Dimensional analysis of furcal entrances in extracted permanent maxillary molars

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Abstract

Aim: To assess the furcation entrance dimension (FED) in extracted maxillary 1st, 2nd and 3rd molars and to correlate the findings to periodontal instrumentation.

Methodology: 103 teeth were included in the study and tooth type was determined. The sample consisted of 43 first, 34 second and 22 third maxillary third molars. Teeth were placed on a 1mm graph and photographs were taken on the buccal, mesial and distal aspects. Dimensional analysis was performed using Adobe Photoshop wherein various diameter circles were placed to scale with the most coronal aspect of the buccal, medical and distal furcations. The circles were placed such that they fit along the mesiodistal dimension on the inner aspect of the furcations.

Result: Buccal furcations (0.76mm) were found to be narrower followed by distal (0.95mm) and mesial (0.96mm) furcations of maxillary molars. Mention the mean values in MM for each furcation. Also mention the average blade widths of specific Periodontal instruments besides curettes. in relation to the instruments, average blade width of the curretes 7-8 (0.75mm), 9-10 (0.75mm), 11-12 (1mm), 13-14 (0.75mm), 2R/2L (1mm), 4R/4L (1mm), piezoelectric ultrasonic scaler tip (0.5mm). 49% of 1st, 65% of 2nd and 73% of 3rd maxillary molars had furcation entrance dimension less than 0.75mm.

Conclusion: Maxillary molars furcation entrances are not only difficult to access but are also ineffectively debrided with standard periodontal instruments much as piezoelectric ultrasonic tips and area-specific curettes. Furcations that are narrower than 0.75mm therefore require instruments that can access and diagnose furcation involvements. In addition, improvements and standardization of piezoelectric ultrasonic tips, periodontal curettes pertaining as well as rotary instruments should be considered to adequately eliminate local factors within narrow furcations.

Keywords: Maxillary molars, furcation entrance dimension, root surface debridement, periodontal curettes

Introduction

The limited access and complex anatomy of furcation areas of maxillary molars is responsible for the retention of plaque, calculus and colonization of microbes which rapidly progresses to destructive periodontal disease leading to marginal alveolar bone resorption and attachment loss.[1,2] With the progression of bone loss apically, the furcation areas of multi-rooted teeth gets involved and worsens the prognosis of the tooth.[3,4]. The morphology of maxillary molars is extremely complex and the clinician

must have a thorough knowledge to improve the success rate of periodontal therapy.[5] Effective instrumentation is difficult to achieve in case of deep pockets and root concavities as they restrict the access of periodontal instruments, leading to incomplete removal of plaque and calculus.[6-8]Sufficient plaque and calculus removal is the primary objective of root surface instrumentation to allow adequate healing at the soft tissue and root interface.[9-11] The root morphology of molars influences the diagnosis, prognosis and treatment of periodontal disease.[4,12] Variations in anatomy of tooth like extra roots are common in molars.[13] Characteristic morphological features such as cervical enamel projections(CEPs), enamel spurs projecting into the furcation from the CEJ and enamel pearls on the root trunk are often seen in molars. The furrows and depressions created by these characteristic features can serve as pathways for bacterial invasion and colonisation which can lead to local periodontitis. Other sequelae can be pulpal involvement because periodontal tissues and pulp are closely related because of their ectomesenchymal origin [14]. Cross-infection between the periodontal ligament and the pulp can occur via the lateral and accessory canals, apical foramen, dentinal tubules, cementum inherent canals, palato-gingival grooves and non-physiological pathways like vertical root fractures and iatrogenic root canal perforations. [15, 16]

Many studies have reported that significant loss of maxillary molars is due to periodontal infection.[8, 17-18] The furcation entrance dimension measurement is very important in predicting the success of periodontal therapy.[19] Clinically, naber's probe is used in measuring the depth of furcation. Level of insertion of the probe into the furcation determines the degree of furcation involvement.[20] Scaling and root planing are considered as the gold standard treatment of choice for periodontitis [21].Hand Curettes are the most often used manual instruments in periodontal therapy to produce a smooth surface free of plaque to permit adequate healing [22]. Periodontal curettes must facilitate access to deep pockets and enable a better adaptation to the radicular areas which has a irregular surface [23]. Complete root debridement during supportive periodontal treatment is achieved by using a series of close, overlapping strokes with the intrument to deplaque entire root surface and also to produce a stable state during active treatment by promoting subgingival microbes that is compatible with periodontal health [24]. The blades of these periodontal instruments should be of adequate width to access and debride narrow furcations but may not necessarily be so compromising the longevity of such teeth.[25,26] Also, the instruments are designed based on the values obtained from Caucasian population but the number of roots and its morphology in Indian maxillary molars were different from both Caucasian and Mongoloid traits [27]. Therefore, the aim of this study was to measure the furcation entrance dimensions in maxillary molars and to associate these findings with the blade widths of the periodontal instruments which are commonly used for root debridement.

Methodology

Sample selection

112 extracted permanent maxillary molars were collected from Saveetha Dental College and Hospitals, Chennai. Extracted teeth were washed in tap water and then immersed in 6% hydrogen peroxide to remove the deposits on the tooth surface and disinfect it. Teeth with wasting diseases, caries, deformed and/or fractured roots, or restored furcations were excluded. 103 teeth were included in the study and the tooth type was determined. The sample consisted of 43 first, 34 second and 22 third maxillary third molars. Gentle ultrasonic scaler set at the lowest power was used to remove further hard and soft deposits present on the teeth. Teeth were numbered for identification.

Image Analysis:

Teeth were placed on a 1mm graph to standardize all the pictures. Pictures were taken on buccal, mesial and distal aspects using a DSLR Camera. Furcation entrance dimensions were measured with Adobe Photoshop. The System generated circles of various dimensions which can be used to fit the furcations of various dimensions. The size of the circle was standardised in each image by comparing it with the 1mm grid present in the background of the tooth. Standardised circles of diameter 0.25, 0.5, 0.75, 1, 1.25, 1.50, 1.75, 2mm were generated. Progressively larger circles were adapted to the entrance of the furcation of molars. The largest circle that fit into the space between the roots in the most coronal curvature of furcation and the adjacent surfaces was selected. In case of any space superior to the area where the circle was fit, then it is considered to be large and the next smaller diameter was considered as the furcation entrance dimension. This was done to calculate the buccal, mesial and distal furcation dimensions. The Average value was obtained for all the furcations in maxillary 1st, 2nd and 3rd molars.





Measurement of instruments

Similarly, new, unused periodontal Currettes 7-8, 9-10, 11-12, 13-14, 2R/2L, 4R/4L, piezoelectric ultrasonic scaler tip and Naber's probe which were commonly used in the furcation periodontal therapy were included. These instruments were placed on 1mm graph sheet to obtain the mesiodistal length of the working ends. Photographs of both the ends were taken using a DSLR camera and transferred for analysis usingAdobe Photoshop. The software generated circles of dimensions 0.25, 0.5, 0.75, 1, 1.25mm. The largest circle that fit the tip of the working end was selected which indicated the blade width of the instruments and the mean value was calculated.



Results

The mean value of the furcation entrance dimension for all the maxillary 1^{st} , 2^{nd} and 3^{rd} molars were calculated and shown in table 1

Table 1: Mean Furcatio	n FED of maxillary molar
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Teeth	Buccal (mm)	Mesial(mm)	Distal(mm)
1 st molar	0.89	1.2	1.16
2 nd molar	0.72	0.85	0.76
3 rd molar	0.69	0.83	0.93

All the maxillary 1st, 2nd and 3rd molars were divided into 4 groups based on the FED and number of molars in each category was calculated according to the site and shown in tables 2, 3 and 4.

Table 2: Distribution of maxillary 1st molars according to the site based on furcation entrance dimensions

FED(mm)	Buccal	Mesial	Distal
<0.25	2	2	1
0.25 - 0.5	10	3	7
0.5 - 0.75	11	6	9
>1	20	31	27

Table 3: Distribution of maxillary 2nd molars according to the site based on furcation entrance dimensions

FED(mm)	Buccal	Mesial	Distal
0.25	5	6	4
0.25-0.5	10	6	10
0.5-0.75	8	7	8
>1	8	16	10

Table 4: Distribution of maxillary 3rd molars according to the site based on furcation entrance dimensions

FED(mm)	Buccal	Mesial	Distal
0.25	2	7	8
0.25-0.5	11	5	5
0.5-0.75	4	4	2
>1	5	6	6

Buccal furcations were found to have the narrowest furcation entrance with 53% of 1st, 74% of 2nd and 77% of 3rd maxillary molars having an entrance dimension less than 0.75mm. Mesial furcations were found to be widest furcation entrance dimension with 73% of 1st, 45% of 2nd and 27% of 3rd maxillary molars having an entrance dimension greater than 0.75mm. Distal furcations were found to have 38% of 1st, 68% of 2nd and 71% of 3rd maxillary molars having an entrance dimension less than 0.75mm.

The summary of mean blade widths for all the curettes 7-8, 9-10, 11-12, 13-14, 2R/2L, 4R/4L, piezoelectric ultrasonic scaler tip, Naber's probe were calculated and shown in table 5.

Table 5: Average tip diameter for all the instruments

Instrument	Average tip diameter(mm)
7-8	0.75
9-10	0.75
11-12	1
13-14	0.75

2R/2L	1
4R/4L	1
Ultrasonic scaler tip	0.5
Naber'sproble	4

Discussion

In this study, 2% of the teeth were completely fused. All the completely fused teeth were 3rd molars. Santos et al. stated that buccal furcations of upper molars showed the narrowest dimension [26]. Bower reported that buccal furcation dimension were narrower in dimension when compared to either the mesial or distal furcation [12] while Chiu et al. reported that mesial furcations had the widest dimensions. [25] This was supported by Hou and co-workers who found that mesial furcations were the widest followed by distal and buccal. [6] In this study, the buccal furcation was found to be the narrowest which was followed by distal and mesial furcations of maxillary molars which is in concordance with the above mentioned studies. [6,12,25,26] The variations in the furcation entrance dimension in this study can be due to differences in the methodology or genetic differences in the study population. In this study, the average blade width of the curettes 7-8 (0.75mm), 9-10 (0.75mm), 11-12 (1mm), 13-14 (0.75mm), 2R/2L (1mm), 4R/4L (1mm), piezoelectric ultrasonic scaler tip (0.5mm). In general the mean value of the blade width instruments was 0.80mm which is similar to Bower's study that reported a blade width of 0.75 mm to 1.10mm.[12] Chiu and coworkers measured different types of periodontal curettes and ultrasonic scaler tips which varied from 0.76 mm to 1.0 mm for curettes and 0.61 mm for ultrasonic scaler tips[25] while Santos et al. found that the anterior third blade width of the curettes were greater than 0.60 mm.[26] Overall when all the sites of furcation was considered, 49% of 1st, 65% of 2nd and 73% of 3rd maxillary molars had furcation entrance dimension less than 0.75mm. These findings indicated that the high percentage of 2nd and 3rd molars are at a very high risk for continued periodontal breakdown due to the difficulty in gaining access to most of the furcations with root planing hand instruments. Clinical studies based on the retention of teeth with furcation involvement shows that root surface instrumentation done to produce a biologically acceptable root surface is more essential than producing a root surface completely calculus free [28, 29]. Furthermore, there is a higher frequency of narrow furcation entrance in maxillary molars when compared to the blade width of curettes used. Therefore, to achieve root surfaces which are biologically acceptable within the furcation areas, hand instruments with a narrower blade width and ultrasonic scaling using a narrow diameter tips would be more appropriate.

Conclusion

Maxillary molars furcation entrances can be a challenge as they cannot be effectively debrided with the standard periodontal instruments such as curettes. Hence, narrow furcation can be best instrumented by periodontal curettes with narrower blade width, ultrasonic scaling or considering the use of other instruments such as rotating instruments and periodontal files.

References:

[1] Heitz-Mayfield LJ. How effective is surgical therapy compared with nonsurgical debridement? *Periodontol2000*. 2005;37:72-87.

[2] Svärdström G, Wennström JL. Prevalence of furcation involvements in patients referred for periodontal treatment. *J Clin Periodontol*. 1996;23(12):1093-9.

[3] Mardam-Bey W, Majzoub Z, Kon S. Anatomic considerations in the etiology and management of maxillary and mandibular molars with furcation involvement. *Int J Periodontics Restorative Dent.* 1991;11(5):398-409.

[4]Wang HL, Burgett FG, Shyr Y, Ramfjord S. The influence of molar furcation involvement and mobility on future clinical periodontal attachment loss. J Periodontol. 1994;65(1):25-9.

[5]Porciuncula HF, Porciuncula MM, Zuza EP, Toledo BE. Biometric analysis of the maxillary permanent molar teeth and its relation to furcation involvement. Braz Oral Res. 2004;18(3):187-91.

[6] Hou GL, Chen SF, Wu YM and Tsai CC, The topography of the furcation entrance in Chinese molars. Furcation entrance dimensions. J Clin Periodontol 1994; 21: 451-456.

[7] Schroeder HE. The effects of furcation morphology on periodontal disease. Dtsch Zahnarztl Z. 1991 May; 46(5):324-7.

[8]Waerhaug J. Healing of the dento-epithelial junction following subgingival plaque control II. As observed on extracted teeth. J Periodontol 1978; 119-134.

[9] Bonnie M Chui, Kwan Y Zee, Esmonde F Corbet and Christopher J Holmgren, Periodontal implications of furcation entrance dimension in Chinese first permanent molars, J Periodontol 1991; 62:308-311.

[10] Caffesse R, Sweeney P, and Smith B. Scaling and root planning with or without periodontal flap surgery. J Clin Periodontol, 1980; 7;73-95

[11] Rabbani GM, Ash MM, Caffesse RG. The effectiveness of subgingival scaling and root planning in calculus removal. J Periodontol; 1981; 52:119-123

[12] Bower R. C., Furcation morphology relative to periodontal treatment: Furcation entrance architecture. J Periodontol. 1979; 50, 23-2

[13] M Ravindranath, <u>P Neelakantan</u>, Maxillary lateral incisor with two roots: a case report. General dentistry, Jan 2011, 59(1):68-69

[14] Mandel E, Machtou P, Torabinejad M. Clinical diagnosis and treatment of endodontic and periodontal lesions. Quintessence Int. 1993;24:135–9

[15] Schroeder HE. The effects of furcation morphology on periodontal disease. Dtsch Zahnarztl Z. 1991 May; 46(5):324-7.

[16] Zehnder M, Gold SI, Hasselgren G. Pathologic interactions in pulpal and periodontal tissues. J Clin Periodontol. 2002;29:663–71

[17] Ramford , S.P., Knowlesm J.W., Morrison, F.G. & Nisslw, R.R. Results of periodontral therapy related to tooth type. J Periodontol. 1980; 51, 270-273.

[18] McFall, W.T. Jr. Tooth loss in 100 treated patients with periodontal disease- Along term study. J Periodontol. 1982; 53, 539-549.

[19] Andréa Marcia Marcaccini; Ângela Pavanelo; Andressa Vilas Boas Nogueira; João Antonio Chaves de Souza; Hélio Ferraz Porciúncula; Joni Augusto Cirelli, Morphometric study of the root anatomy in furcation area of mandibular first molars, Journal of applied oral science, 2012, vol.20 (1).

[20] Carranza's Clinical Periodontology (10th edition) By Fermin A Carranza, Michael G Newman, Henry H Takei, Perry R Klokkevold.

[21] Betsy Joseph, Presanthila Janam, Subhash Narayanan and Sukumaran Anil, Is Antimicrobial Photodynamic Therapy Effective as an Adjunct to Scaling and Root Planing in Patients with Chronic Periodontitis? A Systematic Review, *Biomolecules* 2017, 7(4), 79

[22]Jones SJ, Lozdan J, Boyde A. Tooth surfaces treated *in situ* with periodontal instruments. Scanning electron microscopic studies. Br Dent J. 1972;132(2):57-64.

[23]Francisco J. Otero-Cagide and Barbara A. Long, Comparative In Vitro Effectiveness of Closed Root Debridement With Fine Instruments on Specific Areas of Mandibular First Molar Furcations. I. Root Trunk and Furcation Entrance, J Periodontol 1997;68:1093-1097.

[24] Anna M Pattison, The use of hand instruments in supportive periodontal treatment, Periodontology 2000. 1996; 1(12): 72-89.

[25] Chiu BM, Zee KY, Corbet EF, Holmgren CJ. Periodontal implications of furcation entrance dimensions in Chinese first permanent molars. J Periodontol. 1991;62(5):308-11.

[26] Santos KM, Pinto SC, Pochapski MT, Wambier DS, Pilatti GL, Santos FA. Molar furcation entrance and its relation to the width of curette blades used in periodontal mechanical therapy. *Int J Dent Hyg*. 2009;7(4):263-9.

[27] Neelakantan P, Subbarao C, Ahuja R, Subbarao CV, Gutmann JL, Cone-beam computed tomography study of root and canal morphology of maxillary first and second molars in an Indian population. J.Endod 2010 Oct;36(10):1622-7

[]Kerns DG, Greenwell H, Wittwer JW, Drisko C, Williams JN, Kerns LL. Root trunk dimensions of 5 different tooth types. Int J Periodontics Restorative Dent. 1999;19(1):82-91.

[28] Hirschfeld L, Wasserman B. A long term survey of tooth loss in 600 treated periodontal patients. J Periodontol. 1978; 49:225-237.

[29] Ross IF, Thompson RH. A long term study of root retention in the treatment of maxillary molars with furcation involvement. J Periodontol. 1978; 49:238-244.