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RESEARCH ARTICLE

THE MORPHOLOGY OF THE APICAL FORAMEN IN MANDIBULAR FIRST MOLAR TEETH IN A KASHMIRI POPULATION.

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Abstract

Many of the problems encountered during root canal treatment occur because of an inadequate knowledge of the root canalmorphology. It is also essential to understand the aberrations which are likely to occur in canal form. Root canal morphology especially in the apical third is a critically important factor during conventional root canal treatment and surgical endodontics. Straight root canal extending the entire length of the root ending in an apical foramen is an exception. Wide variations in the dimensions of the apical constriction have been reported. The physiological foramen or apical constriction is considered the terminus of the root canal preparation .Thus, knowledge of the morphological dimensions of this area would be advantageous in determining the final shaping diameter in this area. The aim of this study was to investigate the distance between the physiological and anatomical apex, accessory foramina frequency, and the diameter of the physiological foramen in mandibular molars in Kashmiri population.

Introduction

The clinician performing endodontics must know the size and location of the pulp chamber as well as the expected number of roots and canals. Careful evaluation of two or moreperiapical radiographs is mandatory. These angledradiographs provide much needed information aboutroot canal morphology. Radiographs, however, may not always determine thecorrect morphology particularly when only a buccolingualview is taken.[1]when considering the anatomy of all human teeth, the incidence of the number of rootsand the number of canals varies greatlyin the literature. The root and root canal morphology of teeth are highly variable and can beextremely complex. Numerous factors contribute to variations found in the root and root canal studies reported.[2] These factors include ethnicity, age ,sex unintentional bias in selection of clinical examples of teeth (specialty endodonticpractice versus general dental practice) and study design (in vitro versus in vivo).[3,4,5] Typically, the root canal narrows toward the apex into the apical constriction or physiological foramenand expands to form the physiological foramen.[6]The morphology of apical root varies tremendously. The clinician must be familiar with the various pathways root canals take to apex. The pulp canalsystem is complex and canals may branch, divide andrejoin.

Weine categorized the root canal systems inany root into four basic types.[7]Vertucci et al. utilizing cleared teeth which had their pulp cavitiesstained with haematoxylin dye found a muchmore complex canal system and identified eight pulpspace configurations.[8]The apical root anatomy can be described as apical constriction(AC),

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cementodentinal junction(CDJ),and apical foramen (AF). Theanatomic apex was defined as the most apical root structure The physiological (apical constriction) and anatomical foraminawere determined to be the most inner and outer diametersat the apical terminus of the root canal, respectively. Apical constriction is narrowest part whereas apical foramen is a funnel or crater like structure that differentiates root canal from external root surface.[6, 9] Thus, knowledge of the morphologicaldimensions of this area would be advantageous in determiningthe final shaping diameter in this area. The most common tooth needing endodontic therapy is mandibular first molar.The normal anatomy of the roots and morphology of the root canal system of themandibular first molar tooth are well documented in current and past textbooks.it has typically two mesial canals in a mesial root and one distal canal in distal root.[1, 5, 9]However there are significant differences in number of roots as well as canals in its both roots.

Various studies in different populations and case reports highlight these anomalies.[10,11,12] These anatomical variations should be consideredduring surgical or nonsurgical endodontic procedures ofthe permanent first molars.so keeping in view the results of these conflicting findings regarding the apicalzone and no reports on teeth of Kashmiri population, thepurpose of this in vitro study was to determine the distance between the physiological and anatomical apex, accessory foramina frequency, and the diameter of the physiological foramen in mandibular molars in Kashmiri population.

Materials and Methods:-

A total of 60 freshly extracted human permanentmaxillary and mandibular posterior teeth, with completelyformed apices, obtained from a Kashmiri population were included. Teeth were collectedfrom Department of Oral and Maxillofacial Surgery of Government Dental College and Hospital Srinagar, attended by localpopulation. Ethnicity of the population was furtherverified from the outpatient records. Teeth wereextracted because of periodontal or pulpal disease. Primary teeth and roots withfractures, resorption, or that had received any previous endodontictreatment were discarded.Following extraction teeth were washed under tapwater, and stored in 5% sodium hypochlorite for 24 hours to disinfect their surfaces and remove the remaining organic tissue. All teeth were kept in 0.5% sodium azide solution at 4°C until use. The rootswere then placed in methylene blue (Macsen Laboratories,.India), washed under running water for 10 min, and dried with pressurizedair before examination. In those cases where residual soft tissue remained around and in the area of the apical foramen, it was removed with a K #6 file (DentsplyMaillefer, Ballaigues, Switzerland), working towards the anatomical apical foramen. A computer-aided stereomicroscope with 40X magnification was used in thisstudy (Olympus Optical and Ltd, Japan) for taking images of apical area. An image of eachspecimen (JPEG) was captured, and the data obtained wererecorded for further statistical evaluation. Those images were analyzed with Image J V1.46r software (National Institutes of Health, Bethesda, MD). The root morphology of the apical area wasexamined at 40X magnification. Each root was directly illuminatedand oriented until the physiological foramen was locatedin the middle of and parallel to the objective lens. The mesialand the distal roots ofmandibular molars were examined to detect two main physiologicalforamina. The tooth number and type, root type, physiologicalforamen location and shape, and accessory foramina frequency were recorded. The distance between the physiological foramen and anatomicalapex and the diameter of the physiologicalforamen were measured with the software length measuringmode. The widest and narrowest diameters of each minorapical foramen were measured using the length measuringmode of the software and defined as themaximum and the minimum diameters, respectively. If a root had more than oneapical foramen, then each foramen was focused separatelyparallel to objective lens by changing theorientation of tooth and individual photographs werecaptured. The statistical data were arranged inmean, maximum, minimum, and SD.

Results:-

The average of the minimum and maximum diameters of the physiological foramen of the mandibular molars 0.25 and 0.33 mm.Table 1 shows Number of physiological foramen and accessory foramen frequency in mesial and distal roots ofmandibular first molars.

Table 1:-Number of physiological foramen and accessory foramina (%, n)

Foramen	%	(n)
1(M)	38.33	(23)
2(MB, ML)	61.67	(37)
1(D)	71.66	(43)
2(DB, DL)	28.34	(17)

(M : single mesial, MB : mesiobuccal, ML : mesiolingual D : single distal, DB : distobuccal, DL : distolingual)

Table 2:- Frequency of accessory foramen (%, n)

	M	MB	ML	D	DB	DL
0	73.93(17)	97.30(36)	97.30(36)	93.03(40)	94.12(16)	94.12(16)
1	21.73(5)	2.70(1)	2.70(1)	2.32 (1)	5.88(1)	5.88(1)

(M : single mesial, MB : mesiobuccal, ML : mesiolingual D : single distal, DB : distobuccal, DL : distolingual)

Table 3:-Narrow and wide diameters of the mesial physiological foramina (mm)

	M	M	MB	MB	ML	ML
Foramen	N	W	N	W	N	W
Mean	0.229(±0.061)	.329(±0.098	0.211(±0.082)	0.266(±0.097)	0.192(±0.065)	0.246(±0.088)
Max	0.388	0.648	0.431	0.487	0.362	0.460
Min	0.113	0.188	0.102	0.116	0.112	0.120

(M : single mesial, MB : mesiobuccal, ML : mesiolingual , N : narrow diameter, W : wide diameter)

Table 4:-Narrow and wide diameters of the distal physiological foramina (mm)

	D	D	DB	DB	DL	DL
Foramen	N	W	N	W	N	W
Mean	0.288(±0.073)	0.375(±0.082)	0.235(±0.090)	0.291(±0.093)	0.186(±0.072)	0.237(±0.085)
Max	0.496	0.569	0.474	0.495	0.344	0.460
Min	0.149	0.207	0.111	0.146	0.119	0.156

(D: single distal, DB :distobuccal, DL : distolingualN : narrow diameter, W : wide diameter)

Table 5:-Shape of the mesial and distal physiological foramina (%, n)

M MB ML D DB DL
*Round*13.04(3)29.71(11)32.43(12) 13.95(6)29.41(5) 47.05(8)
*Oval*76.95(18)62.14(23)62.16(23)86.14(37) 70.58(12) 47.05(8)
*Irregular*l10(2)8.1(3) 5.4(2) 4.05(2) 3.01(3) 5.90(1)

The most common foramina morphology in the root apices of the maxillary first molars was oval (50%), followed by irregular (32%) and round (18%).In the present study, the mean distance between the physiologicalforamen and the anatomical apex was 0.86 for mandibular first molar. These results are higher and in agreement with the results reported by otherauthors.

Table 6:-Distance between the mesial and distal physiological foramina and anatomical root (mm)

	M	MB	ML
Mean	0.77	0.75	0.86
SD	0.28	0.27	0.42
Maximum	1.32	1.59	2.66
Minimum	0.33	0.24	0.12

	D	DB	DL
Mean	1.00	0.84	0.97
SD	0.38	0.34	0.45
Maximum	2.44	2.04	2.55
Minimum	0.08	0.34	0.30

Discussion

In clinical practice, the physiological foramen is the most consistent anatomical characteristic and the point of reference as the apical endpoint in root canal treatment. The measurements obtained for the physiological foramina may be significant for clinical applications, such as the determination of endodontic instruments best suited to cleaning and shaping each root canal according to the average diameters.[13]The presence of two anatomical foramina in the mesial (87%) and distal (40%) roots of mandibular molars was higher than ones reported by other authors. [14]

With respect to the diameter of the physiological foramina, we obtained an average measurement of the minimum and maximum diameters of the foramen 0.64 and 0.10 mm in mesial roots and 0.56 and 0.11 in distal roots of the mandibular molars.Frequency of accessory foramina is also higher in distal roots of these teeth. Our findings regarding the mean diameter of the physiological foramen are lower than and to a great extent in agreement with those reported by other investigations, such as Morfis et al. and are in contrast to Arora and Tewari.Morfis et al. studied the apices of 213permanent teeth with the use of a scanning electron determined that 50 % mesial roots of mandibular molars shows multiple AF.[15,16]

Mean distance between the physiological foramina and anatomical apex in mesial roots is 0.77 and 1mm in distal roots. This has important clinical implication during working length determination by radiographic method and should be taken into consideration while treating a Kashmiri patient. If these roots are having multiple canals and foraminathis distance tends to decrease. Similarly in studies by Kuttler and others this distance was reported to be in the range of 0.5-1 mm. This difference may be attributed to the different understudy teeth, age, sex and race of patients, sample origin or study design and methodology. In the present study, a straight line parallel to the root axisfrom the most apical point of the anatomical foramen to a tangentline at the most apical point of the anatomical apex was used to determine the distance between the physiological foramen and theanatomical apex.The unpredictablenature of the position of the apical constrictionwith respect to the radiographic apex further strengthensthe need of using apex locators rather than relying on radiographs for canal length determination.[17]The presence of a greater frequency of oval shapes in the physiological foramina has a direct impact on the endodontic clinic. Generally, penetration by the instruments is limited to the physiological foramen, and these instruments have a shape (round, quadrangular, triangular, etc.) that will ultimately produce a round preparation, which would be adapted to the foramen ;however, this instrument will not be adapted adequately to the constrictions it possesses and the gaps left by the oval ,elliptical or irregular shape.[18]

Conclusion

The incidence of oval canals was higher in this Kashmiri population(70-86%) of mandibular molars.In our study, in mandibular first molar the distance from apical foramen to the anatomic apex was always less than 1mm in distal and 0.77mm in mesial roots.Anatomical variations observed in mandibular molar roots in our study emphasize the importance of studying apical morphology and their anatomic variations in different ethnic populations.

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