagonal shape of the occlusal surface, bifid roots, minimal restorative material and maximum tooth structure preserved.

Table 5, shows comparison between conservative technique (CEC) and ultraconservative technique (NEC). There is statistically significant increase on the resistance to forces in the ultraconservative technique (NEC) when compared with conservative technique(CE). This may probably be attributed to the amount of intact tooth structure with the Ultraconservative technique (NEC) than with conservative technique (CEC).

Table 6, shows the comparison between three technique groups. From the table it can be seen that the preparation with all the three technique groups were not statistically significant except with maxillary premolars which was statistically significant. This may be attributed to the morphology of the crown and two rooted structure seen in upper first premolars.

The main purpose of this present study was to compare the fracture resistance of endodontically treated teeth with various access cavity designs. With the introduction of CEC (conservative access cavity design) [2014]and later ultraconservative NEC (2018) design ,it was necessary to elicit whether this newer designs of access cavity preparation had any influence on the fracture resistance of the endodontically treated teeth.

A study done by a **KRISHAN ET AL in** 2014 concluded that conservative access cavity preparation conserved coronal dentin in premolars and molars and thereby increased the resistance to fracture .The results of the present study was similar, but in their study it was concluded that conservative access cavity preparations compromised the efficiency of canal instrumentation especially in the distal canals of molars.

A study was done by **MOORE ET AL(2016)**and they concluded that invitro conservative access cavity preparation did not impact canal instrumentation in maxillary molar tooth compared with traditional access cavity preparation,.whereas in the present study conservative access cavity preparations (CEC & NEC) showed better results when compared with traditional access cavity preparation(TEC) with respect to fracture resistance, but not instrument efficiency as it was not part of the present study.

A study done by **ALOVISI et al (2017**) concluded that traditional endodontic access cavities preserve the original canal anatomy during shaping procedure compared with conservative access cavity particularly at the apical level. Similarly, in the present study, irrespective of the access cavity preparation technique, preservation of original canal anatomy particularly at the apical level was maintained, probably it may be due to the shape of the tooth and absence of canal curvature . Further studies with more number of samples, newer shaping instruments with lesser taper and in-vivo studies should be performed for the longevity of root canal therapy.

OSMAN et al (2018) concluded that preserving dentin coronally and cervically increased the fracture strength significantly in mandibular molar prepared with conservative access cavity model whereas there was no statistical significant difference in fracture strength between conservative access cavity and traditional access cavity models in maxillary molars, which was similar in the present study.

ALLEN et al (2019) concluded that traditional endodontic access cavity render a tooth more susceptible to fracture compared with MIA designs. Removal of additional tooth structure for crown fabrication yielded higher stress patterns in all cases, regardless of access size where as in the present study traditional group (TEC) showed less resistance to fracture compared with other two techniques (CEC & NEC). In these two techniques, more of pericervical dentin is preserved that resulted in removal of minimum tooth structure and both mesial and distal marginal ridges were preserved that increases the resistance to fracture.

From the results of the present study, it can be concluded that minimal invasive access cavity preparations especially ultraconservative access cavity preparation (NEC) did not decrease the fracture strength in comparison with traditional access cavity preparation (TEC).Restoration of the tooth with direct composite resin increased the fracture resistance in all the three groups and was found to be the maximum with the ultraconservative access cavity preparation technique(NEC).

Further studies involving a bigger sample size and using different composite resins should be done especially in in-vitro situations to validate the results of the present study.

Summary

SUMMARY

Proper access cavity preparation is the most critical step in achieving success in endodontic therapy. Research shows various designs and instruments have been suggested for this critical procedure. The traditional design of access cavity preparation has been in vogue all these years and recently conservative access cavity designs have been suggested.

This in-vitro study was done with the aim of comparing the traditional design of access cavity preparation with two newer designs, conservative and ultraconservative (ninja).

Commonly the teeth encountered for endodontic therapy are maxillary and mandibular first molars and first premolar teeth. Following endodontic treatment the teeth loose their strength and become brittle overtime resulting in fracture of the treated tooth. To prevent such brittle fracture, the teeth are reinforced using a restorative material and by taking support from the inner walls of the root canal.

This necessitated a study with the aim of comparing the resistance to fracture in endodontically treated teeth following various access cavity designs and restoring the tooth with visible light cure composite resin.

Endodontic treatment was completed in 60 teeth (15 each of maxillary first molar and premolar and 15 each of mandibular first molar and premolar)

with one of the three designs of access cavity preparation - traditional (TEC), Conservative (CEC) and Ultraconservative (NEC). Following this, post endodontic restoration was completed in all the specimens using direct composite resin.

All the specimens were then subjected to compressive load directed on the central fossa of each tooth with a 6mm stainless steel ball suspended from universal instron testing machine. The force at which the fracture occurred was noted and recorded (in Newton's). Four specimens, one Maxillary first Molar and premolar, One Mandibular first molar and premolar were used as control and no endodontic treatment was done in these teeth. The 4 specimens were subjected to similar loading test and the value at which fracture occurred was noted and recorded. From the values obtained for different types of teeth, for different access cavity designs and restored with composite resin the results were analysed.

Conclusion

CONCLUSION

- Maxillary and mandibular first molars and premolars were tested in this study as they are the commonest teeth to undergo endodontic therapy.
- The fracture resistance of endodontically treated mandibular molar, maxillary molar and mandibular premolar,after restoration with direct composite resin, was found to be less than the fracture resistance of intact teeth .
- The fracture resistance of endodontically treated maxillary premolar with the post endodontic restoration was found to be less than the fracture resistance of intact teeth except in ultraconservative design.
- The fracture resistance of the intact maxillary molar was found to be 3388 N and in the case of endodontically treated teeth and restored with composite resin was between 1000 N - 2900 N, irrespective of the access cavity preparation technique.
- The fracture resistance of the intact mandibular molar was found to be 2540N and in the case of endodontically treated teeth and restored with composite resin was between 930 N - 2450 N, irrespective of the access cavity preparation technique.
- The fracture resistance of the intact maxillary premolar was found to be 1995 N and in the case of endodontically treated teeth and restored

with composite resin was between 715 N - 2019N, irrespective of the access cavity preparation technique.

- The fracture resistance of the intact mandibular premolar was found to be 2285N and in the case of endodontically treated teeth and restored with composite resin was between 640 N - 1842N, irrespective of the access cavity preparation technique.
- Among the four types of teeth used in the present study the maximum resistance to fracture was seen in maxillary first molar (group B) with ultraconservative cavity preparation(NEC) and minimum resistance was seen in mandibular first premolars(group D).
- The fracture resistance of the intact mandibular molar tooth (group A)was found to be 2540N. The fracture resistance following endodontic treatment and restoring with composite resin for the different access cavity designs when compared, shows a variation from a minimum of 930 N with the traditional access cavity design (TEC) to a maximum of 2450 N with the ultraconservative design (NEC).
- The fracture resistance of the intact maxillary molar tooth (group B)was found to be 3388 N. The fracture resistance following endodontic treatment and restoring with composite resin for the different access cavity designs when compared, shows a variation from a minimum of 1000 N with the traditional access cavity design (TEC) to a maximum of 2900 N with the ultraconservative design(NEC)

- The fracture resistance of the intact maxillary premolar tooth (group C) was found to be 1995 N. The fracture resistance following endodontic treatment and restoring with composite resin for the different access cavity designs when compared, shows variation from a minimum of 715 N with the traditional access cavity design (TEC)to a maximum of 2019 N with the ultraconservative design(NEC).
- The fracture resistance of the intact mandibular premolar tooth (group D) was found to be 2285N. The fracture resistance following endodontic treatment and restoring with composite resin for the different access cavity designs when compared, shows a variation from a minimum of 640 N with the traditional access cavity design (TEC) to a maximum of 1842 N with the ultraconservative design (NEC).
- Among the three techniques of access cavity preparation, the least resistance value was seen in the traditional technique (TEC) in mandibular first premolar (group D) and the maximum resistance value was seen in the ultraconservative access cavity design (NEC) in maxillary first molar (group B).
- Overall, when comparing the techniques alone, the ultraconservative access cavity preparation (NEC) showed the maximum resistance to fracture in comparison with the other two techniques, irrespective of the type of the tooth.

Bibilography

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Annexures

ANNEXURE –I

RAGAS DENTAL COLLEGE & HOSPITAL

(Unit of Ragas Educational Society)
Reconized by the Dental Council of India, New Delhi
Affiliated to The Tamilnadu Dr. M.G.R. Medical University, Chennai
2/102, East Coast Road, Uthandi, Chennai - 600 119. INDIA
Tele : (044) 24530002, 24530003 - 06. Principal (Dir) 24530001 Fax : (044) 24530009

TO WHOM SO EVER IT MAY CONCERN

Date: 24th January , 2020

Place: Chennai

From
The Institutional Review Board,
Ragas Dental College And Hospital,
Uthandi,
Chennai- 119

The project titled **"Fracture Strength Of An Endodontically Treated Teeth With Different Access Cavity Designs"** submitted by **Dr Gayathri .V** has been approved by the Institutional Review Board of Ragas Dental College And Hospital.

DR. N.S.AZHAGARASAN, MDS
Member secretary,
The Institutional Review Board
Ragas Dental College And Hospital
Uthandi,
Chennai-119

ANNEXURE –II

URKUND

Urkund Analysis Result

Analysed Document:	plag 1.docx (D63028167)
Submitted:	1/27/2020 7:22:00 AM
Submitted By:	gayathrivj25@gmail.com
Significance:	8 %