ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)
IJDSIR : Dental Publication Service
Available Online at: www.ijdsir.com
Volume – 4, Issue – 1, February - 2021, Page No. : 491 - 504

To evaluate the effect of conservation of tooth structure by using dental operating microscope in doing different access cavity designs to increase fracture resistance of mandibular first molar – an in vitro study.

[1]Dr Vijayalakshmi Yartha, Post Graduate, Department of conservative dentistry and endodontics, Sri Rajiv Gandhi College of Dental Sciences, RT Nagar, Bangalore-560032.

[2]Dr Shiraz Pasha, Professor, Department of conservative dentistry and endodontics, Sri Rajiv Gandhi College of Dental Sciences, RT Nagar, Bangalore-560032.

Corresponding Author: Dr. Vijayalakshmi Yartha, MDS Third Year Pg Student, Department of Conservative and Endodontics, Sri Rajiv Gandhi College of Dental Sciences, RT Nagar, Bangalore-560032.

Citation of this Article: Dr. Vijayalakshmi Yartha, Dr Shiraz Pasha, "To evaluate the effect of conservation of tooth structure by using dental operating microscope in doing different access cavity designs to increase fracture resistance of mandibular first molar – an in vitro study", IJDSIR- February - 2021, Vol. – 4, Issue - 1, P. No. 491 – 504.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Access cavity provides a straight line access to the apical foramen that helps to do further steps in root canal treatment. The traditional endodontics access cavity design is being followed since many years which removes valuable dentin, leaving tooth structure biomechanically compromised. Conservation of the dentin is important aspect for long-term retention of tooth. Magnification has revolutionized modern endodontics, the use of dental operating microscope helps in preservation of valuable dentin. In this in vitro study along with class 2 cavity preparation the effect of preservation of dentin by doing conservative access, ninja access and truss access is being evaluated and compared with traditional access cavity to determine the fracture resistance of mandibular first molar.

Method: Hundred extracted human mandibular first molars were assigned to five groups: Group 1 – Control group, (left intact), Group 2 – Traditional access cavity, Group 3 – Conservative access cavity, Group 4 – Ninja access cavity, Group 5 – Truss access cavity. Conservative, ninja and truss access cavity were made with the help of dental operating microscope. Cleaning and shaping was done and obturated. The continuous compressive force was applied using universal testing machine and the load at which the tooth fracture was recorded.

Results: This study demonstrates that control group shows significantly highest mean fracture resistance value compared to other study groups. This was followed by Truss access group which showed significantly higher mean fracture resistance values as compared to Ninja, Conservative and Traditional access groups.

Conclusion: There is a significant increase in fracture resistance of endodontically treated tooth prepared with truss access cavity, ninja access cavity and conservative access cavity designs over traditional access cavity designs where truss access cavity showed highest fracture resistance among all.

Key words: Dental operating microscope; Traditional access cavity; Conservative access cavity; Ninja access cavity; Truss access cavity; Universal Testing Machine.

Introduction

Access cavity preparation is one of the most important step for successful endodontic treatment [1]. The design of an access cavity has a significant impact on subsequent procedures and may impact on the outcomes of root canal treatment. Traditionally, clinicians choose to ensure successful detection and management of all root canals through the preparation of convenience-oriented access cavity designs that would ensure achieving straight-line pathways into all root canals [2]. One of the most important causes of fractures in root-filled teeth is the loss of tooth structure. The preparation of the endodontic access cavity following the TEC principles was reported as the second largest cause of loss of tooth structure, that associated with drilling of endodontic cavities [3].

To overcome this, Clark and Khademi modified the endodontic access cavity design to minimize the tooth structure removal. Recently, new designs for endodontic access cavities called conservative or contracted endodontic cavities, ninja access cavity, truss access cavity have been advocated in order to minimize tooth structure removal [4]. Progress in the field of imaging, materials, instruments, and computers has considerably transformed the clinical practice of dentistry. Some of the developments in endodontic practice that make dentin conservation possible include ultra-flexible instruments, visual magnification, superior illumination, enhanced root canal irrigation systems, and three-dimensional imaging technology [cone beam computed tomography (CBCT)]. The use of magnification by dental clinicians when carrying out examinations and treatments is becoming more common place. The best instrument for this purpose is the operating microscope which has been shown to enhance quality, longevity and outcome of clinical work as well as facilitating better ergonomics for dentist.

Many studies evaluating the ability of a tooth to withstand occlusal and functional forces have shown that a tooth with a significant loss of enamel and dentin is distinctly weaker than an intact tooth [4]. Minimally invasive endodontic cavities have been described and proposed to preserve dentin (and enamel) through strategic access: the conservative endodontic cavities (CEC), ultraconservative endodontic cavity (UEC) or better known as "ninja access cavity" or PEAC (point endodontic access cavity) and truss endodontic access cavities (TREC).

As frequency of class II type carious lesions in first permanent molar involving pulp is high in young adults [5], these variously sized access cavity designs are aiming at improving tooth preservation, but they are different in the amount of tissue removal. To date, there are no studies comparing CEC access cavity preparation with ultraconservative ''ninja'' endodontic cavity (NEC) access and truss access cavity preparation along with class 2 composite filled cavity on mandibular first molar. Therefore, the purpose of this study was to investigate the fracture resistance of endodontically treated teeth with a Traditional Endodontic Cavity (TEC), Conservative Endodontic Cavity (CEC), Ninja Endodontic Cavity (NEC) and Truss Endodontic Cavity (TREC) on class 2 composite restored mandibular first molars. The null hypothesis tested was that mandibular first molars with standardised class II (mesial-occlusal) cavities restored with direct composite restorations after accessing their root canal with contracted endodontic cavity designs, may not be more resistant to fracture than molars that have had their root canal accessed traditionally.

Materials And Methods

The study protocol was approved by the ethical committee of Sri Rajiv Gandhi College of Dental Sciences and Hospital Bangalore. Human mandibular first molars which were extracted for periodontal or orthodontic purposes, having single straight canals withwith complete root formation were included. Fractured teeth, carious teeth, teeth with internal or external resorption and teeth with hypoplasia were excluded.

Specimen preparation

7.2 Method of collection of data (including sampling procedure, if any) materials to be used in the study

Recording of data

- Extracted mandibular first molars were collected and cleaned of superficial debris, calculus, tissue tags and were preserved in 10% formalin solution.
- Pre-operative radiographs were taken for all the extracted teeth using paralleling angle technique to check for internal anatomy of canals, resorption, caries, fracture and to ensure that all teeth have almost same dimensions in order to minimize the influence of shape and size variation in the results.
- Only those teeth which meet the inclusion and exclusion criteria were taken into consideration.

Specimens were subsequently assigned to five groups to perform different access cavity preparations.

- Group 1 – Control group, which include teeth that will be left intact.
- Group 2 – Traditional access cavity group.
- Group 3 – Conservative access cavity group.
- Group 4 – Ninja access cavity group.
- Group 5 – Truss access cavity group.
- Class 2 proximal box preparation of dimensions 3mm length,3mm width and 3mm height was made with 245 bur and inverted cone bur for all the groups except for the control group and restored with direct composite resin. (Figure 1)
- The amounts of coronal dentin removal and the access cavity outline was quantified from axial planes of CBCT images. (Figure 2)
- Group 2 – **Traditional Access Cavity** preparation was done using Endo Access Bur. Standard measurements were taken in the form of an isosceles quadrangle with mesial side outline, mesio-distal side outline of buccal aspect and mesio-distal side outline of lingual aspect dimension of 4mm and distal side outline dimension of 3mm. (Figure 3) Access cavity preparation was started leaving 3mm space from the mesial marginal ridge. After the initial drop into the pulp chamber, Endo-Z bur was used to widen the access preparation till the bur reaches the walls of the pulp chamber, so that a straight-line access was made. (Figure 4)
- Group 3 – **Conservative Access Cavity** preparation was done using dental operating microscope with dia burs no. 2. Standard measurements were taken in the form of an isosceles quadrangle with mesial side outline, mesio-distal side outline of buccal aspect and mesio-distal side outline of lingual aspect dimension of 3mm and distal side outline dimension of 2mm. (Figure 3) Access cavity preparation was started leaving 3mm space from the mesial marginal ridge preserving dentin by entering at 45° penetration angle at the mesial quarter of central fossa, and extending the cavity

apically and distally while maintaining part of roof chamber. (Figure 4)

- Group 4 –In **Ninja Access Cavity** tooth was accessed in the same manner as seen in conservative access cavity group, but chamber roof was maintained as much as possible. Standard measurements were taken in the form of an equilateral triangle outline with dimension of 1.5mm on all sides. (Figure 3) Access cavity preparation was started leaving 3mm space from the mesial marginal ridge. The access ninja outline was derived from the oblique projection towards the central fossa on the occlusal plane. By doing this, localization of all the root canal orifices was possible even from different visual angulations. (Figure 4)
- Group 5 –**Truss Access Cavity** preparation was done using dental operating microscope with dia burs no. 2. Access cavity preparation was started leaving 3mm space from the mesial marginal ridge. The access to pulp chamber was gained from occlusal surface to roof of the pulp chamber by orienting the bur parallel to the long axis of the tooth and oval shaped access opening was done with standard dimension of 3mm length buccolingually. (Figure 3) Then, the bur was placed over the distal pulpal horn where the measurement of the point to start the access opening on distal side was taken from the CBCT and the access to the pulp chamber was gained with oval shaped access opening done with standard dimension of 2mm length buccolingually. The tooth structure between mesial and distal openings was kept intact thereby preventing the removal of entire chamber roof. (Figure 4)
- In all types of access cavity canals, the root canal was explored using DG 16 Explorer and working length was determined with K-file size #10 by Ingle's method. Cleaning and shaping was done with Mtwo rotary file system till size 25/.06 in conjugation with irrigation using 3% NaOCl and normal saline. Final irrigation was performed using 5mL 3% NaOCl and 5 mL 17% EDTA.
- All the types of access cavity preparations were then dried using paper points and were obturated using gutta-percha with AH Plus sealer using lateral condensation technique and lastly radiographs were taken and sealed coronally using nanohybrid composite.
- All 100 teeth were mounted on brass rings with roots embedded in self curing resin up to 2mm apical to cementoenamel junction and were placed in custom made bath and mounted in a mechanical material testing machine.
- The teeth were loaded at the central fossa at a 30 degrees angle from the long axis of the tooth. (Figure 5)
- The continuous compressive force at a cross head seed of 1mm/min was applied using a 6mm diameter ball – ended steel compressive head and the load at which the tooth fracture was recorded by the software of load testing machines in newtons.

Figure 1: Class II cavity

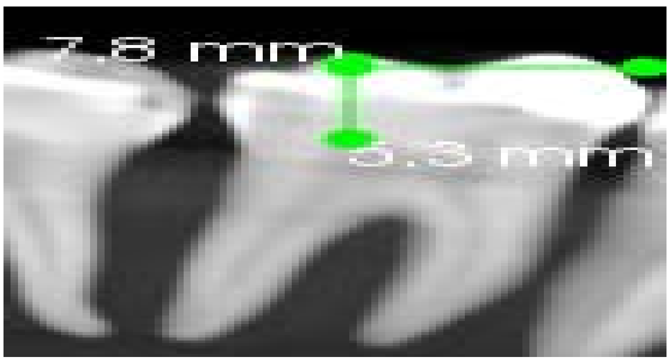


Figure 2: CBCT evaluation for access preparation

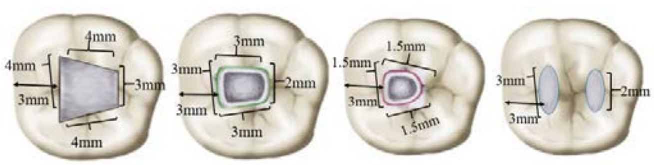


Figure 3: standard dimensions taken for access cavities preparation

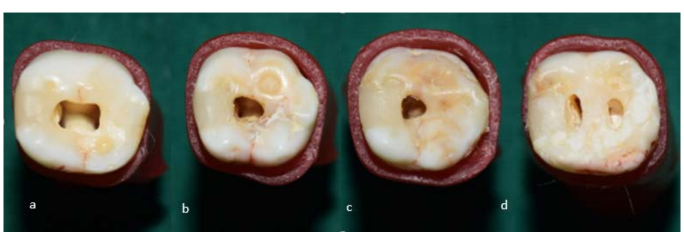


Figure 4: access cavities a) Traditional access cavity b) Conservative access cavity c) Ninja access cavity d) Truss access cavity

Figure 5: Tooth under load in universal testing machine

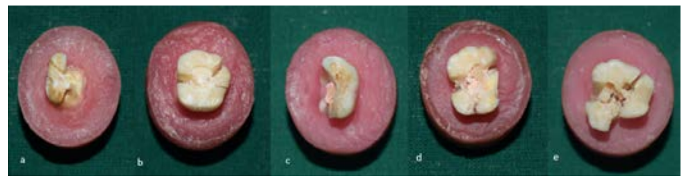


Figure 6: postoperative picture of all access cavity groups after testing for fracture (favourable fractures in control group, truss and ninja access group whereas unfavourable fractures in conservative and traditional access groups). a) Control tooth b) Traditional access cavity c) Conservative access cavity d) Ninja access cavity e) Truss access cavity

Plan for Data Analysis

Statistical analysis was performed using the software statistical package for social sciences (IBM SPSS version 21). Descriptive statistics, included percentages, frequencies, Comparison of mean Fracture Resistance (in N) between 5 study groups using Kruskal Wallis Test and Multiple comparison of mean difference in Fracture Resistance (in N) b/w 5 groups using Mann Whitney Post hoc Test was done.

Results

The objective of this study was to determine the fracture resistance of conservative access cavity, ninja access cavity, truss access cavity with class II cavity filled with composite under dental operating microscope and compared with traditional access cavity with class II composite restoration and control group.

The groups were

Group 1 – Control group, which include teeth that will be left intact.

Group 2 – Traditional access cavity group.

Group 3 – Conservative access cavity group.

Group 4 – Ninja access cavity group.

Group 5 – Truss access cavity group.

All the teeth were loaded at the central fossa at a 30 degrees angle from the long axis of the tooth. The continuous compressive force at a cross head seed of 1mm/min was applied using a 6mm diameter ball – ended steel compressive head and the load at which the tooth fracture was recorded by the software of load testing machines in newtons.

Group 1: Control teeth group

S.no	Group 1	Force in newtons
1	Control	3066.3
2	Control	4299.2
3	Control	3837.3
4	Control	3849.1
5	Control	2721.3
6	Control	3931.5
7	Control	4502.2
8	Control	3362.7
9	Control	3527.4
10	Control	2983.2
11	Control	3230.3
12	Control	3076.3
13	Control	3413.7
14	Control	2513.4
15	Control	3326.4
16	Control	3225.4
17	Control	4105.0
18	Control	2990.0
19	Control	5800.6
20	Control	3506.8

Group 2: Traditional access cavity group

S.no	Group 2	Force in newtons
21	Traditional Access	1211.1
22	Traditional Access	1183.7
23	Traditional Access	1109.1
24	Traditional Access	1438.6
25	Traditional Access	1052.2
26	Traditional Access	1591.6
27	Traditional Access	1185.6
28	Traditional Access	1085.6
29	Traditional Access	1013.0
30	Traditional Access	2449.7
31	Traditional Access	1780.0
32	Traditional Access	1216.0
33	Traditional Access	2035.9
34	Traditional Access	1070.0
35	Traditional Access	1367.1
36	Traditional Access	1216.0
37	Traditional Access	977.7
38	Traditional Access	2040.8
39	Traditional Access	1006.2
40	Traditional Access	1087.6

Group 3: Conservative access cavity group

S.no	Group 3	Force in newtons
41	Conservative Access	1262.1
42	Conservative Access	2895.9
43	Conservative Access	1433.8
44	Conservative Access	1506.3
45	Conservative Access	1231.7
46	Conservative Access	1024.8
47	Conservative Access	1324.9
48	Conservative Access	1607.3
49	Conservative Access	1080.7
50	Conservative Access	1180.7
51	Conservative Access	1183.7
52	Conservative Access	2033.9
53	Conservative Access	1401.4
54	Conservative Access	1496.5
55	Conservative Access	2662.5
56	Conservative Access	1179.7
57	Conservative Access	1031.7
58	Conservative Access	1298.4
59	Conservative Access	1326.8
60	Conservative Access	1005.2

Group 4: Ninja access cavity group

S.no	Group 4	Force in newtons
61	Ninja Access	1331.7
62	Ninja Access	1086.6
63	Ninja Access	1440.6
64	Ninja Access	1605.3
65	Ninja Access	2232.9
66	Ninja Access	1042.4
67	Ninja Access	1120.9
68	Ninja Access	1189.5
69	Ninja Access	1265.1
70	Ninja Access	2151.6
71	Ninja Access	1234.7
72	Ninja Access	1050.2
73	Ninja Access	2203.6
74	Ninja Access	1023.8
75	Ninja Access	2217.3
76	Ninja Access	1368.0
77	Ninja Access	1168.9
78	Ninja Access	1211.1
79	Ninja Access	1337.6
80	Ninja Access	2183.0

Group 5: Truss access cavity group

S.no	Group 5	Force in newtons
81	Truss Access	1839.6
82	Truss Access	1750.5
83	Truss Access	1661.2
84	Truss Access	2259.5
85	Truss Access	2555.6
86	Truss Access	2470.3
87	Truss Access	1769.1
88	Truss Access	1796.6
89	Truss Access	1554.4
90	Truss Access	1931.2
91	Truss Access	1928.3
92	Truss Access	1824.9
93	Truss Access	1734.6
94	Truss Access	1852.9
95	Truss Access	2448.7
96	Truss Access	2014.3
97	Truss Access	1713.2
98	Truss Access	1820.1
99	Truss Access	1779.9
100	Truss Access	1879.9

Table 1: Comparison of mean Fracture Resistance (in N) between 5 study groups using Kruskal Wallis Test

Groups	N	Mean	SD	Min	Max	P-Value
Control	20	3563.41	737.11	2513.4	5800.6	<0.001*
Traditional Access	20	1355.88	413.70	977.7	2449.7	
Conservative Access	20	1458.40	511.77	1005.2	2895.9	
Ninja Access	20	1473.24	451.80	1023.8	2232.9	
Truss Access	20	1929.24	281.42	1554.4	2555.6	

*** - Statistically Significant**

Table 1 compares the mean Fracture Resistance values between different study groups.

The test results demonstrate that Control group shows a mean fracture resistance value of 3563.41 ± 737.11, Traditional access group with 1355.88 ± 413.70, Conservative access group with 1458.40 ± 511.77, Ninja access group with 1473.24 ± 451.80 and Truss access group with 1929.24 ± 281.42. This difference in the mean Fracture Resistance values between different study groups was statistically significant at P<0.001. **[Refer Table no.1 & Graph no. 1]**

Graph no. 1 Mean Fracture Resistance values (in N) between different study groups

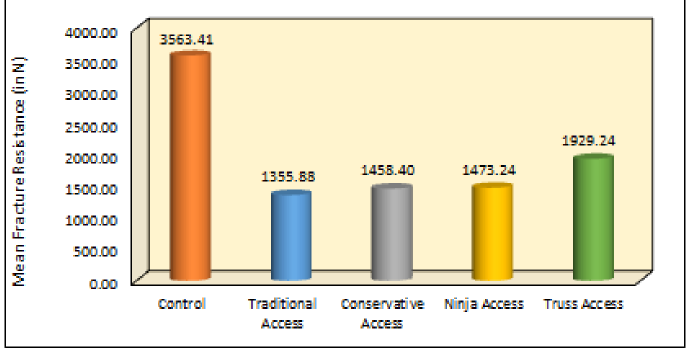


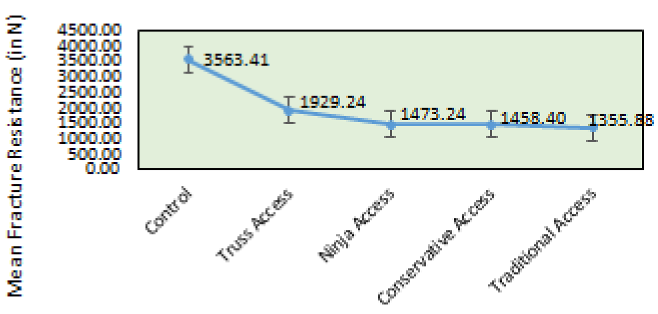
Table 2: Multiple comparison of mean difference in Fracture Resistance (in N) b/w 5 groups using Mann Whitney Post hoc Test

(I) Group	(J) Group	Mean Diff. (I-J)	95% CI for the Mean Lower	Upper	P-Value
Control	Traditional	2207.53	1766.13	2648.93	<0.001*
	Conservative	2105.01	1663.61	2546.40	<0.001*
	Ninja	2090.17	1648.77	2531.56	<0.001*
	Truss	1634.17	1192.77	2075.56	<0.001*
Traditional	Conservative	-102.53	-543.92	338.87	0.38
	Ninja	-117.37	-558.76	324.03	0.24
	Truss	-573.37	-1014.76	-131.97	<0.001*
Conservative	Ninja	-14.84	-456.24	426.56	0.87
	Truss	-470.84	-912.24	-29.44	<0.001*
Ninja	Truss	-456.00	-897.40	-14.60	0.001*

*** - Statistically Significant**

Table 2 illustrates multiple comparison of mean difference in Fracture Resistance values b/w groups. The Post hoc test demonstrates that control group shows significantly highest mean fracture resistance value compared to other study groups at P<0.001. This was followed by Truss access group which showed significantly higher mean fracture resistance values as compared to Conservative and Traditional access groups at P<0.001 and with Ninja success group at P=0.001. This in turn followed by ninja access group showing relatively higher fracture resistance values as compared to conservative access [0.87] and traditional access group [0.24] and finally the conservative access group showed relatively higher fracture resistance as compared to traditional access group [0.38]. However, the differences between these groups was not statistically significant. **[Refer Table no. 2 & Graph no. 2]**

Graph no. 2 Mean Fracture Resistance values (in N) between different study groups [Arranged in Ascending Order]



Discussion

The presence of dentin including anatomic structures such as cusps, ridges and arched roof of the pulp chamber may prevent tooth fracture after the final restoration in endodontically treated teeth [6]. Maximum preservation of as much of the pulp chamber roof as possible during access preparation would maintain the fracture resistance of teeth following root canal treatment. The endodontic access cavity preparation might also result in increased cuspal deflection during function and increase the possibility of cusp fracture [7,8]. This in-vitro study evaluated the fracture resistance of different modern access cavity designs with class II cavities restored with composites and compared them with the traditional access cavity design and control group.

Mandibular first molars were used in this study because they hold the first spot on the list of teeth requiring endodontic intervention, and having the least survival rates, thus prioritizing them when researching different access cavity designs that may prolong life expectancy of the teeth [9,10]. The external and internal anatomy of the molars were standardized to limit the variation of the occlusal table and dentin thickness with the help of radiographs [11].

The most frequently involved cavity class in teeth requiring root canal treatment is class II (about 65%), with mandibular posterior teeth showing a higher prevalence than maxillary posterior teeth [12], which lead to choose mandibular first molars in this study to evaluate possible benefits of performing a contracted access design on these teeth. Steele and Johnson found significantly lower compressive strength when MOD (mesio occlusodistal) preparations were performed in addition to access to the pulp chamber [13]. These findings are corroborated by Hansen et al who reported greater survival rates for teeth restored with MO/DO restorations as opposed to MOD preparations in root canal-treated teeth [14]. Taking this into consideration in our study, standardized class II (mesio-occlusal) cavities were prepared in all groups except control group and filled with direct composite restoration.. All 100 teeth were mounted on brass rings with roots embedded in self curing resin up to 2mm apical to cementoenamel junction to simulate the clinical condition that corresponds clinically to the level of the alveolar ridges.

Vertical fractures are most frequently observed in mandibular molar teeth among endodontically treated posterior teeth [15,16]. Among mandibular molar teeth, occlusal enamel and dentin located at the center of a tooth are subject to high chewing pressure [17]. By preserving the pulpal chamber roof using contracted cavity preparation, the aim is to distribute the occlusal forces before they reach the pulpal chamber floor [18]. Jiang et al. reported that protecting the tooth tissue in endodontic treatment can enhance the tooth fracture strength. [19]

Cone-beam computed tomographic (CBCT) imaging was done to identify all the canals and to measure the location of the orifice from the occlusal plane and from marginal ridges. In this study, standardised measurements were assigned for all access cavity designs to minimise the discrepancies in the results. An adequate endodontic access cavity is a key step to achieve proper cleaning, shaping and filling of all root canals within a tooth. Recently inspired by the minimally invasive dentistry concept, several designs of endodontic access cavities have been proposed by using dental operating microscope to minimize tooth structure loss and thus theoretically increase mechanical stability and fracture resistance of root filled teeth (Clark & Khademi 2010a, b). The dental operating microscope (DOM) is an integral tool in today's endodontic practice. It helps to optimize visualization of the tooth and its substructures. In our study we have used dental operating microscope for better visibility during root canal treatment procedure by single operator at 10.9 magnification.

First, diverging from general basic principles of traditional straight-line endodontic access cavities, conservative endodontic access cavities (CEC) have been suggested to maximize the preservation of the pulp chamber roof (Clark & Khademi 2010a,b). Then, overestimating the CEC concept, there came the so-called ultraconservative endodontic access cavities (UEC), also popularly known as "ninja" access (Plotino et al. 2017), and truss-access or orifice-directed design cavities (Neelakantan et al. 2018). There are no studies comparing the fracture resistance of all these groups, therefore this study aimed in determining the fracture resistance of conservative access cavity, ninja access cavity, truss access cavity with class II cavity filled with composite and compared with traditional access cavity with class II composite restoration and control group.

In this study, fracture resistance was assessed with a mechanical testing machine as in other studies [6,20-22]. Before the fracture resistance test round bur of 0.5mm diameter was used to perform access cavity preparations in all the groups except in traditional access group and control group as the smallest diameter round bur helps in preparing a very contracted cavities, then biomechanical preparation is done with Mtwo Niti files and the root canals were filled, and restorations of endodontic accesses with composite resin were performed, reproducing the usual clinical procedures. Single operator performed all specimen preparation procedures in order to avoid different results caused by different operator skills. In this study the same loading force was applied for all teeth to standardize the procedure [6]. A 30^0 inclination angle was used because teeth are most vulnerable to fracture when eccentric forces are applied [23], reaching the failure point at lower loads when compared with the axial fracture loads of other studies done by de Freitas et. al and Ortega VL et. Al [24,25]. The continuous compressive force at a cross head speed of 1mm/min was applied in this study using a 6mm diameter ball – ended steel compressive head and the load at which the tooth fracture was recorded by the software of load testing machines in newtons. An Instron (Norwood, MA) Universal Testing machine was used to measure tooth fracture resistance because the use of this machine is the simplest and most frequently used method to evaluate tooth strength. However, this in vitro test provides a static load until failure occurs, whereas in the oral cavity loads are dynamic and, thus, it may not simulate in vivo conditions. The diameter of the sphere head was selected to be 6 mm to allow adequate contact with the cuspal inclines during testing. Additionally, these conditions are similar to those of other studies on molars that tested fracture resistance. [26]

The results of this study shows that control group shows significantly highest mean fracture resistance value compared to other study groups.This was followed by

Truss access group which showed significantly higher mean fracture resistance values as compared to Conservative and Traditional access groups and with Ninja access group. This result may be explained by the fact that in the truss access cavity group the dentin bridge remained and connected the buccal and lingual surfaces of the tooth, thus improving the fracture resistance compared with that of all other access cavity groups. This in turn followed by ninja access group showing relatively higher fracture resistance values as compared to conservative access and traditional access group and finally the conservative access group showed relatively higher fracture resistance as compared to traditional access group. Thus null hypothesis is rejected. The results of the present study are in agreement and corroborate reports that showed improved fracture strength of teeth because of dentin preservation obtained by cavity size reduction [7,27,28].

In Truss access cavity slot and oval cavities were performed over the mesial and distal canals of the model, respectively, guided by the CBCT images and the pulp chamber roof was maintained beneath the ‘‘truss’’ of the tooth structure. The maintenance of the “truss” provides added strength. Truss access is the design of choice in a mandibular molar when the canal convergence is minimal, and the platform is wide. The preserved dentin structure helps to resist tensile and compressive forces by bracing the lingual and buccal dentin walls. [29]

In agreement with previous reports by moore et. al and Ozy € €urek T et. al, the fracture strength of intact teeth (control group) was significantly higher than the ones in all the tested groups independent of the endodontic access cavity used [30,31].

Ninja endodontic access cavities minimize the tooth structure removal while maintaining the mechanical stability of the tooth for long-term survival and function of the endodontically treated teeth. Here, teeth are accessed at central fossa and extended only as necessary to detect canal orifices, thus preserves the roof of pulp chamber.thus in our study ninja access group showed relatively higher fracture resistance values as compared to conservative access and traditional access group. The novel conservative endodontic cavity (CEC) involves preservation of the pulp chamber roof. It represents a paradigm shift away from coronally divergent walls, complete unroofing with exposure of all pulp horns and straight-line access into the canals. [6] Clinically, the specific outline of access cavities for each tooth can be plotted on cone-beam computed tomography (CBCT) images. In this manner all canals are identified in advance and the trajectory to access each canal is projected to outline the smallest cavity possible. [6] Some articles reported that endodontic cavity size reduction with a CEC improved the fracture strength of teeth in comparison with the ones accessed by a TEC, allowing residual dentin preservation [6,32] which is in agreement with this study where Conservative, Ninja and truss access cavities showed more fracture strength when compared to traditional access cavity. However, in a recent study, the CEC cavity did not increase the fracture strength of restored maxillary molars in comparison with ones prepared with TEC, suggesting no apparent benefit of CEC in this regard [31]. This contrasting finding is probably because of the differences in the methodology of that study including the type of teeth considered; the techniques and materials used for endodontic and restoring procedures. In this study we have standardised the dimensions of access cavity with the help of CBCT and sketch outline to prevent discrepancies.

All specimens assessed for failure modes by visual inspection. “Favourable failures” were defined as repairable failures, including retention failures, and fractures of the root above the level of simulated bone. “Unfavourable failures” were defined as irreparable failures or root fractures below the level of simulated bone. Truss access cavity, ninja access cavity showed more favourable fractures when compared to conservative and traditional access cavity designs. (Figure 5) The reason behind this is because of preservation of tooth structure which lead to increased fracture resistance. Besides the correlation with fracture strength, a reduced access cavity could influence the efficiency of all root canal therapy [31,33]. In particular, it could influence the possibility to detect root canals. In this study we have done CBCT for the teeth to prevent the problem of missing the canals. In addition there will be problems in obturating the pulp chamber without voids, mainly in the groups of truss access cavity design and ninja access cavity designs. According to the findings of a recent study by gambarini et. al, there was no statistically significant difference in the fracture strengths of class II mesio-occlusal endodontic cavities prepared with TEC and CEC methods when restored with the same material. Moreover, the results of our study showed that loss of tooth walls, in particular marginal mesial ridges, causes a significant reduction in tooth fracture resistance. Another factor could be the typically small diameter of distobuccal roots because root preparation with a thicker file leads to a further weakening of it [34]. In our study we used MTwo niti rotary files for the instrumentation and prepared till 25 size Niti file with 6 percent taper because of their ability for minimal preparation at the orifice and helps in preserving the dentin.

In addition, the ideal access cavity would allow complete removal of pulp tissue, debris, and necrotic materials. However, the smaller the access cavity, the higher the risk of bacterial contaminations and the possibility of missing some root canal orifices [35].That is why in our study we have used endoactivator after instrumentation with niti rotary files to improve the disinfection.

Although minimally invasive dentistry and the preservation of tooth structure are well-founded concepts, the risk of extended treatment time without demonstrated beneficial clinical outcomes may have hindered the adoption of CEC designs in endodontics despite the availability of supportive technologies that include CBCT pretreatment planning, microscope-enhanced visualization, heat-treated nickel-titanium instruments with enhanced flexibility and cyclic fatigue, and energized disinfection protocols. It appears that clear benefits have yet to be supported by research. Thus far, surrogate in vitro data on the fracture strength of posterior teeth have varied, from intangible impacts of CECs to improved fracture strength compared with similar teeth with TECs.

Conclusion

Within the limitations of the study it can be inferred that:

1. Truss access group showed significantly higher mean fracture resistance values as compared to Ninja access group, Conservative access group and Traditional access groups.
2. Truss access cavity,ninja access cavity showed more favourable fractures when compared to conservative and traditional access cavity designs. The reason behind this is because of preservation of tooth structure which lead to increased fracture resistance.
3. Use of microscopes in performing root canal treatment helps in preservation of tooth structure which in turn will improve the fracture resistance of the tooth.

References

1. Lang H, Korkmaz Y, Schneider K, Raab WH. Impact of endodontic treatments on the rigidity of the root. J Dent Res 2006;85:364-8

2. Schroeder KP, Walton RE, Rivera EM. Straight line access and coronal flaring: effect on canal length. J Endod 2002;28:474–6.
3. Rezaei Dastjerdi M, Amirian Chaijan K, Tavanafar S. Fracture resistance of upper central incisors restored with different posts and cores. Restor Dent Endod 2015; 40:229–35.
4. Clark D, Khademi J. Modern molar endodontic access and directed dentin conservation. Dent Clin North Am 2010;54:249–73.
5. Khan, Hasham. Frequency of class II type carious lesions in first permanent molars and their association with pulp.. Pak Oral Dent J. Vol 29, No. 1, (June 2009)
6. Krishan R, Paque F, Ossareh A, Kishen A, Dao T, Friedman S. Impacts of conservative endodontic cavity on root canal instrumentation efficacy and resistance to fracture assessed in incisors, premolars, and molars. J Endod 2014; 40: 1160–6.
7. Panitvisai P, Messer HH. Cuspal deflection in molars in relation to endodontic and restorative procedures. J Endod 1995; 21: 57–61.
8. Salaverry A, Borges GA, Mota EG, Burnett Junior LH, Spohr AM. Effect of resin cements and aging on cuspal deflection and fracture resistance of teeth restored with composite resin inlays. J Adhes Dent 2013; 15: 561–8.
9. Hull TE, Robertson PB, Steiner JC, del Aguila MA. Patterns of endodontic care for a Washington state population. J Endod 2003;29:553–6.
10. Fransson H, Dawson VS, Frisk F, et al. Survival of root-filled teeth in the Swedish adult population. J Endod 2016;42:216–20.
11. Rocha L, Sousa Neto M, Fidel S, et al. External and internal anatomy of mandibular molars. Braz Dent J 1996;7:33–40.
12. Faria AC, Rodrigues RC, de Almeida Antunes RP, de Mattos Mda G, Ribeiro RF. Endodontically treated teeth: characteristics and considerations to restore them. J Prosthodont Res 2011;55:69–74.
13. Steele A, Johnson BR. In vitro fracture strength of endodontically treated premolars. J Endod 1999;25:6–8.
14. Hansen EK, Asmussen E, Christiansen NC. In vivo fractures of endodontically treated posterior teeth with amalgam.Endod Dent Traumatol 1990;6:49–55.
15. Toure B, Faye B, Kane AW, et al. Analysis of reasons for extraction of endodontically treated teeth: a prospective study. J Endod 2011;37:1512–5.
16. Zadik Y, Sandler V, Bechor R, Salehrabi R. Analysis of factors related to extraction of endodontically treated teeth. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008;106:e31–5.
17. Rocca GT, Saratti CM, Cattani-Lorente M, et al. The effect of a fiber reinforced cavity configuration on load bearing capacity and failure mode of endodontically treated molars restored with CAD/CAM resin composite overlay restorations. J Dent 2015; 43:1106–15.
18. Jang W, Bo H, Yongchun G, LongXing N. Stress distribution in molars restored with inlays or onlays with or without endodontic treatment: a three-dimensional finite element analysis. J Prosthet Dent 2010;103:6–12.
19. Jiang Q, Huang Y, Tu X et al. (2018) Biomechanical properties of first maxillary molars with different endodontic cavities: a finite element analysis. Journal of Endodontics 44(8): 1283–1288.
20. Luthria A, Srirekha A, Hegde J, et al. The reinforcement effect of polyethylene fibre and composite impregnated glass fibre on fracture

resistance of endodontically treated teeth: an in vitro study. JConserv Dent 2012;15:372–6.

21. Pradeep P, Kumar VS, Bantwal SR, Gulati GS. Fracture strength of endodontically treated premolars: an in-vitro evaluation. J Int Oral Health 2013;5:9–17.
22. Cobankara FK, Unlu N, Cetin AR, Ozkan HB. The effect of different restoration techniques on the fracture resistance of endodontically-treated molars. Oper Dent 2008;33:526–33.
23. ElAyouti A, Serry MI, Geis-Gerstorfer J, et al. Influence of cusp coverage on the fracture resistance of premolars with endodontic access cavities. Int Endod J 2011;44:543–9.
24. de Freitas CR, Miranda MI, de Andrade MF, et al. Resistance to maxillary premolar fractures after restoration of class II preparations with resin composite or ceromer. Quintessence Int 2002;33:589–94.
25. Ortega VL, Pegoraro LF, Conti PC, et al. Evaluation of fracture resistance of endodontically treated maxillary premolars, restored with ceromer or heat-pressed ceramic inlays and fixed with dual-resin cements. J Oral Rehabil 2004;31:393–7.
26. Monga P, Sharma V, Kumar S. Comparison of fracture resistance of endodontically treated teeth using different coronal restorative materials: an in vitro study. J Conserv Dent 2009;12:154–9.
27. Assif D, Nissan J, Gafni Y, et al. Assessment of the resistance to fracture of endodontically treated molars restored with amalgam. J Prosthet Dent 2003;89:462–5.
28. Al-Omiri MK, Al-Wahadni AM. An ex vivo study of the effects of retained coronal dentine on the strength of teeth restored with composite core and different post and core systems. Int Endod J 2006;39:890–9.
29. "Best practices in endodontics: A desk reference" Journal of Conservative Dentistry : JCD vol. 18,6 (2015): 507.
30. Ozy € €urek T, €Ulker O, Demiry € €urek EO, et al. The effects of endodontic ac- € cess cavity preparation design on the fracture strength of endodontically treated teeth: traditional versus conservative preparation. J Endod 2018; 44:800–5.
31. Moore B, Verdelis K, Kishen A, et al. Impacts of contracted endodontic cavities on instrumentation efficacy and biomechanical responses in maxillary molars. J Endod 2016;42:1779–83.
32. Plotino G, Grande NM, Isufi A, et al. Fracture strength of endodontically treated teeth with different access cavity designs. J Endod 2017;43:995–1000.
33. .Rover G, Belladonna FG, Bortoluzzi EA, et al. Influence of access cavity design on root canal detection, instrumentation efficacy, and fracture resistance assessed in maxillary molars. J Endod 2017;43:1657–62.
34. Zandbiglari T, Davids H, Sch€afer E. Influence of instrument taper on the resistance to fracture of endodontically treated roots. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;101:126–31.
35. Asundi A, Kishen A. A strain gauge and photoelastic analysis of in vivo strain and in vitro stress distribution in human dental supporting structures. Arch Oral Biol 2000: 45: 543–550.