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Morphometric analysis of the apical foramina in extracted human teeth

Shape and location of the apical foramina

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ABSTRACT

Background: The aim of the study was to analyze the morphology of the apical foramen in permanent maxillary and mandibular human teeth.

Methods: The anatomic parameters include shapes (rounded, oval, uneven, flat and semilunar) and location (center, buccal/labial, lingual/palatal, mesial, and distal) of the apical foramina was evaluated. The shapes and locations of apical foramen were analyzed based on tooth type (central incisor, lateral incisor, canine, premolars, and molars) arch type (maxillary and mandibular), and position (anterior and posterior). All the teeth were investigated for the apical

foramina shape and location using a stereomicroscope at a magnification of 10X. Descriptive statistics performed using SPSS (Version 21.0, IBM, NY, USA) at p value less than 0.05.

Results: The common shape of apical foramina was round (65%) and location was center (32%). The frequency of deviation of apical was 68% in overall teeth. Apical foramina in maxillary anterior teeth showed more deviation while posterior teeth in mandibular teeth. The most common shape of apical foramina was round (65.1%) followed by (31%) and flat and semilunar shapes are very rare in studied subjects.

Conclusions: The most frequent direction of deviation is the distal surface, followed by the mesial surface. The variation is more common in mandibular posterior teeth, while maxillary posteriors showed the least difference. The commonest shape of the apical foramen is of a round shape, followed by the oval. The oval shape of the apical foramen is most frequent with central incisors.

Key words: apical foramina, morphology, location, shape, root, stereomicroscope

INTRODUCTION

The success of the root canal treatment includes effective mechanical preparation as well as chemical cleansing of the pulp space and its complete filling with an inert substance. Root canal morphology of teeth specifically in the apical third is a judgmentally significant factor during the endodontic treatment. It is very essential to envision and to have a thorough anatomic knowledge of the tooth before root canal treatment [1]. Cautious radiographic examination and evaluation of the tooth is mandatory and Arora and Tewari [3] reported that the angled radiographs could offer the inclusive evidence of root canal morphology. Moreover, the regular radiographs may not reveal the comprehensive anatomic picture of the tooth including root as they are two-dimensional images of a three-dimensional structure [13]. The majority of the clinicians used an apical constriction as an endpoint for biomechanical preparation of the endodontic therapy. Clinically it is very difficult to establish or locate the apical constriction and

apical foramen; a few prior reported studies postulated that the radiographic apex is more dependable as an endpoint [12]. The radiographic apex is the tip of the root determined by radiographs however, the tip of the root identified morphologically is considered as anatomical apex [3, 5, 7]. Dissimilarities in the location of the radiographic apex in relation to the anatomic apex might be the result of various root morphology and radiographic distortion [14]. Prior studies have often established that the position of the apical foramen is not always located at the root apex or center of the apex. If the apical foramen is found away from the center it is considered as deviated and it could be distal, mesial, lingual/palatal, and labial/ buccal. The occurrence of deviation of the apical foramen ranges between 46% and 92% [6,15]. It has been described and it is assumed that the apical foramina is round, although studies showed that shape can vary from round to oval [17] or other shapes such as uneven, semilunar, and flat. It has been reported that it is very imperative to be aware of the occurrence of apical foramina in various ethnic groups and its anatomical variations. Numerous studies had reported diverse tendencies in the location and shapes of the apical foramina amongst the different ethnicities [2,4,8,25]. The prior reported studies focused on either maxillary teeth or mandibular teeth and anterior and posterior teeth. The distribution of shapes and location of apical foramina based on tooth type was not clearly discussed in the published literature. Therefore, the present study was aimed to analyze the morphology of shapes and locations of the apical foramen in permanent maxillary and mandibular human teeth based on arch, position and tooth type.

MATERIALS AND METHODS

Extracted human teeth were used in the present in-vitro study. The teeth with completely formed apices without any form of pathological defects were included in the study while teeth with pathological defects such as fracture, hypercementosis, root resorption (internal or external), without crowns and etc., teeth with single root of multi rooted teeth were excluded from the study. Thirty specimens of each tooth type (i.e., central incisors, lateral incisor, canine, 1st and 2nd premolars, 1st and 2nd molars) were involved in the study. All the specimens were cleaned manually from the build-up of calculus and remnants of periodontal tissues and were stored in containers filled with saline. The teeth were dried with cotton and compressed gauge, and the

apical areas were stained with graphite (Apsara Platinum Extra Dark Pencils) to facilitate the identification of the apical foramen of each root. The largest diameter with opening found at the root apex was denoted as the apical foramen. Containers with number code labeled individually were used to keep the teeth separate. The specimens were mounted on a glass slide (long axis of the teeth are parallel to the glass slab) to calculate anatomic parameters. A stereomicroscope was used to examine the apical foramina at 10X. The parameters of apical foramen evaluated were the shapes (rounded, oval, uneven, flat, and semilunar), location (center, buccal, lingual, mesial, and distal) of the apical foramen of each tooth used for analysis (Fig. 1 and 2). In maxillary first premolars and both maxillary and mandibular molars number of roots were considered for the analysis. It was considered as the deviation of apical foramina when a large portion of the major apical foramen ($\geq$ 50%) was not located at the center. The shape and location of apical foramen in maxillary and mandibular arch were evaluated. The distribution of apical foramina-based teeth position (anterior and posterior) also evaluated .The overall distribution of apical foramina of each tooth in the entire sample was considered for final analysis. Descriptive statistics done using SPSS (version 21.0, IBM, NY, USA), and $p < 0.05$ was considered statistically significant with 95% confidence interval.

RESULTS

In the present study the total number of apical foramen evaluated were 696 (mallixary - 377 and mandibular -319) of 420 teeth. The commonest shape found in all evaluated apical foramen was round shape (65.1%) followed by oval shape (31.0%) (Fig. 3). The round shape of apical foramen was more common in mandibular teeth (68.2%) than the maxillary teeth (62.3%). On the other hand oval shape was more common in maxillary teeth (32.4%) than mandibular teeth (29.6%). The flat shape of apical foramen was only reported in maxillary teeth. The commonest shape of apical foramen for mandibular central incisors was oval with 53.3%. The commonest shape was round in both anterior (57%) and posterior teeth (68%) (Table1). The round shaped apical foramen was slightly more in mandibular anterior teeth (29.9%) than the maxillary anterior teeth (27.2%) shown in Fig.4. Among the posterior teeth, maxillary posterior teeth reported more of round shaped apical foramen (36.1%) than the mandibular teeth (31.6%).

The commonest location of the apical foramen was center (31.6%) and the second commonest location of apical foramina distal (18.2%) (Fig.5). Apical foramen residing in the center was reported more in roots of maxillary teeth (33.2%) while it was 29.8% in roots mandibular teeth, this suggests higher deviation of apical foramen in mandibular teeth (70.2%) the results were statistically significant ($p<0.05$). The deviation of apical foramen was commonly reported in distal location in roots mandibular teeth (20.7%) while roots of maxillary teeth showed palatal deviation of apical foramen (19.1%) summarized in Table 2. Table 3 represents the percentage of commonest location of apical foramen as well the percentage of deviation among anterior and posterior teeth. In anterior teeth the deviation is more in maxillary arch with 86.4% while in posterior teeth it was more with mandibular arch with 87.5%. Over all common shapes was round in the roots of lateral incisors (4.7%), canine (6.6%), first premolar (8.5%), second premolar (8.9%), first molar (18.3%) and second molar (14.2%) while oval shape (4.7%) was common in central incisors roots that evaluated (Table 4).The frequent location of apical foramina in roots of anterior teeth was in the maxillary arch was palatal (13.6%) while center location (16.8%) of apical foramina was common in mandibular teeth followed by labial (16.3%). The frequent location of apical foramina in the roots of posterior teeth was in the maxillary arch was center (19.7%) followed by mesial and digital (9.4%), while center (12.5%) location followed by digital (11.3%) in mandibular teeth (Table 5).

DISCUSSION

Changes in the apex's shape and location are possible under specific influences on the tooth include occlusion, adjacent drifting tooth, and pressure exerted by the tongue [23]. These subsequent changes lead to the changes in the alveolar bone around the tooth. This might lead to resorption on the cemental wall of the apical foramen may be due to the exerted pressure is inevitable. Apparently, this results in the foramen's deviation that alters from the radiographic root apex [4]. Anatomy, of course, is the foundation of the art and science of healthcare. There is a need to have knowledge of the microscopic and topographic anatomy of the dental apex [12].

The anatomic parameter examined in the present study was the shape and location of the apical foramen. It was evident that the frequent location was center and the topical shape was

round. The shapes of apical foramina in the present study were classified as round (65.1%), oval (31%), uneven (2.7%), semilunar (0.6%), and flat (0.6%). Flat shaped apical foramen was evident only in maxillary second molars teeth and not existent in any mandibular tooth type. Semilunar shaped apical foramina were evident in maxillary second premolars and mandibular lateral incisor, and canine while uneven apical foramina was not evident in second molars of both maxillary and mandibular teeth. All the tooth types found to have commonly round shaped apex more and only in central incisors where oval shaped apical foramina are frequently evident. These findings from the present study were in agreement with Chinese study [20] and Brazilian study [18]. The Chinese study examined 1282 teeth photographed by the XTL-2 photstero microscope and found 94% of an apical foramen in the study sample with a round shape [20]. On the other hand the Brazilian study found 52.9% of apical foramen was with a round shape of 1331 root specimens were evaluated. In contrast, a few prior studies [3, 10] found that the oval-shaped apical foramina are very common. A German study [15] reported that 71% of an apical foramen in the maxillary molars showed an oval shape, while it was evident in 53% of the roots of the mandibular molar teeth. In the present study, only 29% of 696 the apical foramen was of oval shape while 17% for maxillary posteriors and 12% for mandibular molars. An Indian study [3] reported that the commonest shape of apical foramen to be an oval shape (81%) of 800 extracted maxillary and mandibular posterior teeth in a stereomicroscopic study. On the other hand, a Korean study [10] inspected 60 mandibular molars and found that the frequent shape of the apical foramen was an oval shape (69.9%). However, the results from these three studies were not compared with the present study because the present study analyzed all the teeth types. The Brazilian study [18] allocated their sample into incisors, canines, premolars, and molars groups, respectively, for the maxillary and mandibular arches. The authors found that the maxillary molars group showed the maximum number of apical foramina with a round shape (67.6%). In comparison, the maxillary premolars group showed the maximum number of apical foramen with an oval shape (33.7%). On the other hand, in the present study, we found that the mandibular canine group showed a maximum of apical foramen with a round shape (77.8%). In comparison, the maxillary incisors group showed a maximum of apical foramen with an oval shape (46.7%). The German study [15] separated the specimens into four groups include mandibular first molar, mandibular second molars, maxillary first molar, and maxillary second molars. These German authors [15] found the maxillary first molar group showed more number

of the oval-shaped apical foramen (74%), while the maximum round-shaped apical foramen was found in mandibular molars (44%).

The most common location of apical foramen was observed at the center (31.6%) of 696 roots (420 teeth) in the present study, followed by distal location (18.2%). These results are in agreement with previous studies performed on the apical foramina of human teeth [17,22]. Martos and co-workers [17] concluded that the commonest location of apical foramen was the center for all evaluated groups of specimens. The results were similar to the present study except for the maxillary canine and mandibular incisors group, which showed the commonest location as lingual and buccal, respectively. A South Indian study [9] reported that 84% of evaluated roots of maxillary central incisor, 75% of the maxillary lateral incisor, and 15% of maxillary canine showed apical foramen location to be in the center. The authors analyzed only 285 roots of maxillary anterior teeth. A Brazilian study [22] investigated 84 maxillary central incisors and found that 25% of specimens with the apical foramen location in the center. Teo and co-workers [24] found the apical foramens in 54.3% of the 635 maxillary central incisors were centered. An Iranian stereoscopic analysis of 100 maxillary central incisors found 17% of apical foramen location was in the center [21]. A Japanese study found that 16.7% of central incisors and cuspids and 6.7% of lateral incisors have a location of an apical foramen in the center of 90 maxillary anterior teeth [19]. In the present study, only 36.7% of maxillary central incisors, 33.3% of maxillary lateral incisors, and 10% of maxillary canines showed apical foramen in the center. Another Japanese study investigated 510 maxillary central incisors and found 55% of an apical foramen in the apex [11]. In the present study, only 36.7% of maxillary central incisors, 33.3% of maxillary lateral incisors, and 10% of maxillary canines showed apical foramen in the center. The deviation was almost 70% in anterior teeth and 67% in posterior teeth. Moreover, we have analyzed the shapes and locations for the entire sample to draw the percentage of each shape and location based on tooth type. These results are first of its kind hence not compared with any of the studies published earlier. A Croatian study [16] studied the apical foramen of all anterior teeth and found that 41% of central incisors, 40% of the lateral incisors, and 38.5% of canines showed apical foramen in the center of the apex. In the present study, 31.7% of central incisors, 33.3% of the lateral incisors, and 24.6% of canines showed apical foramen located in the center of the apex. The Iranian study [21] found that the roots of 137 maxillary second premolars found that in the maxillary second premolar. In the present study, 29% of maxillary

first premolars, 45% of maxillary second premolars, 32.5% of mandibular first premolars, and 22.8% of mandibular second premolars showed apical foramen with a central location. In the present study, 23.7% of permanent molars roots present the location of an apical foramen in the center while it was almost similar for the distal location, with 23.4%.

The clinical determination of the apical foramina is based on the clinicians' tactile sensitivity and the subjective understanding of the radiographs. The Instrumentation and obturation filling should not extend beyond the apical foramen considered as effective endodontic treatment. In some instances, the buccal position of apical foramina may result in over instrumentation. There is an association between the root apex and the apical foramen, which normally does not coincide. The apical foramina are very small in size, but the relatively significant anatomical variation of apical micromorphology cannot be evident in 2-dimensional imaging. There is a need to use supplementary methods like an operating microscope,electronic methods and 3-dimensional imaging.

CONCLUSIONS

Anatomical knowledge of apical foramina is very essential for the success of endodontic treatment. The commonest shape of the apical foramen is of a round shape, followed by the oval. The oval shape of the apical foramen is most frequent with central incisors. The common location of apical foramina was center in all teeth and the most frequent direction of deviation is the distal surface, followed by the mesial surface. The variation is more common in mandibular posterior teeth, while maxillary posteriors showed the least difference.

REFERENCES

1. Abarca J, Zaror C, Monardes H, Hermosilla V, Muñoz C, Cantin M. Morphology of the physiological apical foramen in maxillary and mandibular first molars. Int J Morphol. 2014; 32:671-677.
2. Al-Qudah AA, Awawdeh LA. Root canal morphology of mandibular incisors in a Jordanian population. Int Endod J. 2006; 39:873–7.
3. Arora S, Tewari S. The morphology of the apical foramen in posterior teeth in a North Indian population. Int Endod J. 2009; 42:930-939.

4. Asna M, Nouri M, Mozayyeni MA, Seradji F. Evaluation of apical foramen situation by anatomic apex and diagnostic value of radiography on determination of its location (A stereo microscopic study). J Dent Sch. 2004; 22:361-368.
5. Basrani B, Revah S, Robinson C. Ubicacion del foramen apical. Rev Asoc Odontol Argent. 1997; 85:230-232.
6. Cheung GSP, Yang J, Fan B. Morphometric study of the apical anatomy of C-shaped root canal systems in mandibular second molars. Int Endod J. 2007; 40:239-246
7. El-Ayouti A, Weiger R, Löst C. The ability of root ZX apex locator to reduce the frequency of overestimated radiographic working length. J Endod. 2002; 28:116-119.
8. Gulabivala K, Opasanon A, Ng YL, Alavi A. Root and canal morphology of Thai mandibular molars. Int Endod J. 2002; 35:56–62.
9. Jain P, Balasubramanian S, Sundaramurthy J, Natanasabapathy V. Position of apical foramina in permanent maxillary anterior teeth representative of an Indian population: An in vitro study. J Int Oral Health. 2017; 9:279-283.
10. Jeong H, Park S-j, Park S-H, Choi G-W. Morphology of the apical root canal system in Korean mandibular first molar. Restorative Dent and Endod. 2009; 34:137-144.
11. Kasahara E, Yasuda E, Yamamoto A, Anzai M. Root canal system of the maxillary central incisor. J Endod. 1990; 16:158-161.
12. Kuttler Y. Microscopic investigation of root apexes. J Am Dent Assoc. 1955; 50: 544–552.
13. Mallineni SK, Anthonappa RP, King NM (2016) Reliability of horizontal and vertical tube shift techniques in the localisation of supernumerary teeth. Eur Arch Paediatr Dent. 17:455-460.
14. Mallineni SK, Jayaraman J, Wong HM, King NM. Dental development in children with supernumerary teeth in the anterior region of maxilla. Clin Oral Investig. 2019; 23:2987-2994
15. Marroquín BB, El-Sayed MA, Willershausen-Zönnchen B. Morphology of the physiological foramen: Maxillary and mandibular molars. J Endod. 2004; 30:321-328.
16. Martic D, Prpić-Mehicić G, Simeon P, Pevalek J. Morphometrical analysis of main and accessory canals in apical root portion of frontal teeth. Coll Antropol. 1998; 22:153-159.
17. Martos J, Ferrer-Luque CM, Gonzalez-Rodriguez MP, Castro LA. Topographical evaluation of the major apical foramen in permanent human teeth. Int Endod J. 2009; 42:329–334.
18. Martos J, Lubian C, Silveira LF, Castro LA, Ferrer-Luque CM. Morphologic analysis of the root apex in human teeth. J Endod. 2010; 36:664-667
19. Mizutani T, Ohno N, Nakamura H. Anatomic study of the root apex in the maxillary anterior teeth. J Endod. 1992; 18:344–347.
20. Pi X, Li C, Chen Z. The micro-anatomy and clinical significance of the apical foramen in 1,282 permanent teeth. Zhonghua Kou Qiang Yi Xue Za Zhi. 1996; 31:294-295.
21. Rahimi S, Shahi S, Yavari HR, Reyhani MF, Ebrahimi ME, Rajabi E (2009) A stereomicroscopy study of root apices of human maxillary central incisors and mandibular second premolars in an Iranian population. J Oral Sci. 2009; 51:411-415
22. Souza RA, Figueiredo JAP, Colombo S, Dantas JCP, Lago M, Pécora JD. Location of the apical foramen and its relationship with foraminal file size. Dental Press Endod. 2011; 1:64-68.
23. Teng F, Du FY, Chen HZ, Jiang RP, Xu TM. Three-dimensional analysis of the physiologic drift of adjacent teeth following maxillary first premolar extractions. Sci Rep. 2019 Oct 10;9(1):14549. doi: 10.1038/s41598-019-51057-4.
24. Teo CS, Chan NC, Loh HS. The position of the apical foramen of the permanent incisors. Aus Dent J. 1988; 33:51-55
25. Wasti F, Shearer AC, Wilson NH. Root canal systems of the mandibular and maxillary first permanent molar teeth of south Asian Pakistanis. Int End J. 2001; 34: 263-266.

Table 1. Distribution of shapes of apical foramina (%) in anterior and posterior teeth in both the arches

Shapes	Anterior		Posterior	
	Maxillary	Mandibular	Maxillary	Mandibular
Round	27.2	29.9	36.1	31.8
Oval	18.5	17.9	17.2	11.9
Semilunar	0	1.6	0.2	0
Flat	0	0	0.8	0
Uneven	3.3	1.6	1.8	0.2
Total	49	51	56.1	43.9

Table 2. Distribution of location of apical foramina (%) in anterior and posterior teeth in both the arches

Location	Anterior		Posterior	
	Maxillary	Mandibular	Maxillary	Mandibular
Distal	7.1	4.3	9.4	11.3
Mesial	9.2	6.0	9.4	8.8
Buccal/labial	6.0	16.3	8.4	6.7
Palatal/lingual	13.6	7.6	9.2	4.6
Center	13.1	16.8	19.7	12.5
Total	49	51	56.1	43.9

Table 3. Distribution of deviation of apical foramina location (%) in anterior and posterior teeth in both the arches

Arch	Anterior		Posterior		p-value
	Center	Deviation	Center	Deviation	
Maxillary	3.6	86.4	19.5	80.5	P < 0.05
Mandibular	16.8	83.2	12.5	87.5	

Table 4. Distribution of shape of the apical foramina (%) in total sample

Shape	Central Incisor	Lateral Incisor	Canine	First premolar	Second Premolar	First Molar	Second molar	Total
Round	3.7	4.7	6.6	8.5	8.9	18.3	14.2	65.1
Oval	4.7	3.3	1.6	2.4	3.1	10.1	5.7	31
Semilunar	0	0.3	0.2	0	0.2	0	0	0.6
Flat	0	0	0	0	0	0	0.6	0.6
Uneven	0.2	0.7	0.4	0.3	1	0.2	0	2.7
Total	8.6	9.1	8.8	11.2	13.2	28.6	20.5	696 (100)

Table 5. Distribution of location of the apical foramina (%) in total sample

Location	Tooth type	Central Incisor	Lateral Incisor	Canine	First premolar	Second Premolar	First Molar	Second molar	Total
Distal		1	1	1	2.4	1.3	7.2	4.3	18.2
Mesial		0.7	1	2.3	2.6	2	5.3	3.4	17.4
Buccal/labial		2.2	2	1.7	1.7	2.7	3	3.6	17
Lingual/palatal		2	2	1.6	1	2.3	4.6	2.3	15.8
Center		2.7	3	2.2	3.4	4.9	8.5	6.9	31.6
Total		8.6	9.1	8.8	11.2	13.2	28.6	20.5	696(100)

Figure 1. Shapes of apical foramina (A) round, (B) oval (C) semilunar, (D) flat, and (E) uneven in the study.

Figure 2. Deviations of the apical foramen (A) lingually, (B) buccally (C) mesially, and (D) distally.

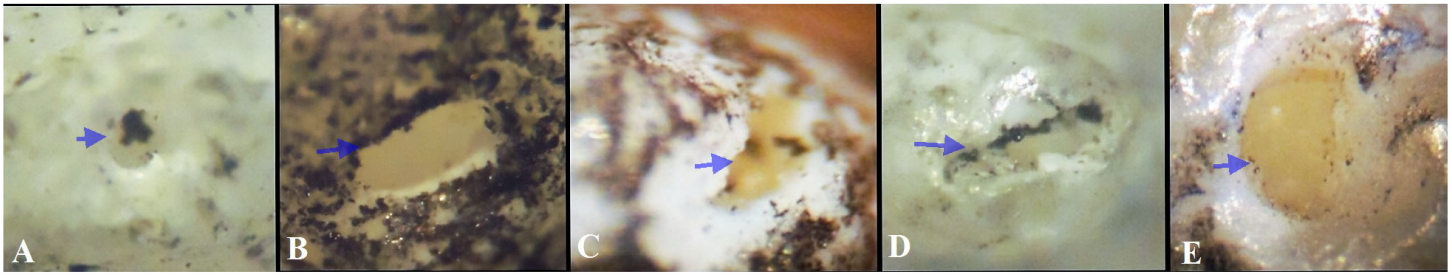
Figure 3. Distribution of shapes based on tooth type.

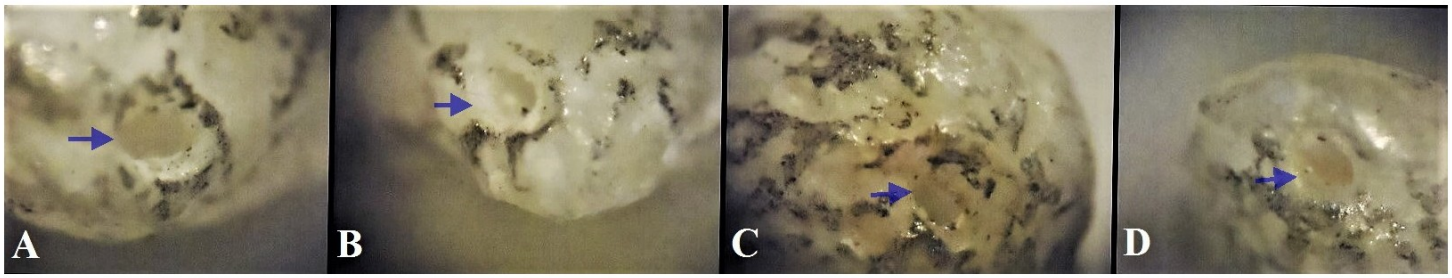
Figure 4. Distribution of shape of apical foramina in roots of maxillary and mandibular teeth.

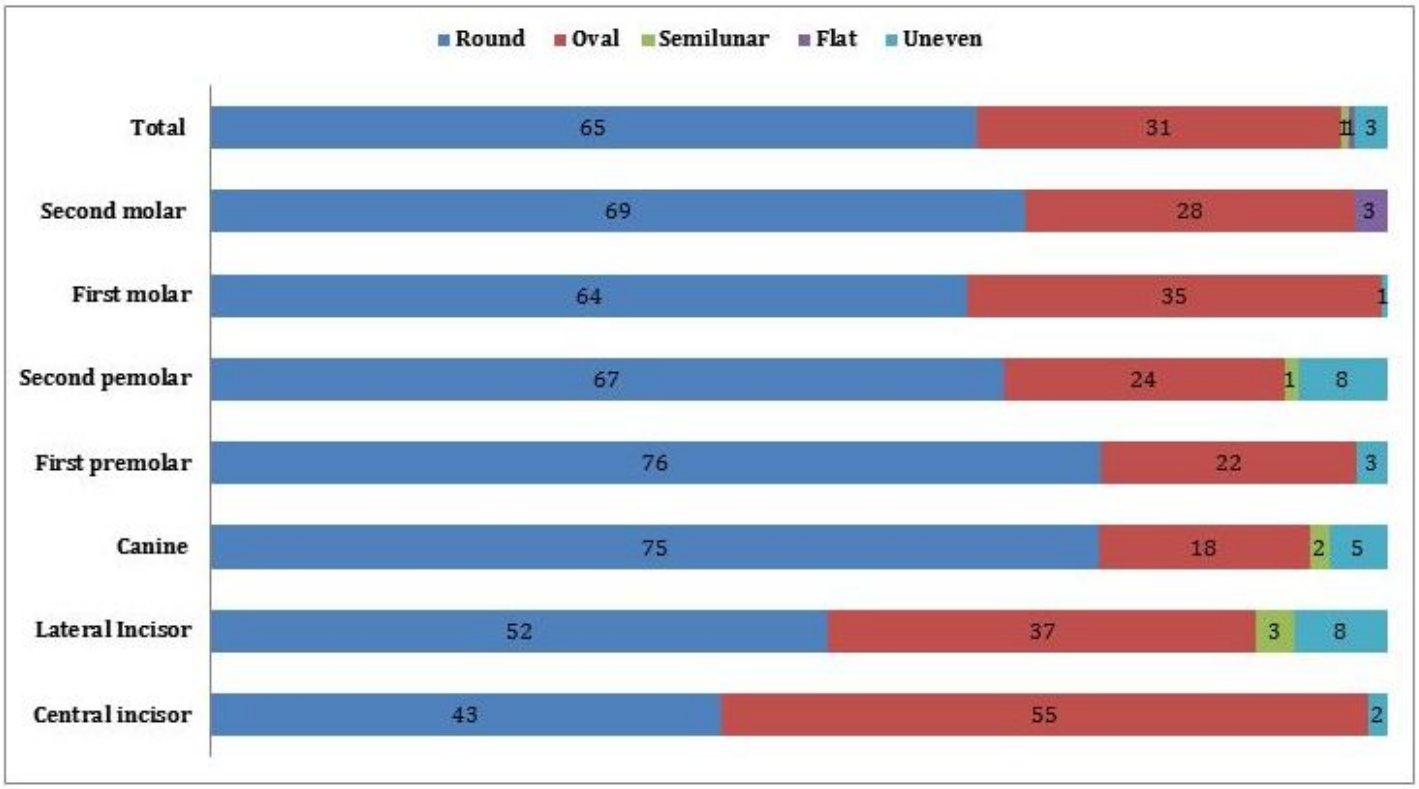
Figure 5. Distribution of location of apical foramina based tooth type.

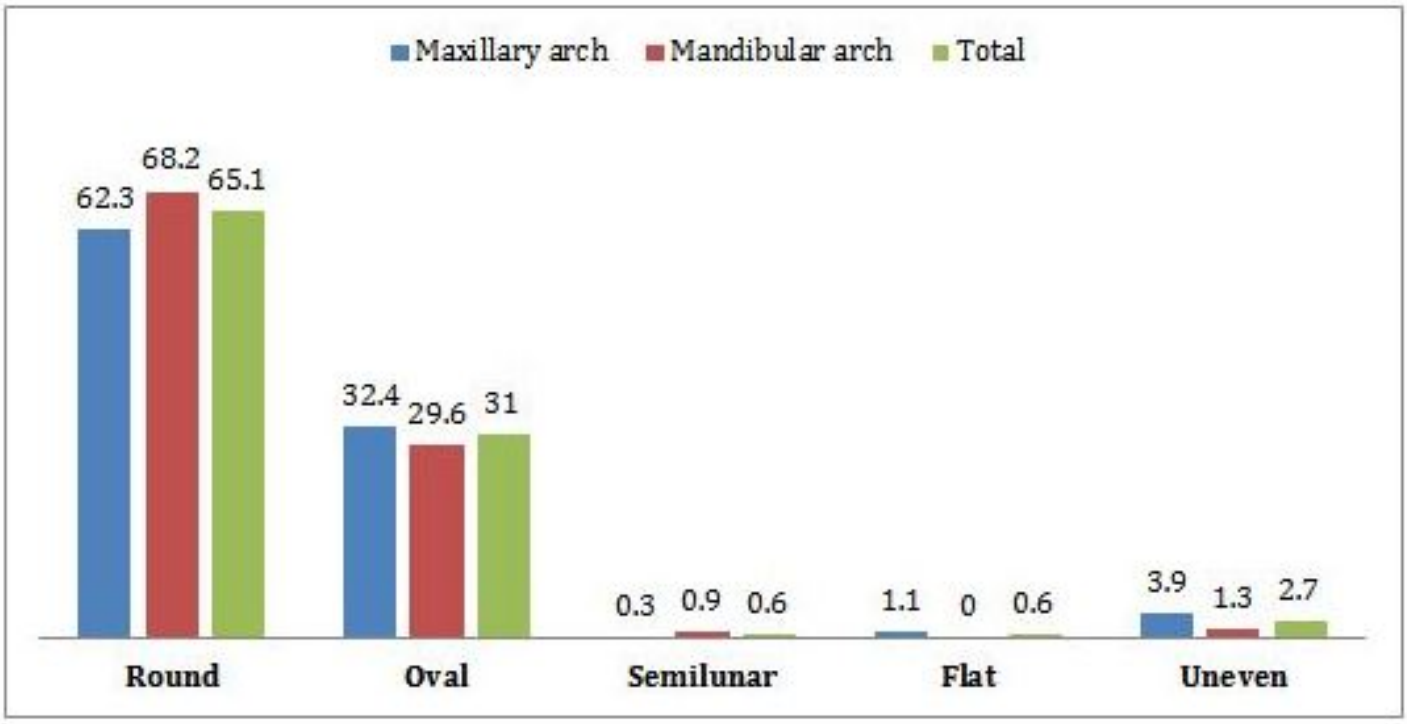
Figure 6. Distribution of location of apical foramina in roots of maxillary and mandibular teeth.

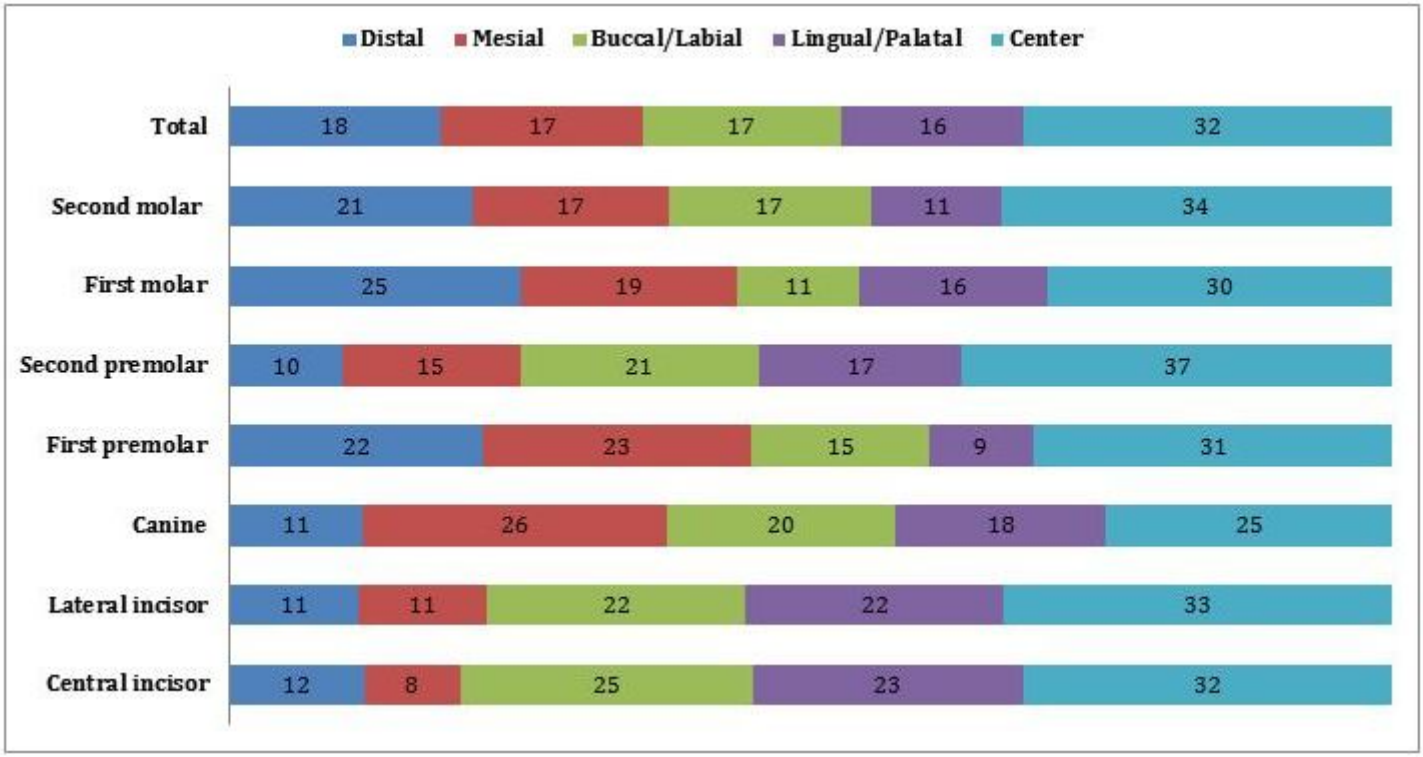
Figure 7. Distribution of deviation of apical foramina in roots based on the arch.

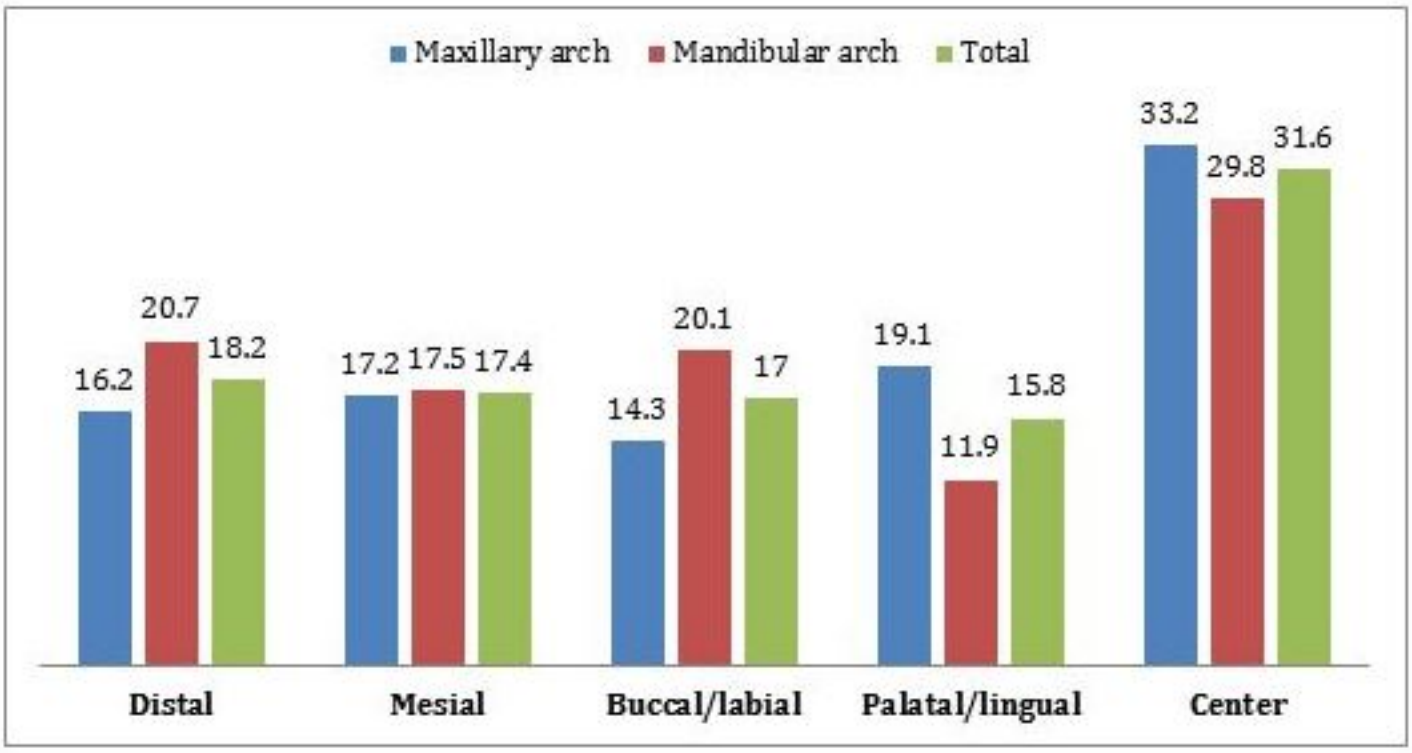

A
B
C
D
E

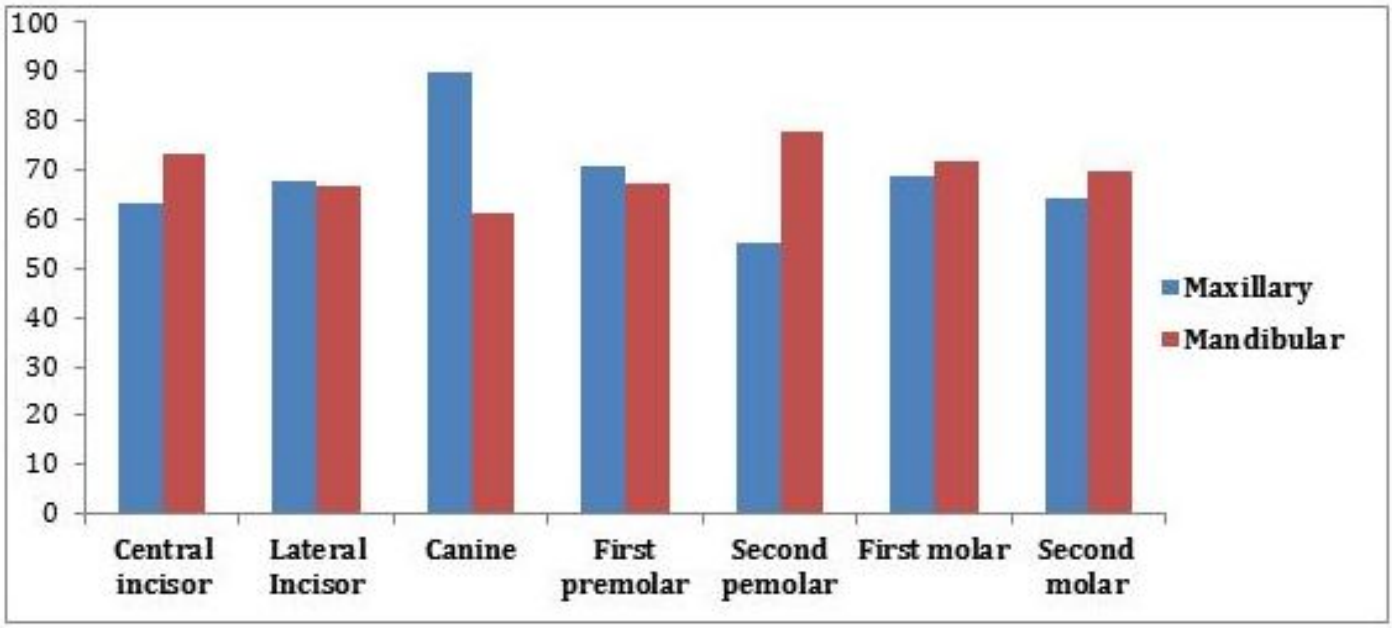

A
B
C
D


Round
Oval
Semilunar
Flat
Uneven
Total
65
31
1
1
3
Second molar
69
28
3
First molar
64
35
1
Second pemolar
67
24
1
8
First premolar
76
22
3
Canine
75
18
2
5
Lateral Incisor
52
37
3
8
Central incisor
43
55
2


Maxillary arch
Mandibular arch
Total
62.3
68.2
65.1
32.4
29.6
31
0.3
0.9
0.6
1.1
0
0.6
3.9
1.3
2.7
Round
Oval
Semilunar
Flat
Uneven


Distal
Mesial
Buccal/Labial
Lingual/Palatal
Center
Total
18
17
17
16
32
Second molar
21
17
17
11
34
First molar
25
19
11
16
30
Second premolar
10
15
21
17
37
First premolar
22
23
15
9
31
Canine
11
26
20
18
25
Lateral incisor
11
11
22
22
33
Central incisor
12
8
25
23
32


Maxillary arch
Mandibular arch
Total
16.2
20.7
18.2
17.2
17.5
17.4
14.3
20.1
17
19.1
11.9
15.8
33.2
29.8
31.6
Distal
Mesial
Buccal/labial
Palatal/lingual
Center


100
90
80
70
60
50
40
30
20
10
0
Central incisor
Lateral Incisor
Canine
First premolar
Second pemolar
First molar
Second molar
Maxillary
Mandibular