Research Article
J Nepal Soc Perio Oral Implantol. 2025 Jul-Dec;9(18):66-74.

Submitted: Apr 9, 2026
Accepted: May 3, 2026
Published: Jul 30, 2026

Determination of Root Trunk Length of Maxillary and Mandibular First Molar

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ABSTRACT

Background: The length of root trunk in addition to the amount of horizontal and vertical bone loss supplements furcation classification in the determination of diagnosis, prognosis, and treatment planning.

Objectives: The primary objective was to determine the root trunk length of the maxillary and mandibular first molar. The secondary objective was to assess the association between socio demographic factors and root trunk length of maxillary and mandibular first molar.

Methods: Total of 112 patients who had indication of extraction of either upper or lower first molar teeth were recruited. After extraction of teeth, the vertical dimensions of the root trunk and root length were measured with Digital Vernier Caliber.

Results: Out of 112 teeth, 43 were obtained from male and remaining 69 from female. Similarly, out of 112, 80 teeth were mandibular first molar and remaining 32 were maxillary first molar. The mandibular buccal root trunk (BRT) and lingual root trunk (LRT) length was 4.26 ± 0.99 and 4.86 ± 0.95 mm, respectively. Similarly, the maxillary mesial root trunk (MRT), buccal root trunk (BRT) and distal root trunk (DRT) length was 4.56 ±.91, 4.91 ± .67 and 5.62 ± 0.87 mm, respectively.

Conclusion: For maxillary first molar, the longest root trunk is DRT followed by BRT and then MRT while for mandibular first molar; LRT is longer than BRT length.

Keywords: Bone loss; furcation; root trunk.

INTRODUCTION

Furcation is defined as an area of a multirooted tooth where the roots diverge, and furcation invasion as the pathologic resorption of bone within a furcation.[1]Among different inherent anatomic features of furcation involved tooth, the root trunk (RT) dimension is one of the most important features to be considered in the determination of prognosis and treatment of periodontitis. RT can be defined as the part of the root complex that extends between the cementoenamel junction and the furcation entrance.[2] For a similar class III furcation involvement, there appears greater difference in the prognosis between long and short root trunks as evident by study of Hou et al.[3] The main rationale of the present study is to determine root trunk and root length measurements, which can be baseline data for further studies in the future. Secondly, this study also tries to find out the effect of age and gender on root trunk length, which was not considered in earlier studies.

The primary aim of the study was to determine the root trunk length of the maxillary and mandibular first molar. The secondary objectives of the study were to determine the root length of the maxillary and mandibular first molar, to determine periodontal attachment loss in different types of root trunk of the maxillary and mandibular first molar and to assess the association between socio-demographic factors and root trunk length of maxillary, and mandibular first molar

METHODS

A cross-sectional study was conducted at the College of Dental Surgery, BPKIHS, Dharan, Nepal. One

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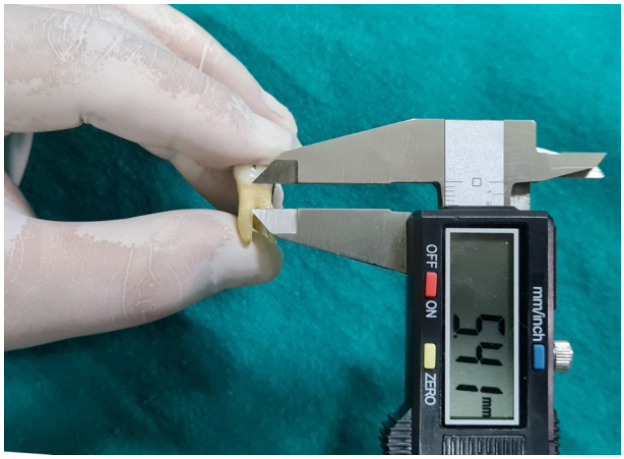
Citation
Shrestha S, Acharya P Jaisani MR. Determination Of Root Trunk Length Of Maxillary And Mandibular First Molar. J Nepal Soc Perio Oral Implantol. 2025 Jul-Dec;9(18):66-74.

hundred and twelve subjects were selected from patients attending the OPD of the Department of Oral and Maxillofacial Surgery between September 2020 and February 2021 who had the first molar, either of the maxilla or mandible, with a hopeless prognosis, which was indicated for extraction. A hopeless prognosis of teeth is defined when there is inadequate attachment to maintain health, comfort, and function. A consecutive sampling technique was used to enrol the patient in the study. Written informed consent was obtained from all the participants who were enrolled in the study.

Inclusion criteria for the study were patients with maxillary or mandibular first molar of either side indicated for extraction, teeth having an intact root and furcation region, teeth with a preserved cementoenamel junction unaltered by loss of tooth substance due to caries, fracture, or tooth wear on at least one aspect. Exclusion criteria were fused roots teeth with a crown and bridge, teeth damaged to such an extent that they prevent exact measurement of root trunk or root length and root resorption due to any pathologies.

The first molar teeth, either of the maxilla or mandible, which were extracted from those patients who had an indication of extraction for the same, were recruited for the study that fulfilled inclusion and exclusion criteria. The teeth were first fixed and stored in 10% formalin until use in the Department of Periodontology and Oral Implantology. They were then placed in a 3% sodium hypochlorite solution for 3 hours to aid in removing the remaining soft tissue. All teeth were carefully debrided of tissue tags and calculus using ultrasonic and hand instrumentation.

The vertical dimensions of the root trunk and root length were assessed with a digital Vernier caliper (Brand Name: Zhart Model Number: CT-ZT-VERNIER) figure 1 and figure 2. It has a measuring range of 0-150 mm, resolution: 0.01 mm, accuracy: ± 0.02 mm / <0.001 in (<100 mm); ± 0.03 mm / 0.001 in (>100-200 mm), and repeat accuracy: 0.01 mm / 0.0005 inch. Measurements of the maxillary molars included the vertical height of the buccal root trunk (BRT), mesial root trunk (MRT), distal root trunk (DRT), mesiobuccal root length (MBRL), distobuccal root length (DBRL), and palatal root length (PRL). Similar measurements were obtained for mandibular molars, including buccal and lingual root trunks (BRT & LRT) and mesial and distal root lengths (MRL & DRL). The periodontal attachment loss was calculated as root trunk length divided by root length multiplied by 100. Root trunk is categorized into type A, type B and type C as per classification scheme developed by Hou and Tsai in the year 1997 where Type A has the shortest RT involving less than one third of the root length, type B has root trunk length between one third and one half of the length of the root, while type C has root trunk length more than one half of the root length.[3]



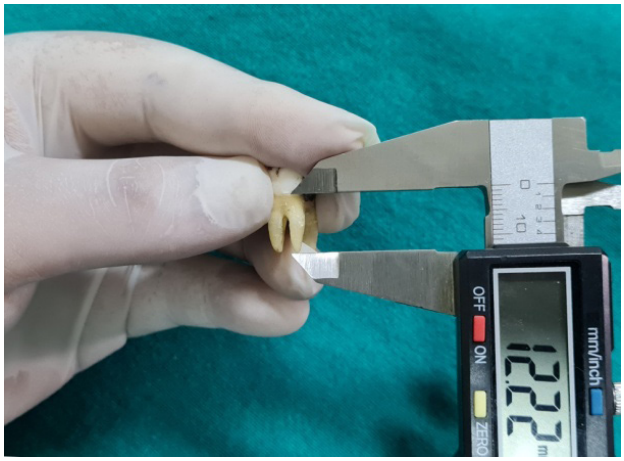


Figure 1 and 2: Measurement of root trunk length and root length with the calliper

RESULTS

A total of 112 patients attending the Department of Oral and Maxillofacial surgery were recruited for the study. The socio-demographic characteristics comprised of age group and gender. Out of 112 patients, 43 (38.39) were male, and the remaining 69 (61. 60) were female. Similarly, out of 112 extracted first molars, 80 (71.42) were mandibular, and the remaining 32 (28.57) were maxillary teeth. Forty-one patients (36.60) were in the less than or equal to 40 years category and the remaining 71 (63.4) were in the more than 40 years category as shown in table 1.

In the case of the mandibular first molar, the most common buccal root trunk type was type A (61.3%) followed by type B (35.0%) and type C (3.8%) while the common lingual root trunk was type B (62.5%) followed by type A (32.5%) and type C (5.0%), respectively. The mean root trunk length and percentage of attachment loss in different categories of root trunk type of mandibular first molar were presented in table no. 2. In the case of the mandibular first molar, the mean lingual root trunk (LRT) length and mean attachment loss in the lingual aspect were higher than the mean buccal root trunk (BRT) length and mean attachment loss in the buccal aspect as shown in table no.3. The average mesial root length (MRL) was higher than the average distal root length (DRL) of the mandibular first molar as tabulated in table no. 4.

Table 1: Gender, age category and tooth type of study sample

Characteristics		Frequencies	Percentage (%)
Gender	Male	43	38.39
	Female	69	61.60
Tooth	Maxillary first molar	32	28.57
	Mandibular first molar	80	71.42
Age category	<= 40 years	41	36.60
	>40 years	71	62.39

Table 2: Mandibular root trunk length, type and percentage of attachment loss in each type

Characteristics		Root trunk length Mean ±SD (mm)	Frequencies (%)	Attachment loss in percentage (Mean ± SD)
Buccal root trunk (BRT) type	A	3.65 ± 0.49	49 (61.3%)	27.50 ± 3.37
	B	5.06 ± 0.62	28 (35.0%)	38.54 ± 4.25
	C	6.73 ± 0.78	3 (3.8%)	52.09 ± 2.30
Lingual root trunk (LRT) type	A	3.96 ± 0.42	26 (32.5%)	29.71 ± 2.77
	B	5.16 ± 0.61	50 (62.5%)	38.85 ± 3.73
	C	6.91 ± 1.45	4 (5.0%)	57.28 ± 2.42
Total	A	3.76 ± 0.49	75 (46.87)	28.26 ± 3.33
	B	5.12 ± 0.61	78 (48.75)	38.74 ± 3.90
	C	6.83 ± 1.12	7 (4.37)	55.06 ± 3.52

Table3: Average root trunk length with attachment loss of mandibular first molar

Characteristics	N	Mean ± SD (mm)	Range (mm)	Attachment loss in percentage (Mean ± SD)
Buccal root trunk (BRT) length	80	4.26 ± 0.99	2.67 - 7.64	32.28 ± 7.49
Lingual root trunk (LRT) length	80	4.86 ± 0.95	3.23 - 8.98	36.80 ± 7.19

Table 4: Average root length of mandibular first molar.

Characteristics	N	Mean ± SD (mm)	Range (mm)
Mesial root length (MRL)	80	13.42 ± 1.32	10.15 - 16.13
Distal root length (DRL)	80	13.09 ± 1.34	9.60 - 15.74

There was no significant difference in BRT length, LRT length, MRL, and DRL between male and female gender as well as between ≤ 40-year categories and > 40-year categories as depicted in tables no. 5 and 6.

Table 5: Mandibular root trunk length and root length in male and female. #= independent sample t test

Characteristics	Gender		p- value #
	Male (N=39)	Female (41)	
Buccal root trunk (BRT) length	4.15 ±.91	4.33 ± 1.04	0.440
Lingual root trunk (LRT) length	4.82 ± .89	4.88 ± 0.99	0.816
Mesial root length (MRL)	13.44 ± 1.18	13.40 ± 1.42	0.903
Distal root length (DRL)	13.01 ± 1.31	13.14 ± 1.37	0.687

Table 6: Mandibular root trunk length and root length in<=40 years category and > 40 years category. #= independent sample t test

Characteristics	Age group		p- value #
	<= 40 years (N= 26)	>40 years (54)	
Buccal root trunk (BRT) length	4.25 ± 0.95	4.26 ± 1.02	0.942
Lingual root trunk (LRT) length	4.83 ± 0.94	4.87 ± 0.96	0.816
Mesial root length (MRL)	13.07 ± 1.37	13.59 ± 1.28	0.100
Distal root length (DRL)	12.71 ± 1.19	13.27 ± 1.38	0.083

In the case of the maxillary first molar, the most common mesial root trunk type was type B (62.5%) followed by type A (37.5%) while the most common buccal root trunk was type B (81.2%) followed by type C (12.5%) and type A (6.2%), and the most common distal root trunk type was type B (75.0%) followed by type C (21.9 %) and type A (3.1%), respectively. The mean root trunk length and percentage of attachment loss in different categories of root trunk type of maxillary first molar were presented in table 7. In the case of the maxillary first molar, the mean distal root trunk (DRT) length and mean attachment loss in distal aspect were highest followed by the mean buccal root trunk (BRT) length and mean attachment loss in the buccal aspect, and mean mesial root trunk (MRT) length and mean attachment loss in mesial aspect as shown in table no.8. The palatal root length (PRL) was the longest followed by mesiobuccal root length (MBRL) and distobuccal root length (DBRL), respectively as shown in table no. 9.

There was no significant difference in MRT, BRT, DRT length, MBRL, DBRL, and PRL between male and female gender, as well as between ≤ 40-year categories and > 40-year categories as depicted in tables no. 10 and 11.

Table 7: Root trunk type, length and attachment loss percentage in each root trunk type of maxillary first molar

Characteristics		Root trunk length Mean ±SD (mm)	Frequencies (%)	Attachment loss in percentage (Mean ± SD)
Mesial root trunk (MRT) type	A	3.63 ± 0.27	12 (37.5%)	28.69 ± 2.34
	B	5.12 ± 0.66	20 (62.5%	39.57 ± 5.29
	C	0	0	0
Buccal root trunk (BRT) type	A	4.27 ± 0.098	2 (6.2%)	31.96 ± 0 .29
	B	4.85 ± 0.65	26 (81.2%)	39.56 ± 4.36
	C	5.60 ± 0.46	4 (12.5%)	53.11 ± 2.49
Distal root trunk (DRT) type	A	4.38	1 (3.1%)	31.61
	B	5.45 ± 0.73	24 (75.0%)	42.84 ± 4.70
	C	6.39 ± 0.89	7 (21.9%)	54.88 ± 7.12
Total	A	3.77 ± 0.37	15 (15.62)	29.32 ± 2.45
	B	5.13 ± 0.72	70 (72.91)	40.69 ± 4.94
	C	6.10 ± 0.83	11 (11.45)	54.23 ± 5.75

Table 8: Average root trunk length and attachment loss of maxillary first molar

Characteristics	N	Mean ± SD (mm)	Range (mm)	Attachment loss in percentage (Mean ± SD)
Mesial root trunk (MRT) length	32	4.56 ± 0.91	3.09 - 6.52	35.49 ± 6.91
Buccal root trunk (BRT) length	32	4.91 ± 0.67	3.63 - 6.22	40.78 ± 6.47
Distal root trunk (DRT) length	32	5.62 ± 0.87	3.63 - 7.91	45.12 ± 7.59

Table 9: Average root length of maxillary first molar

Characteristics	N	Mean ± SD (mm)	Range (mm)
Mesio buccal root length (MBRL)	32	12.51 ± 1.48	10.07 - 15.59
Disto buccal root length (DBRL)	32	11.80 ± 1.61	8.39 - 15.66
Palatal root length (PRL)	32	13.27 ± 1.05	11.50 - 15.94

Table 10: Root trunk length and root length of maxillary first molars in male and female. # independent sample t test

Characteristics	Gender		p- value #
	Male (N=12)	Female (20)	
Mesial root trunk (MRT) length	4.49 ± 0.79	4.60 ± 0.99	0.736
Buccal root trunk (BRT) length	4.98 ± 0.62	4.86 ± 0.71	0.638
Distal root trunk (DRT) length	5.69 ± 0.69	5.58 ± 0.98	0.728
Mesio buccal root length (MBRL)	12.43 ± 1.52	12.56 ± 1.50	0.818
Disto buccal root length (DBRL)	11.74 ± 1.17	11.83 ± 1.86	0.878
Palatal root length (PRL)	13.42 ± 0.83	13.19 ± 1.17	0.566

Table 11: Root trunk length and root length of maxillary first molars in ≤ 40 and > 40 years age group. # independent sample t test

Characteristics	Age group		p- value #
	≤ 40 years (N= 15)	> 40 years (N= 17)	
Mesial root trunk (MRT) length	4.51 ± 1.08	4.60 ± 0.76	0.782
Buccal root trunk (BRT) length	4.83 ± 0.63	4.98 ± .71	0.547
Distal root trunk (DRT) length	5.55 ± 0.92	5.68 ± 0.84	0.672
Mesio buccal root length (MBRL)	12.48 ± 1.28	12.54 ± 1.68	0.918
Disto buccal root length (DBRL)	11.52 ± 1.26	12.04 ± 1.88	0.374
Palatal root length (PRL)	13.14 ± 0.71	13.39 ± 1.29	0.518

According to the study done by Dababneb et al.,(4) M ± SD of buccal root trunk (BRT) has been reported as 3.48 ± 1.8 mm. Based on this study, mean (M) =3.48, and Standard deviation (SD)= 1.8

Sample size calculation for one sample test, $N= (Z_{\alpha}^2 SD^2)/L^2$

Where, Z_{α} at 95% confident interval (CI) = 1.96 (SD)= 1.8, L= 10% of mean= 0.35. Therefore, $n= (1.96)^2 *(1.8)^2/ (0.35)^2= 102.86$. Adding 10% non-response, the final sample size was determined to be 112.

Collected data were entered into Microsoft Excel 2007 and were analysed in a statistical package for social

science (SPSS) version 11.5. Descriptive statistics were calculated (mean, standard deviation, percentage, and proportion) followed by a tabular and graphical presentation. For inferential statistics, independent sample t-tests were applied to find out the significant difference between dependent and independent variables at 95% CI where p=0.05. The study was carried out after approval by the Institutional Review Committee of BPKIHS.

DISCUSSION

When a periodontal disease invades a furcation of a multirooted tooth, there is a significant difference in periodontal attachment loss between the short and long root trunk length teeth, even though the grade of furcation involvement is the same. Among various morphologic characteristics of furcation, root trunk length is one of the most important factors that help in the diagnosis, treatment planning, and prognosis of furcation involvement.

In the present study, 61.60% of patients were female, and the remaining 38.39% were male, which doesn't mean that furcation involvement is more prevalent in females, nor does it mean that tooth extraction is more difficult. The reason behind this might be that a male patient, even though he had an indication of tooth extraction, might not seek treatment because of time constraints due to work or other jobs. Extracted teeth were used to measure the morphological features (root trunk length and root length) of teeth, as this method is simple and accurate, and remeasurements can be done at any point during the study. Out of 112 extracted first molars, 71.42% were mandibular teeth, and the remaining 28.57% were maxillary teeth, which doesn't imply that the extraction of mandibular first molars is more common than maxillary first molars. The reason for this finding is due to sample recruitment criteria, i.e., the tooth root should be intact, and as the maxillary first molar is three-rooted, apical root tip fracture is more common during extraction. Therefore, the tooth with a root tip fracture was excluded, reducing the frequency of maxillary teeth in the study. The number of patients in the > 40-year category was 71 (62.39%), which was more than in the < 40 category. The reason behind such a finding might be that even if diseases like caries or periodontitis had occurred earlier, before age 40, the tooth might have been maintained by root canal therapy or non-surgical or surgical periodontal therapy, and the tooth was indicated for extraction later, after 40.

Examination of furcation in the maxilla is more difficult than in the mandible because through-and-through furcation involvement may not be detected due to the presence of a palatal root for buccal furcation, as well as proximal furcations, which may not be detected when adjacent tooth roots are in close proximity. Therefore, such teeth can be identified as furcationally involved with surgical exposure only. As a great variation in the length of the root trunks has been observed in the studies,[5-9] the interpretation of clinical data should be done cautiously.

In the case of the maxilla, the result of the present study is consistent with the study by Gher and Dunlap, who found the maximum root trunk length in the distal aspect, followed by the buccal aspect, and the least in the mesial aspect.[7] In the present study, mesial root trunk (MRT) length was least compared to buccal root trunk (BRT) and distal root trunk (DRT) lengths, which disagrees with the studies by Kern et al.[8] and Ouyang et al.[10], who observed the least root trunk length in the buccal aspect. The maximum root trunk length observed in the present study was 7.91 mm for the maxillary first molar. Gher and Dunlap, in their study on maxillary first molars, found that the mean distance from the CEJ to the point at which the roots separate from the root trunk was 5.0 mm for the mesiobuccal root and 5.5 mm for the distobuccal root. Therefore, they anticipated the grade III furcation involvement with the horizontal attachment loss of 6 mm or more.[6] In the case of the maxillary first molar, Hou and Tsai found that the prevalence of root trunk types A, B, and C was 41%, 47.1%, and 11.9%, respectively.[3] In contrast to the observation of Hou and Tsai, the prevalence of root trunk types A, B, and C was 46.87%, 48.75%, and 4.37%, respectively, which means that the prevalence of type C root trunk was lower in the present study. In the present study, we didn't observe the type C root trunk in the mesial root trunk, while Dababneh (4) and Al-Zoubi (11) didn't observe the type C root trunk not only in the mesial root trunk but also in the buccal root trunk. The mean length of the distal root trunk of the maxillary first molars was 5.62 mm, which was higher than the values observed by Roussa et al.[12] and Gher and Dunlop [6], who observed

that the length of 4.14 mm, 4.31 mm, and 4.8 mm, respectively.

In the case of the mandible, the type B root trunk is most common, followed by the type A, with the type C being least common. The average attachment losses in types A, B, and C were 28.26 ± 3.33, 38.74 ± 3.90, and 55.06 ± 3.52%, respectively, which means that there is almost twice as much attachment loss in type C compared to type A root trunk when grade III furcation involvement occurs. Hou et al. found 3 times more periodontal attachment loss between types A and C molars that are affected by class III FI, which is more compared to the present study's findings. The mean value of the lingual root trunk was higher compared to the buccal root trunk, which was in accordance with the previous studies.[8, 5] In the mandibular first molar, in contrast to the observation by Roussa et al.,[12] Mandelaris et at. ,[5] and Kern et al.,[8] who found the mean buccal root trunk as 2.8, 3.14, and 3.3 mm, respectively, the present study revealed a higher buccal root trunk length, i.e., 4.26 mm. The minimum BRT and LRT length in buccal and lingual aspects was 2.27 and 3.23 mm, respectively, which implies that furcation involvement could occur even at the attachment loss of 2.67 buccally and 3.23 mm lingually. The table showed the comparison of root trunk length measurements of the present study and earlier studies.

Even though a molar with a short root trunk is more vulnerable to furcal involvement, it has a better prognosis after treatment as less periodontal destruction has presumably occurred with furcation involvement.[15] The tunnelling procedure is indicated in molars with a short root trunk and a wide furcation entrance diameter as a part of resective furcation therapy because the postoperative plaque control measures by the patient are efficient.[16] The prerequisites for the tunnelling procedure according to Rüdiger[17] are that the root trunk length should be 4 mm or less and the diameter of the furcation entrance should be 0.5 mm or more. The measurement of root trunk length relative to the dimensions of root length revealed that with an increasing root trunk, there is a decrease in root length. A furcation-involved molar is not indicated for root resection or tunnelling with a long root trunk and short roots,[16] a wide furcation entrance, and a furcation fornix coronal to the alveolar crest[18] because these teeth lose more periodontal support with furcal invasion.

The length of the root is directly associated with the amount of attachment supporting the tooth. For maxillary first molars, the mean lengths of the mesiobuccal, distobuccal, and palatal roots were 12.51 ± 1.48, 11.80 ± 1.61, and 13.27 ± 1.05 mm, respectively, which was in accordance with the study done by Dababneh et al.[4]which confirmed

Table 12: Comparison of root trunk length measurements of the present study and earlier studies in mm.

Author and year of publication	Maxillary First molar			Mandibular First molar	
	MRT	DRT	BRT	LRT	BRT
This study	4.56	5.62	4.91	4.86	4.26
Roussa 1998(12)	3.49	4.14	3.46	3.5	2.8
Plagmann 2000 (9)	4.8	4.5	4.3	4.3	3.3
Gher and Dunlap 1985(6)	3.6	4.8	4.2	-	-
Dunlap and Gher 1985 (7)	-	-	-	4.0	4.0
Rosenberg 1988(13)	5	3.5	3	-	-
Mandelaris 1998(5)	-	-	-	4.17	3.14
Kerns 1999 (8)	4.7	4.7	4	4.3	3.3
Porciuncula 2007 (14)	4.44	4.26	3.5	-	-

that the shortest root was distobuccal and palatal was the longest, while the result disagreed with the observation by Roussa et al.[12], who found that the distobuccal root was the longest. For the mandibular first molar, the mean MRL and DRL were 13.42 ± 1.32 and 13.09 ± 1.34 mm, respectively, which were slightly lower compared to the findings by Roussa et al.,[12] who obtained the MRL and DRL as 14.20 2.50 and 14.00 ± 2.50 mm, respectively. There were no differences either in root-trunk lengths or root lengths between the genders as well as age categories.

Limitations and recommendations

Besides root trunk and root length, there are various morphologic complexities in the furcation area that should be borne in mind while managing the furcation-involved molar teeth. Those morphologic factors include cervical enamel projection,[19] bifurcational ridges,[20] root proximity,[21] furcation entrance dimension,[22] root fusion,[23] and enamel pearls.[24] Further studies are recommended that investigate the effect of each of those morphologic factors.

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