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# Original Research

## Location and dimensions of access cavity in permanent incisors, canines, and premolars

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***ABSTRACT:***
**Aim:** The aim of the study was to determine the location and dimensions of access cavity with straight-line access in incisors, canines, and premolars and to evaluate the largest diameter of their root canals in the mesiodistal and vestibulooral direction. **Materials and Methods:** 200 extracted teeth of each group were randomly selected and digitally radiographed from the mesiodistal and vestibulooral direction. Position of the straight-line access midline in relation to anatomical landmarks (incisal edges, fissures, and cusps) was recorded. The largest diameters in mesiodistal and vestibulooral direction were measured. **Results:** For the anterior teeth, the predominant location of straight-line access was from incisal edge, except for maxillary central incisors, where location was equally distributed between incisal edge and oral surface. In mandibular premolars, the straight-line access was positioned vestibular from central fissure. **Conclusions:** Knowledge of location and size of access cavity facilitates achieving balance between straight-line access to the apical third of the root canal and preservation of tooth structure.

**Keywords:** Bicuspid; canine; computer-assisted; cuspid; dental pulp cavity; incisor; image processing; premolar

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## INTRODUCTION

The outline form of endodontic access openings is related to and is a reflection of the anatomy of the pulp. In order to achieve straight-line access to the apical portion of the root canal, the access must be of sufficient size and proper location to allow instruments to stand free from the walls of the pulp chamber. One type of tooth which exhibits an unusual anatomy requiring a special approach to access is the mandibular premolar. Such teeth are often difficult to treat due to their crown/root relationship and pulpal anatomy. The polymicrobialaetiology of periapical disease is well established but the exact nature of the bacterial flora and its distribution in the root canal system and dentine is not well defined.[1]Access cavity preparation is the first step in a series of procedures in endodontic treatment and as such particularly important because it affects all subsequent procedures and finally the outcome. An appropriately designed access cavity assures unobstructed straight-line access to the apical third of the root canal.[2]While too large access cavity unnecessarily weakens the tooth, which can lead to crown or root fracture, too small or incorrectly shaped access cavity impedes proper instrumentation of root canal.In anterior teeth straight-line access is achieved through a cavity, made on incisal edge or even labial surface of the tooth as it was reported in previous studies on access cavity.In anterior teeth straight-line access is achieved through a cavity, made on incisal edge or even labial surface of the tooth as it was reported in previous studies on access cavity.[2-6]

Location of access cavity in anterior teeth determines the amount of preserved dentin in the cingulum area, which is important for the ferrule effect.[7-9]In premolars, the loss of cusps or marginal ridges increases the long-term risk for tooth fracture.Therefore, the access cavity preparation requires the precise balance between providing adequate access for endodontic therapy on one side and on the other side preservation of tooth structure, important for restorability and long-term survival of the tooth. The aim of the study was to determine the location and dimensions of access cavity with straight-line access in incisors, canines, and premolars and to evaluate the largest diameter of their root canals in the mesiodistal and vestibulooral direction.

## MATERIAL AND METHODS

From a pool of extracted human teeth, the samples of each of the following tooth types were randomly selected: Maxillary central incisor, maxillary lateral incisor, maxillary canine, maxillary first premolar, maxillary second premolar, mandibular incisor, mandibular canine, mandibular first premolar, and mandibular second premolar, in total 200 teeth. Due to similar anatomic features, central and lateral mandibular incisors were analysed as one group. Teeth with restorations, root-canal treatment, or caries reaching the pulp chamber were excluded. An optical bench was constructed to maintain projection geometry between X-ray unit tube, teeth holder, and storage phosphor plate holder. The teeth were placed on a plastic holder with a 5-mm wide metallic reference object and radiographed from the mesiodistal and vestibulooral direction with intraoral X-ray unit (PlanmecaProstyle Intra, Planmeca Oy, Helsinki, Finland) at 70 kV and exposure time of 0.20 s. Images were acquired with storage phosphor plate system (DigoraFmxSoredex, Soredex, Tuusula, Finland) and exported in bitmap format.

In computer software, the following reference points were marked: Incisal edge for the anterior teeth; buccal and oral cusp tip and the lowest point of the central fissure system for the premolars. Position of straight-line access midline in the incisor and canine images was determined on the mesiodistal radiographs as it was described previously.[5]The root canal was 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 canal was marked. A midline line 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 center point where ideal access should be made to obtain straight-line access to the apical third of the root canal.[4]Similarly, in the maxillary premolar images the center point was determined in relation to cusp tips and in mandibular premolars the center point was determined in relation to central fissure system. Finally, images with marked reference points were exported in BMP format and imported in image analysis software (Image Tool 3.0, Department of Dental Diagnostic Science at The University of Texas Health Science Centre, San Antonio, Texas, USA), calibrated with 5 mm metallic reference object. The largest diameter of the root canal in mesiodistal and vestibulooral direction was determined for each tooth. Relative frequencies of access location as well as mean, standard deviation, and 95% confidence interval (CI) of both diameters were calculated for each tooth type with SigmaStat for Windows version 2.03 (Aspire Software International, Ashburn, USA).

## RESULTS

**Table 1: Location of straight-line access in incisors and canines**

| Tooth type | Location of Straight Line Access | | |
|---|---|---|---|
| | Vestibular | Incisal | Oral |
| Maxillary central incisor | 0 | 60 | 60 |
| Maxillary lateral incisor | 7 | 70 | 10 |
| Maxillary canine | 0 | 50 | 20 |
| Mandibular incisor | 23 | 90 | 0 |
| Mandibular canine | 0 | 100 | 0 |

**Table 2: The mean and standard deviation of largest canal diameter in mesiodistal and vestibulooral direction**

| Toothtype | Mean of Largest Diameter In Mm | |
|---|---|---|
| | Mesiodistal | Vestibulooral |
| Maxillary central incisor | 1.50 | 1.44 |
| Maxillary lateral incisor | 1.20 | 1.38 |
| Maxillary canine | 1.55 | 2.55 |
| Maxillary first premolar | 1.30 | 5.60 |
| Maxillary second premolar | 1.40 | 4.12 |
| Mandibular incisor | 0.65 | 1.70 |
| Mandibular canine | 1.35 | 2.60 |
| Mandibular first premolar | 1.32 | 2.50 |
| Mandibular second premolar | 1.23 | 2.90 |

For the anterior teeth, the predominant location of straight-line access was from incisal edge, except for maxillary central incisors, where location was equally distributed between incisal edge and oral surface

[Table 1]. For maxillary premolars, the location of straight-line was always between the cusp tips. For mandibular premolars, the location of straight-line access was always buccaly from central fissure. The shape of access cavity was round in maxillary central and lateral incisors. For other teeth, the shape of access cavity was oval; however, the ratio between mesiodistal and vestibulooral canal diameter varied considerably [Table 2]. For clinical application, location and 95% CI of size of access cavity was calculated and superimposed on occlusal photography of maxillary and mandibular teeth.

## DISCUSSION

The results of our study showed that in majority of anterior teeth straight-line access was gained through incisal edge or vestibular surface. The exception was maxillary central incisor, in which the access location of access was equally distributed between incisal edge and incisal half of oral surface. It should emphasized that in no single occasion the access cavity was projected through the gingival half of oral surface, which in most often used clinically. The methodology used in the study [5] determines straight-line access projected from middle third instead of whole length of the canal, utilized in previous studies.[2,3] Such approach is clinically more relevant, as it assures straight-line access to apical third, while apical curvature is usually preserved by flexibility of nickel-titanium instruments. As apical curvature was not included in such evaluation, the access cavity was positioned more centrally, preserving more tooth substance. Results of our study confirmed the results of studies, reporting the location of access cavity in maxillary lateral incisors,[2] maxillary and mandibular anterior teeth,[3] mandibular incisors,[5] and mandibular premolars.[10] The location of access cavity in maxillary premolars has not been reported previously. Analysis of premolars revealed that in maxillary premolars the straight-line access was positioned between the cusp tips and in mandibular premolars, it is positioned buccaly from central fissure.

There is only one published study, evaluating largest canal diameter.[10]It evaluated canal width of mandibular premolars in mesiodistal direction and found that width of the canals was less than 1.4 mm in most cases, what is in accordance of our study. In other words, present study revealed that there is no need to extent the access cavity into the marginal ridges of premolars or into the lingual cusp in mandibular premolars.The traditional lingual approach in anterior teeth was used as a compromise between esthetical and endodontic requirements. The development in restorative dentistry and adhesive systems makes the restoration of access cavity on incisal edge or buccal surface feasible, and it should be of no concern in today's dentistry.

It should be emphasized that this could only serve as a guideline, as there are numerous cases demonstrating anatomic variations not only in complex teeth as molars, but also in incisors,[11] canines,[12] and premolars [13,14]which are usually considered as teeth with less complicated anatomy. Exact size and location, especially in complex cases, should therefore be always evaluated from periapical radiographs or cone beam computed tomography scan.[15,16]

The results of our study showed that the size of access preparation could be relatively small, as it was determined by the diameter and shape and direction of the root canal. The benefit of the operating microscope during has been demonstrated even among undergraduate students.[17]The rapid technology development in dental education enables training of access cavity preparation on haptic virtual reality simulator using microcomputed tomography tooth models resulting in reduction of procedural errors in endodontic access preparation.[18]

## CONCLUSION

Results of this study do not support the traditional lingual access cavity preparation in anterior teeth, except in maxillary central incisors, described in most endodontic textbooks, which have remained unchanged for several decades. Additionally, such approach neglects the importance of ferrule effect and increase risk of tooth fractures. The precise balance between providing adequate access and preservation of tooth structure should be aim the of access cavity preparation, enhancing both successful outcome and long-term survival of the tooth.

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