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# Influence of Lingual and Incisal Access Cavity Preparation on Straight Line Apical Access and Fracture Resistance In Mandibular Anteriors: An In Vitro Study

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## ABSTRACT

**Aim**: Evaluation of straight-line access and fracture resistance of mandibular anterior teeth by conventional lingual access and incisal access approach using CBCT and Universal testing machine respectively.

**Materials and Method:** 72 extracted permanent mandibular incisors and canines of similar dimensions were selected and divided into three groups i.e. intact teeth without endodontic access cavity (control), incisal access (Group II) and lingual access (Group III). Positions of straight-line access in group II were determined on the mesio-distal digital imaging. The root canal was divided into cervical, middle, and apical third. A midline was drawn connecting the midpoints and extending in incisal direction. The point, at which the line crossed the external crown surface, was recorded as vestibular, incisal, or oral. This represented the centre point or the ideal access. After endodontic access cavity preparation in Group II and Group III CBCT images were acquired. Later, fracture resistance was evaluated using Universal testing machine.

**Results**: In mandibular anteriors, the straight-line access to the root canal was obtained from the incisal edge. The results for the fracture resistance testing showed that, the Group III (lingual Access) demonstrated the least mean value of fracture resistance and was highly significant.

**Conclusion**: Within limitation of this in-vitro study, it can be concluded that incisal access opening provides a straight-line access to apex and better fracture resistance as compared to that of conventional lingual approach in mandibular anterior.

**Keywords:** Access Cavity, Fracture Resistance, Mandibular Anteriors, Straight Line Access.

## INTRODUCTION

According to theoretical concepts, achieving success in endodontic therapy depends on complete root canal debridement gained by occlusal access opening in the most direct route towards the long axis of tooth.[1] Endodontic access cavity

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preparations primarily aims at locating canal orifices, obtaining straight-line access to the apical one third, while conserving tooth structure for providing functional requirements.

Traditionally, in anterior teeth lingual access of root canal was considered clinically as for the esthetic concerns but with evolution of better bonding and resin based material formulations, this concern can be eliminated.[2-3] Mandibular incisor anatomy presents as an endodontic challenge during the access cavity preparation due to smaller dimensions and high prevalence of additional canals. [3] As reported by Benjamin and Dowson the prevalence of two canals in mandibular incisors is as high as 41.4%.[4]

Clinically, literature states that lingual access cavity preparation leads presence of lingual shoulder which leads to difficulty in location and instrumentation of lingual canal in mandibular incisors.[3] Literature also presents with divided opinion on placement and location of access cavity in mandibular incisors including extended lingual access towards cingulum, facial access and incisal-facial.[5-8] But there is no documented evidence regarding the effect of access cavity preparation on the fracture resistance of mandibular incisors. Therefore, the current in-vitro research was conducted to compare the conventional lingual access and incisal access on mandibular anteriors for evaluation of straight line access by CBCT imaging and fracture resistance using Universal testing machine.

## MATERIALS AND METHODS

Seventy-two extracted permanent mandibular anterior extracted for periodontal purpose were collected, cleaned, disinfected and stored according to CDC guidlines.[9] All the samples were kept hydrated in normal saline during the entire duration of study.

Inclusion criteria were extracted single rooted human permanent mandibular incisors and canines, teeth with complete root formation and exclusion criteria were calcified canals, internal or external resorption, crown or metallic restoration, crown and/or root fracture, developmental anomalies.

Samples were divided into 3 groups (n=24) having 3 subgroups each Group I - Intact tooth (control), Group II - Incisal access opening and Group III - lingual access opening. Subgroup A- Permanent mandibular central incisor, B- Permanent mandibular lateral incisor and C Permanent mandibular canine. Position of straight-line access in the incisor and canine for Group II were determined on the mesio-distal Radio Visio Graphic imaging. Root canals were divided into cervical, middle, and apical third. The midpoint between the vestibular and oral wall at the junction of the middle and apical third and the junction of the coronal and the middle third of the root canals were marked. A midline was drawn connecting the midpoints and extending in incisal direction. The point, at which the line crossed the external crown surface, was recorded as vestibular, incisal, or oral. This represented the centre point where ideal access should be made to obtain straight-line access to the apical third of the root canal.[3] (Fig- 1)

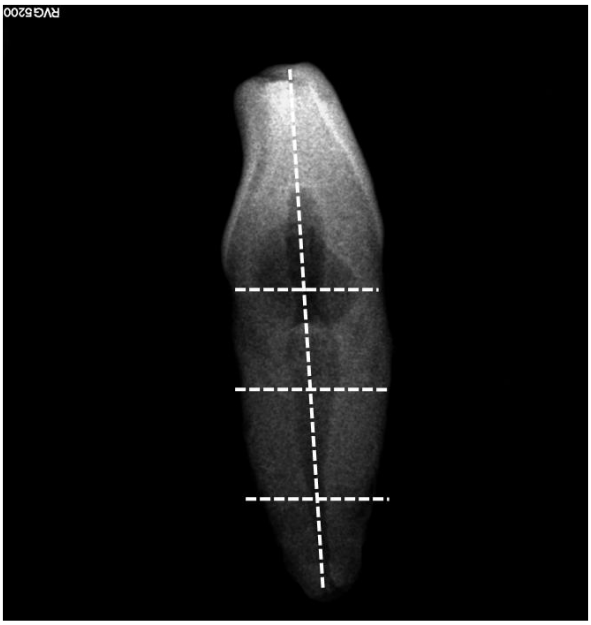

Fig 1: Plotting of straight line access location in mandibular incisors.

Conventional lingual and incisal endodontic access cavities were made with a high speed handpiece (NSK, Japan) and Endo Access Kit (Dentsply/Maillefer, Switzerland). A straight canal access was obtained and tissues were extirpated. Root canals were irrigated with 5 ml. of 3% sodium hypochlorite (NaOCl) solution. The canal patency was verified with size #10 K-file

(Dentsply/Maillefer, Switzerland) to the apex and the reference points were marked i.e incisal edge for the incisor and cuspal tip for canines and CBCT image acquisition was done Group II and III. The CBCT images were obtained with a CS 9300 Select (Carestream Health, Inc, USA). The working model was placed on the dental impression holder onto the 3D bite block support in the chin rest base, to standardize the imaging. The images were examined with the 3D Object Acquisition Interface (Carestream Health, Inc, USA). A reference point was determined from the incisal plane, following the visible canal curvature in the respective CBCT slice. Relative frequencies of access location as well as mean, standard deviation, and diameters of root canal were calculated for each tooth type. (Fig-2)

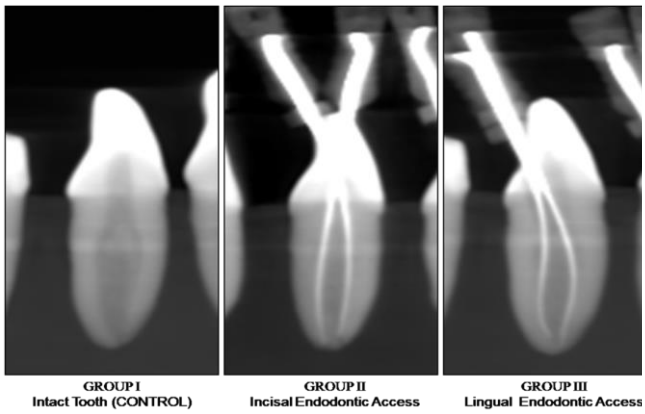


Fig 2: CBCT evaluation of access opening in mandibular incisors.

The fracture resistance of samples of all the groups was tested under a static load parallel to the long axis of the tooth using a Universal testing machine. A compressive mode of load was applied using a metallic rod with round tip (2.0 mm diameter) on the tooth at a crosshead speed of 1 mm/min until fracture occurred. The maximum fracture loads were recorded in Newtons.

**Statistical analysis**

Data were collected and statistical analysis was performed, for mean and standard deviation for fracture resistance of teeth. All groups were compared and analyzed by using Unpaired't' test. ($P < 0.05$) was considered statistically significant.

## RESULTS

Result obtained after evaluation of CBCT imaging showed that for permanent mandibular anteriors, the accurate location of straight-line access was from incisal edge. (Table 1)

Table 1: Location of straight line access in permanent mandibular incisors and canines.

| Tooth Type | Group II (Incisal) | Group III (Lingual) |
|---|---|---|
| A. Permanent Mandibular Central Incisors | 91.6 | 8.3 |
| B. Permanent Mandibular Lateral Incisors | 83.3 | 16.6 |
| C. Permanent Mandibular Canines | 100% | 0% |

The mean of fracture resistance values and the standard deviation for Group II vs. Group III was not significant (P=0.43) for mandibular central incisors, highly significant (P=0.0022) for mandibular lateral incisors and significant (P=0.017) for mandibular canines. Group III demonstrated the least mean value of fracture resistance and was highly significant difference from the control group.

Table 2: Mean and SD of fracture load (Newton) of permanent mandibular anteriors.

| Tooth Type | Group I (Control) | Group II (Incisal) | Group III (Lingual) |
|---|---|---|---|
| A. Permanent Mandibular Central Incisors(Mean ± SD) | 760.5 ±21.19 | 347.06± 51.35 | 329.5± 34.48 |
| B. Permanent Mandibular Lateral Incisors(Mean ± SD) | 1350.31 ± 151.60 | 1176.40 ± 43.38 | 877.18± 222.38 |
| C. Permanent Mandibular Canines (Mean ± SD) | 1436.87 ± 60.70 | 1200.31 ± 180.36 | 1004.06 ± 97.81 |

## DISSCUSSION

Access cavity preparation plays a provital role in endodontic therapy as it aids in providing adequate access for chemo-mechanical preparation and obturation, preservation of tooth structure, restorability and improving long term survival rate.[10] An in vitro investigation on endodontically treated teeth concluded that the loss of tooth structure during endodontic access cavity preparation is in direct relation to their fracture during their routine function in oral cavity.[11]

Endodontic failures observed and documented in mandibular incisors are due to failure in location, debridement and incomplete obturation of lingual canal.[12] Mauger MJ et al[3] in their study on mandibular incisors found that, 27.6% had the center of the straight line access facial to the incisal edge, whereas 72.4% had straight line access at the incisal edge. No teeth had straight line access plotted lingual to the incisal edge. Similar results were seen in our study that, the incisal access opening provides the straight-line access to the apical third of root in 91.6% of mandibular central incisors, 83.3% in mandibular lateral incisors and 100% of mandibular canine using CBCT. CBCT was used for evaluation as its accuracy in detecting the internal three dimensional anatomy of tooth is more when compared to conventional digital radiographs.[13,14] The clinical implication of the obtained results will be modification in conventional lingual access opening to incisal access openings in mandibular incisors for better lingual canal location, debridement and obturation.

Role of peri-cervical dentin in imparting fracture resistance to tooth is unquestionable, it is that surface of tooth which extends roughly 4mm above and 4mm apical to crestal bone.[15] Research conducted earlier suggested that modified incisal access cavity design that conserves the peri-cervical dentin should be taken into clinical practice so as for improving clinical longevity of tooth by increasing the fracture resistance.[16,17] Fracture resistance evaluation of mandibular incisors showed that there is significant difference between the Group I & Group II. i.e. ($p<0.001$) highly significant for mandibular central incisors, ($p=0.007$) significant for lateral incisors and ($p=0.0034$) highly significant for canines. Whereas there is highly significant difference between the Group I and Group III, i.e. ($p<0.0001$) for mandibular central incisors, lateral incisors and canines. When Group II and Group III were compared with the Group I (control group), Group II showed better fracture resistance than group III. Results of current study can be explained on the basis that lingual access opening would compromise the fundamental principle of conservation of tooth structure i.e removal of peri- cervical dentin resulting in lower fracture resistance of tooth as compared to the incisal access opening.

## CONCLUSION

Within the limitation of current study, it can be concluded that incisal access opening provides a straight-line access to apical one third of the root canals in mandibular anteriors and it also results in conservation of tooth structure leading to improved fracture resistance as compared to that of conventional lingual approach.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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