Original Article

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Assessment of Distance from Apical Foramen and Apical Constrictions to Root Apex of Maxillary and Mandibular Permanent Anterior Teeth among Bangladeshi National

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ABSTRACT

Background: It is essential to understand apical anatomy when administering endodontic therapy. Reports of the prevalence of numerous foramina in single-rooted teeth are inconsistent. The lack of consensus regarding the distinction between apical and lateral foramina and races, as well as differences in investigative methods and nomenclature, may be the cause of this. In order to ascertain the distance between the root apex and the apical foramen and the root apex and the apical constriction, the investigation was conducted. **Methods:** Center incisor, lateral incisor, and canine teeth made up 66 of the mandibular teeth and 66 of the maxillary teeth, totaling 132 anterior teeth. Remaining periodontal tissue was mechanically removed, and markers were applied to the teeth. Using a Leica®EZ4E with 10× eye pieces and a 4.4:1 zoom stereomicroscope and digital camera, the teeth were dried and inspected. A stage micrometer and image J software were used to estimate the distance from the tooth's anatomical apex. Statistical analysis between root apex morphology between the mandible and maxillary anterior teeth was performed by SPSS and differences between the groups were calculated by Chi square and student-t test; a value of p <0.05 was considered as statistically significant. **Results:** The results found that the distance between apical constrictions to root apex was 0.96 to 1.11 mm. **Conclusion:** There is no difference between maxillary and mandibular anterior teeth in respect to apical foramen and apical constrictions to root apex.

KEY WORDS: root apex, apical foramen, apical constriction

INTRODUCTION

Understanding the anatomy of the apex is essential when conducting endodontic procedures. This is due to the fact that the presence and positioning of lateral foramina have been examined far less than that of apical foramina. In addition, the literature lacks a definitive agreement on the exact point that separates the apical area from the lateral zone of the root. For example, foramina up to 4.31 mm from the apex were regarded as apical apertures.[1] On the other hand, 90% of the apical foramina in maxillary central incisors were located within 1.2 mm of the apex, according to Kasahara et al. [2]. A distance of 1.7 mm from the root tip was used to differentiate the apical foramen from the lateral ones, mainly because it was rare for a single apical foramen to exceed this distance from the tip in our anterior tooth samples. Due to variations in study methodologies and the definitions of apical and lateral foramina, drawing definitive conclusions from earlier studies proved challenging.

There is ongoing discussion on the average diameter of all apical foramina. While Miyashita[4] reported an average diameter of 0.30 mm and a distance from the apex of 0.38 mm, Abdullah et al.3 found an average diameter of 0.31 mm and an average distance from the apex of 0.41 mm. Miyashita[4] identified lateral canals in 50% of his examined teeth, a notably high rate, particularly since he only analyzed the last 3.3 mm of the roots,[4] while Abdullah et al.[3] found lateral openings in just 9%, as they assessed the whole root surface. However, not all canals described by Miyashita were visible on the root surface; some were obstructed by calcareous or soft tissue deposits.[4]

The variety and quantity of teeth featuring multiple apical foramina, lateral foramina, and a combination of apical and/or lateral foramina should be examined. In a histological study of the maxillary central incisors' apical region, Kerekes et al.[5] found that 15 out of 20 specimens had multiple apical canals. Most teeth with extra apical canals had one to four accessory canals, but one specimen had 20 different types. Kerekes et al.[5] prepared thin sections of the apical

regions of their specimens but seemingly did not scale the teeth prior to sectioning. The cutting process may have led to the formation of artificial fissures in the dentin, which could have resulted in an exaggerated count of accessory canals. Martos et al.[6] utilized electron microscopy to investigate the apical regions of 29 permanent teeth, revealing that the diameter of the main foramen ranged from 0.2 to 0.49 mm, a measurement that aligns closely with the sizes of individual apical foramina observed in this study. These researchers noted that the diameter of additional apical foramina varied between 0.05 and 0.06 mm. This dimension is somewhat smaller compared to the sizes of multiple apical foramina reported in the study by Abdullah et al.[3] In a study focused on mandibular anterior teeth in a Turkish population, According to Sert et al.7, 15% of mandibular canines, 13% of lateral incisors, and 7% of central incisors had lateral canals. Furthermore, Mizutani et al.[8] investigated the occurrence and distribution of accessory canals in Japanese maxillary anterior teeth. This research utilized a straightforward method for examining the intricate surface characteristics of human tooth roots to analyze apical and lateral foramina in extracted anterior teeth from a Bangladeshi population, which has not been extensively studied in terms of root morphology.

MATERIALS & METHODS

This cross-sectional analytical study was conducted jointly in the Department of Conservative Dentistry and Endodontics and at the Department of Zoology, Dhaka University, Dhaka-1000. Purposive sampling technique was followed: anterior teeth of mandible and maxilla was select for the investogation. Inclusion criteria are as follows: The teeth of patient who needed extraction and Tooth with completely formed apex.

Sample collection

For this study, adult patients who required anterior tooth extractions and were seen at BSMMU's Department of Oral and Maxillofacial Surgery as well as other dental units were chosen. The context of the study, which was authorized by the BSMMU IRB, was explained to all patients.

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- History taking- Selection of tooth was begun with obtaining information of patient's complaints, desires, medical and dental history.
- General tooth examination was conducted by using a combination of clinical and radiographic technique as well as adjunctive tests during the first appointment.

Study procedure

The oral and maxillofacial section provided the permanent anterior teeth, which included canines and the central and lateral incisors of the maxillary and mandibular teeth. The working microscope showed that every tooth was fully grown. Teeth that were immature, had experienced resorption, or were damaged were not included in the study. Once extracted, the teeth were preserved in 70% ethanol solution. Residual periodontal ligament tissue was eliminated using an ultrasonic scaler. The teeth were marked, dried, and then examined with a Leica® EZ4E stereomicroscope featuring 10x eyepieces and a 4.4:1 zoom. Utilizing a stage micrometer and Image J software, the distance between the apical foramen and the root apex was measured. Furthermore, the separation between the root apex and the apical constriction was assessed.

Evaluation Criteria

Using a stage micrometer and Image J software, the distance between the foramen and the root apex was measured along the long axis of the root, beginning at the apex tip and continuing to the point considered to be the foramen's center. Foramina that were located 1.8 mm or closer to the root apex were classified as apical foramina.

Data collection and analysis

The distance from apical constriction to root apex was measured. Statistical analysis between the mandible and maxillary teeth was performed by SPSS and differences between the groups was calculated by Chi square test; a value of p <0.05 was considered as statistically significant.

RESULTS

When comparing mandibular lateral incisors to maxillary lateral incisors, Table 1 revealed no discernible change in the distance between the apical constriction and root apex (p>0.05). The average distance between the root apex and the apical foramen for the maxillary and mandibular canines was 0.51±0.23 mm and 0.42±0.15 mm, respectively. There is no statistically significant change (p>0.05). The mean distance between the mandibular and maxillary lateral incisors was 0.46±0.11 mm and 0.56±0.14 mm, respectively. The statistically significant difference shows that maxillary lateral incisors have a longer distance from the apical foramen to the root apex than mandibular lateral incisors (p<0.05). Moreover, the average distance between the maxillary and mandibular teeth's apical foramen and the root apex for the central incisors was 0.43±0.26 mm and 0.53±0.19 mm, respectively. There is no statistically significant change (p>0.05). The distance between the maxillary and mandibular teeth's apical constriction and root apex is compared in Table 2. For maxillary canines, maxillary lateral incisors, and maxillary central incisors, the average distance between the apical constriction and the root apex was 0.96±0.20 mm, 1.01±0.15 mm, and 1.09±0.12 mm, respectively. The average distance between the apical constriction and the root apex of mandibular teeth was 0.98±0.13 mm for central incisors, 1.01±0.16 mm for lateral incisors, and 1.11±0.17 mm for canines. This indicates that the maxillary and mandibular canine and central incisor have significantly different locations for the apical constriction (p<0.05). However, there is no significant difference in the distance between the apical constriction and root apex for mandibular lateral incisors compared to maxillary lateral incisors (p>0.05).

Table 1. Distribution of distance from apical foramen to root apex (mm) between study sample (n=132)

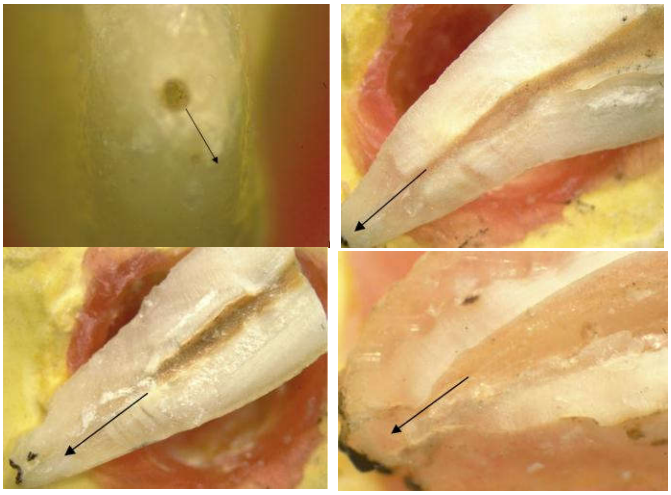
Teeth	Distance from apical foramen to root apex (mm)		*p*-value
	Maxillary (n=66) Mean±SD	Mandibular (n=66) Mean±SD	
Canine (n=22)	0.51±0.23	0.42±0.15	0.149
Lateral incisor (n=22)	0.56±0.14	0.46±0.11	0.010
Central incisor (n=22)	0.43±0.26	0.53±0.19	0.160

p-value obtained by Unpaired t-test, p<0.05 considered level of significant

Table 2. Distribution of distance from apical constriction to root apex (mm) between study samples (n=132)

Teeth	Distance from apical constriction to root apex (mm)		*p*-value
	Maxillary (n=66) Mean±SD	Mandibular (n=66) Mean±SD	
Canine (n=22)	0.96±0.20	1.11±0.17	0.011
Lateral incisor(n=22)	1.01±0.15	1.01±0.16	1.000
Central incisor(n=22)	1.09±0.12	0.98±0.13	0.008

p-value obtained by Unpaired t-test, p<0.05 considered level of significant



From left to right Figure 1. Assessment of distance between apical foramen to root apex. Figure 2, 3, and 4: Assessment of distance between apical constrictions to root apex

DISCUSSION

The current study found that the distance between the apical constriction and the root apex was between 0.96 and 1.01 mm. This distance is in close agreement with the findings of Mizutani et al.[8], who reported distances of 1.010 mm for lateral incisors, 0.825 mm for central incisors, and 0.863 mm for canines. However, McDonald and Hovland[9] found that in 93.4% of canals, the apical constriction was within 0.5 mm utilizing the Endocater apex locator. Differences in the measurement techniques used could be the cause of the disparity between the current study and McDonald and Hovland.[9]

Clinical applications, such as determining which endodontic tools are best suited for cleaning and shaping each root canal according to its average size, may benefit from the physiological foramina data. The diameter of the apical foramina in the mandibular and maxillary anterior teeth, for example, varied between 0.25 and 0.33 mm in our study. This suggests that while use a #15 or #20 file could preserve the canal's and the foramen's permeability, it would not sufficiently instrument the complete canal walls or the physiological foramen to their true diameter. As a result, it calls for the use of more sophisticated tools that can guarantee appropriate apical region extension and irrigation. This would reduce any remaining debris or bacteria in the root canal system and improve the prognosis overall.

The success of both surgical and non-surgical endodontic therapies depends on an understanding of the anatomy of the root apex. By determining the natural foramen's size, the right tools can be used to carefully enter the foramen and provide sufficient permeability during endodontic preparation. To guarantee thorough preparation, this entails controlling the foramen's potential and determining its size.

The physiological foramen's shape is crucial for endodontic procedures because the instruments only allow for one cleaning and round preparation. Therefore, in order to ensure that the canal and foramen are cleaned and sealed properly, the foramen's shape should be changed to a round one, or other techniques or tools that can handle non-round forms must be investigated. With the help of resources like periapical x-rays, apex locators, tactile sensitivity, and the operator's skill, the study's findings about the shape of the apical foramina in anterior teeth help choose instruments that are the right size for each situation.

CONCLUSION

There was variation in the distance between the root apex and the apical constrictions. In the end, the study's findings verified that the apical foramen and the distance between apical constrictions and the root apex of the maxilla and mandible's anterior teeth do not differ statistically significantly. These findings advance our understanding of the structural variations in permanent anterior teeth between Bangladeshis, which is critical for successful endodontic therapy.

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