# The Effect of Access Cavity Design on Fracture Resistance of Endodontically Treated First Molars: An Vitro Study.

Original Article

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## ABSTRACT

**TITLE:** The Effect of Access Cavity Design on Fracture Resistance of Endodontically Treated First Molars: An Vitro Study.

**INTRODUCTION:** Fracture was found to be the main cause of extraction of endodontically treated teeth. Susceptibility of endodontically treated tooth to fracture is mainly associated with loss of tooth structure because of dental caries or due to endodontic procedures such as access cavity preparation and root canal preparation. Recently concept of conservative access cavity is inspired by concepts of minimally invasive dentistry.

**METHODOLOGY:** The null hypothesis tested was that there is no difference in fracture strength of sound molars, molars with conservative and those with traditional access cavities design. Forty two extracted human intact maxillary and mandibular molars were assigned to Traditional Access Cavity (TAC), Conservative Access Cavity (CAC) and Sound Control groups (SC) [n=7 maxillary and 7 mandibular teeth in each of three groups]. TAC groups were prepared with pulp chamber de-roofing and straight line access. For CAC a soffit and pericervical-dentine were maintained. Working length was determined and canals were left un-obturated and mounted in self-cured acrylic resin molds of PVC for testing. Specimens were then tested with a compression testing machine and data for force required to fracture was recorded in Newton for analysis. Data was normally distributed; Oneway ANOVA and post-hoc Tukey tests was used for analysis. The software R & R Studio was used for statistical analysis.

**RESULTS:** Fracture strength of conservative access cavity was higher than traditional access cavity.

**CONCLUSION:** A balance is required between cleaning and preserving tooth structure and if tooth condition permits, preservation of pericervical dentine, avoidance of aggressive flaring and retaining even some soffit as practically as possible needs to be taken into consideration.

**KEYWORDS:** CONSERVATIVE ACCESS CAVITY,TRADITIONAL ACCESS CAVITY, FRACTURE STRENGTH

## INTRODUCTION:

One of the most important steps in successful endodontic treatment is access cavity preparation.

Traditional endodontic access cavity involves removal of much amount of dentine, coronally to gain straight-line access to canals, and radiculary by overflaring the canals orifices, which may weaken the tooth and increases its susceptibility to fracture.

Extended preparation of endodontic access cavity is necessary for proper debridement of root canal but it critically reduces the amount of sound dentin and increases the deformability of tooth.

Moreover, in root canal and post space preparation it was found that loss of coronal tooth structure to gain straight-line access has a significant loss of fracture resistance.

Extraction was found to be the most frequent consequence of fracture of endodontically treated tooth.

The emergence of Minimally Invasive Dentistry and the modern imaging devices, illumination and magnification have inspired the emergence of the recent conservative endodontic access cavity design. The trend is preserving sound dentine by avoiding deroofing of the pulp chamber and avoiding over-flaring of canal orifices as well as avoiding aggressive dentine removal for shaping.

Hence the aim of this study was to check the fracture strength of conservative access vs traditional access cavity.

## AIM:

The aim is to evaluate the fracture strength of conservative versus traditional access cavity design in molar teeth in vitro.

Materials and method

In this study 21 maxillary and 21 mandibular molars extracted for periodontal reasons were collected and after debridement and removal of staining, calculus, and attached soft tissue with hand scalers, the teeth were stored in 10% formalin until used.

To standarize preparation and to minimize

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confounding factors and variables; all preparations were carried out by one operator,42 teeth were divided into three group each cointaining 14 Maxillary and 14 Mandibular in standard control group(SC) , traditional access cavity group(TAC) group and conservative access cavity (CAC) group.

The endodontic cavities were made with tapered diamond points at high speed and a pathway to the pulp space and the canal orifices achieved, the pathway was unimpeded and unobstructed for traditional access cavity(TAC) group to create straight-line access.

**TRADITIONAL ACCESS CAVITY:**

In traditional access cavity(TAC) External outline form was established by projecting the internal anatomy of the pulp onto the external surface, by complete deroofing of the pulp chamber to gain straight line access to canals orifices.

The convenience form used was to allow for unobstructed access to the canals orifices, direct access to the apical foramen, cavity expansion to accommodate filling techniques, and cavity enlargement to have control on instrumentation and obturation.

For maxillary molars, access was made in the mesial fossa without involving the distolingual cusp and was kept mesial to the oblique ridge. Access cavities had a rhomboid shape to allow for locating MB-2, and were not extended into the mesial marginal ridge and they were widest buccolingually.

For mandibular molars, the entry point used was just mesial to the central pit with access cavity located in the mesial half of the tooth to create straight line access for the mesial canals. The distal extension was allowed to gain straight line access to the distal canals.(Fig-1)

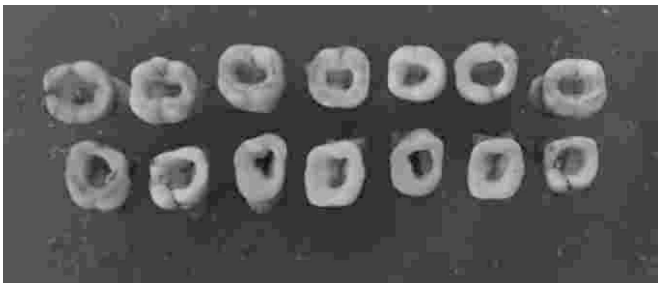


**Fig-1- Prepared traditional access cavity(TAC) (n=14)**

**CONSERVATIVE ACCESS CAVITY:**

In conservative access cavity(CAC) ,Coronal access preparation objective used was to remove as little tooth structure as necessary to locate canals orifices and to maintain a soffit which has been defined as a small piece or tiny lip of dentinal roof of 0.5-3.0 mm around the entire pulp chamber.

Access was accomplished by cutting near functional cusps, while staying 1-2 mm away from nonfunctional cusps, and the distal half of the occlusal surface was avoided,Radicular apical preparation was just wide enough to clean canals and remove the biofilm, without aggressive dentine removal for shaping.(Fig-2)

In this study design canals were left prepared without obturation, contrary to normal clinical setting. This was to eliminate and exclude confounding variables such as types, methods and efficiency of obturation and restorations.

Conventional coronal flaring for traditional access cavity(TAC) and minimal flaring for conservative access cavity(CAC) was used to open canals orifices and enlarge the coronal aspect of the root canal.

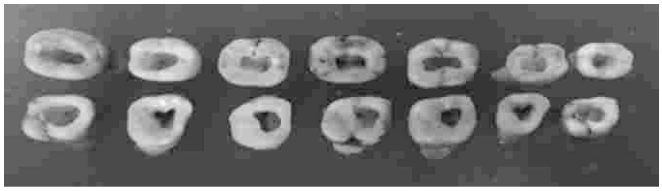


**Fig-2- Prepared conservative access cavity (CAC) (n=14)**

Irrigation with sodium hypochlorite 2.5% was used thoroughly between each instrument change and throughout canal preparation, using a 30 gauge needle. Working length was determined visually using ISO size 10 K-file to negotiate canals to full working length

The apical part of canals were negotiated with a series of progressively increasing size hand K files #15 and #20, #25 and #30.(Manikin, Tochigi, Japan).

Apical Canal preparation continued in step back in sequence until #25 k file apical size achieved for mesial canals of mandibular molars and maxillary molars. Distal canals of mandibular molars and palatal canals of maxillary molars were prepared to working length upto #30 k file sizes.

## SPECIMEN MOUNTING AND LOADING FOR TEST:

All teeth including the sound control groups, after instrumentation were mounted on polyvinyl chloride (PVC) cylinders (25 mm diameter x 25 mm height), with the roots embedded in self-curing resin 3 mm apical to the cementoenamel Junction to simulate the alveolar bone level.

**Fig-3 –Mounted specimen(n=42)**

The resin was mixed according to the manufacturer's instructions and was inserted in the PVC cylinders (fig 3) immediately after mixing,and allowed to set for 24 hours ,stored in normal distal water to prevent cracking till loading , and then the teeth were centrally-positioned with the long axis of the tooth parallel to the PVC cylinder walls teeth.

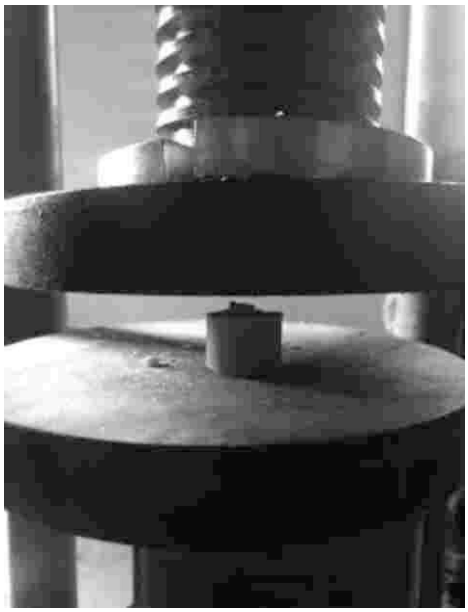


**Fig-4- Loading of specimen for testing**

The PVC molds were adjusted to place the loading arm of the universal testing machine(fig-4) over the center of the cavity preparation, with the load applied to the occlusal inclines of the buccal and lingual cusps vertically down the long axis of the tooth.

All teeth were then subjected to gradual continuous nondestructive occlusal loading until failure, in a compression testing machine . Failure was defined as a 25% or more drops in the applied load and this was noticed to be frequently preceded by a crack sound.

## RESULTS:

Fracture strength of conservative access cavity(CAC) was statistically significantly higher in mandibular molars (P Value = 0.0431) compared to traditional access cavity(TAC) groups, without differing significantly from the sound control groups.

Fracture strength of Maxillary Molars conservative access cavity (CAC) group did not differ significantly from that of the standard control (SC) control group with a P Value of (0.2706), whereas that of the traditional access cavity(TAC) group was statistically significantly lower than the control group with a P value ( 0.003601).

All Root-canal treated teeth were more susceptible to fracture than sound teeth essentially due to dentinal tooth structure removal during endodontic therapy.

## MANDIBULAR MOLARS:

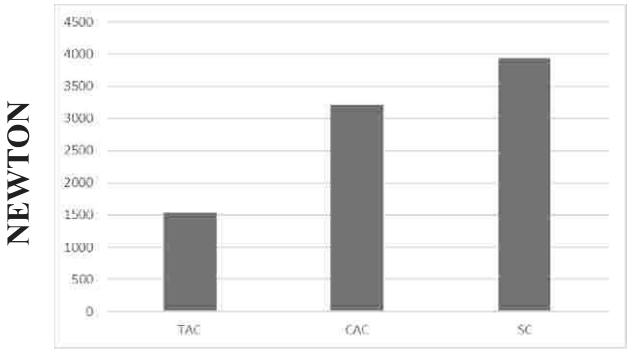
| Fracture strength in Newton | MEAN | SD | P Value (ONE WAY ANOVA) | POST HOCK TURKEY TEST |
|---|---|---|---|---|
| TAC | 1529.14 N | ±421.07 | 0.00429 P Value<0.05) Result is significant at p less than 0.05 | SC-CAC 0.4977 TAC-CAC 0.0431 TAC-SC 0.0038 |
| CAC | 3204.85 N | ±1609.22 | | |
| SC | 3937.85 N | ±1227.72 | | |

**MAXILLARY MOLARS**

| Fracture strength in Newton | MEAN | SD | P Value (ONE WAY ANOVA) | POST HOCK TURKEY TEST |
|---|---|---|---|---|
| TAC | 1828.57 N | ±298.35 | 0.004932 P Value<0.05 ) Result is significant at p less than 0.05 | SC-CAC 0.2706 TAC-CAC 0.1004 TAC-SC 0.0036 |
| CAC | 3194.71 N | ±1173.23 | | |
| SC | 4194.28 N | ±1620.37 | | |

**STATISTICAL ANALYSIS:-**

**Mandibular Molars:**

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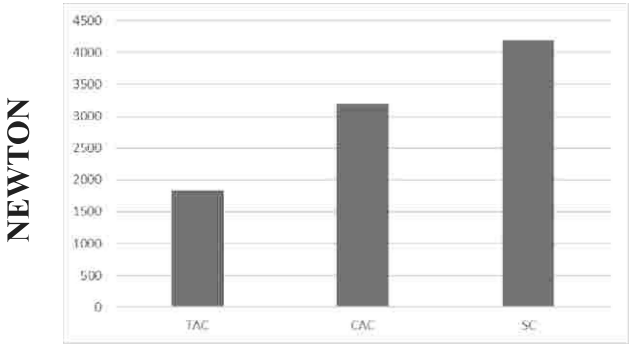
**Maxillary Molars:**

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**DISCUSSION:**

The emergence of minimally invasive dentistry has led to the recent concept of conservative endodontic access cavity; the aim is to preserve sound dentine by avoiding un-roofing of the pulp chamber and avoiding over-flaring of canal orifices as well as avoiding aggressive dentine removal for shaping.

This new philosophy of conservation discourages the use of Gates-Glidden burs and large round burs so as to avoid walls gouging and loss of precious dentine, especially around the Pericervical dentine where it acts as a buttress against structural flexure and ultimate fracture.

In our study, the results for mandibular molars were consistent with previous work of Krishan R. et al. 2014 for mandibular molars and also in agreement with Plotino G. et al. 2017 who found fracture load was significantly higher for conservative access cavity(CAC) group in all posterior teeth including maxillary molars.

The current study results for maxillary molars were consistent with the findings of Moore B et al. 2016 and Rover G. et al. 2017 studies, both have shown no differences in fracture strength of maxillary molars accessed with traditional access cavity(TAC) compared to conservative access cavity(CAC). Our results for maxillary molars were also in agreement with a recent study which found conservative access cavity(CAC), compared with traditional access cavity(TAC) had no significant effect on fracture resistance.

These findings could be supported with the observation that endodontically treated maxillary molars have a lower incidence of fracture than mandibular molars.

The shape and size of the access opening is governed by the extent of caries or previous restorations, and the conservative access cavity(CAC) model may appear inappropriate, but conservative access cavity(CAC) model even if applied partially may increase the fracture strength of endodontically treated molars.

However the main drawback of conservative access cavity preparation(CAC) is the limitation in the examination of the pulp chamber and the difficulties in the debridement of the area under the pulp roof that does not get exposed according to Taba Ozyurek et al 2018.

**CONCLUSION:**

A balance is required between cleaning and preserving tooth structure and if tooth condition permits, preservation of pericervical dentine, avoidance of aggressive flaring and retaining even some soffit as practically as possible needs to be taken into consideration.

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