Evaluation of Root and Canal Morphology of Maxillary First Premolars in a Bangladeshi Population: An in vitro study.

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Abstract:-
Context: **Morphologic characteristics of root canals directly influence the outcome of root canal treatment as biomechanical preparation and sterilization depend on canal morphology.**
Objectives: **The main objective of the present study was to evaluate the root and root canal morphology of maxillary 1st premolars of the Bangladeshi inhabitants using tooth clearing and staining techniques.**
Methods and Materials: 1746 extracted maxillary 1st premolars collected from Rajshahi Medical College dental Unit and private oral care center within Rajshahi were selected for this study and stored in normal saline. Root numbers were determined by Visual and radiographic examinations. 5%nitric acid was used to decalcify teeth after pulp tissue removal. Ascending concentrations of alcohol and methyl salicylate were used for dehydrating and clearing teeth respectively. India ink was used for staining and 5 x magnifications were used for evaluating the number of roots, root canals, and location of apical foramina.
Results: Of the 1746 teeth, 290 (22.33%) had one, 1348 (77.19%) had two, and eight maxillary 1st premolars (0.45%) had triple roots. Among all teeth, 2.28% (40 teeth) had a single canal (Type I), 97.24% (592 teeth) had two canals (Types II and III), 0.45% (8 teeth) had three canals (Type V), and 0.34% (6 teeth) had one root canal two apical foramina (type IV). Concerning the location of apical foramen 734 teeth (42.03%) had apical foramen at the apex and 1012 teeth (57.97%) had apical foramen lateral to the apex.
Conclusion: Bangladeshi maxillary 1st premolars are primarily double rooted type III canal configuration. While performing the endodontic treatment, different variants of canal configuration of maxillary 1st premolars should be kept in mind by the clinician.

Keywords:- Root Canal Configuration, Maxillary 1st Premolar, Dental Anatomy, Bangladeshi Population.

I. INTRODUCTION

For quality dental care, acceptable root canal treatment is an important element[1]. Proper knowledge regarding the internal root canal configuration of teeth undergoing endodontic therapy is a prerequisite to proper root canal preparation, obturation, and an acceptable outcome[2]. Inadequate knowledge regarding the internal canal morphology causes treatment failure in endodontics[3]. For acceptable endodontic treatment outcomes, proper evaluation of internal root canal morphology is essential. Roots number and canal configuration variation make the maxillary 1st premolar's internal anatomy complex with relatively innocent simplicity of the external surface of roots[4].

Due to genetic variation among different races maxillary 1st premolar appeared with wide variations in the root numbers and canal morphology in different literature[3, 5-7]. Pecora et al [7] showed predominance (55.8%) of single-rooted maxillary 1st premolars in Brazilian dentition. Dashrath [8] found 58 % one-rooted maxillary 1st premolar in Nepalese Population. Dinakar et al [9] reported 52.88% single-rooted maxillary 1st premolar in the Indian population whereas Neelakantan et al[10] reported 11.7% single- rooted maxillary 1st premolar in India. Neelakantan et al[10] found a high incidence (86%) of double rooted maxillary 1st premolar in the Indian population. Atieh et al[11] reported 80.9% double rooted maxillary 1st premolar in the Saudi population whereas Tian et al [12] reported a relatively lower incidence (33%) of double rooted maxillary 1st premolar. Regarding three rooted maxillary 1st premolar Peiris et al [13] found 0.0% cases in Sri Lankan population and Lipski et al[14] found 9.1% cases in the Polish population.

Single canal in maxillary 1st premolar was found as high as 49.4% by Loh et al [15] in Singaporean population and 45.2% by Ozcan et al [16] in a Turkish population and also as low as 2.1 % by Lipsky et al [14] in Polish population and 3.6% in the Jordanian population. A high incidence (94.3%

& 87.2%) Maxillary 1st premolar having a double root canal was reported by Awawdeh et al[17] in Jordanian population and Dinakar et al[9] in the Indian population respectively. Whereas Loh et al[15] found 50.6% in the Singaporean population and Ozcan et al[16] found 55.7% in the Turkish population. Three root canals prevalence varies from 0.0% by Loh et al 1998[15] to 9.2% by Lipsky et al [14] respectively.

II. METHODS AND MATERIALS

Total 1746 extracted maxillary 1st premolar extracted due to carious or periodontal problems and prosthodontics or orthodontics needs were randomly collected from Dental Unit Rajshahi Medical and also from different private oral care center within Rajshahi, Northern area of Bangladesh. Mature teeth with intact clinical crowns were included in this study and teeth having Immature or resorbed apices were excluded from the study. Blood, saliva or any debris were removed from the extracted teeth by thorough washing. All teeth were immersed in 5.25% sodium hypochlorite (Organo Biotech laboratories Pvt Ltd New Delhi, India.) for 30 minutes. Calculus or any remaining external tissues were cleaned by scaling. The study samples were saved in normal saline until further evaluation. Root numbers of the study samples were visually examined and note down the observation. The study samples were then gathered into four groups centered on root numbers (Table I). Internal root canal morphology was evaluated by radiograph in two planes (mesiodistal and mesiodistal + 40-degree horizontal angle) [16].

After access cavities preparation the study samples were immersed in 5.25% sodium hypochlorite for 24 hours for dissolving pulp tissue. Teeth were washed under running tap water for 2 hours and dried overnight[17]. 27 gauge endodontic irrigating syringe needle (BU Kwang Medical Inc., Seoul, Korea) was used to inject India ink (Sanford Rotring GmbH, Hamburg, and Germany) into the pulp chamber[17]. By applying negative pressure by using the central suction system the ink was drained into the root canal up to the apical foramen. Gauze soaked in alcohol was used to remove the excess ink. After staining the samples were dried up in the air and 5% nitric acid (Analytical reagents 69-71%; Gainlad Chemical Co., Clwyd, UK) was used for 3 days for decalcification[17]. The solution of nitric acid was changed daily and anticipated decalcification was checked by periodic radiography. Under running tap water the teeth were washed overnight and then dried in the air. Ascending concentrations of ethyl alcohol (70%, 96%, and 99%) were used for 12 hours for dehydrated specimens. The study samples were dipping in methyl salicylate solution (Regent Chemicals, Mumbai) to make it transparent[17]. The specimens were inspected using 5X magnification with a magnifying glass and photographed using a digital camera. Internal root-canal anatomy was evaluated according to Weine's[18] classification as follows: 1) Type I: Single canal from the pulp chamber to the apex, 2) Type II: Two separate canals leaving the pulp chamber but merging short of the apex to form one canal, 3) Type III: Two separate and distinct canals from the pulp chamber to the apex, 4) Type IV: One canal leaving the pulp chamber and dividing

into two separate and distinct canals. 5.) Type V: three separate and distinct channels, extending from the pulp chamber to the apex. The Location of apical foramina was evaluated and noted as apical foramen at apex or lateral to the apex.

III. RESULTS

Among 1746 specimens, 390 teeth (22.33%) were recognized as single-rooted and 1348 teeth (77.19%) as double rooted. (Table I). Regarding double rooted maxillary 1st premolars 998 teeth (57.15%) had two separate roots and 350 teeth (20.04%) had two fused roots (Table I). 8 teeth (0.45%) were identified as triple rooted (Table I). All triple rooted specimens had two joined buccal and a single palatal root. Regarding canal configuration 34 teeth (1.94%) were identified as Type I, 256 teeth (14.66%) as Type II, 1442 teeth (82.58%) as Type III, 6 teeth (0.34%) as Type IV, and 8 teeth (0.45%) as Type V Weine's canal configuration. Concerning the location of apical foramen 734 teeth (42.03%) had apical foramen at the apex and 1012 teeth (57.97%) had apical foramen lateral to the apex (table III).

Table I: Distribution of Number and percentage of Root types in Maxillary 1st premolar (n = 1746)

Root Morphology	Frequency	Percentage
Single	390	22.33
Two separate roots	998	57.15
Two fused roots	350	20.04
Three roots	08	00.45
Total	1746	100%

Table II: Distribution of Number and percentage of Root Canal in Maxillary 1st premolar (n = 1746)

Root Canal Morphology	Frequency	Percentage
One canal one foramen (Type I)	34	1.94
One canal two foramina (Type IV)	06	00.34
Two canal one foramen (Type II)	256	14.66
Two canal two foramina (Type III)	1442	82.58
Three canal three foramina (Type V)	08	00.45
Total	1746	100%

Table III: Distribution of apical foramen location in Maxillary 1st premolar (n = 1746)

Location of apical foramen	Frequency	Percentage
At apex	734	42.03
At lateral to apex	1012	57.97
Total	1746	100%

IV. DISCUSSION

The teeth clearing technique was used for evaluating the internal anatomy of the teeth in the present study as it delivered better visualization of the canal configuration of teeth[17]. Canal configuration differs significantly amongst various inhabitants worldwide in many studies. The tooth clearing technique provides the greatest information on the original internal root canals morphology. Gupta *et al.* stated that the combination of nitric acid and methyl salicylate for the transparent tooth model provided the best results[19]. Maxillary premolars account for 15.8%–21.5% of all endodontically treated teeth[20]. The literature review showed that there were no studies on maxillary premolars in the Bangladeshi population. Roots number of Maxillary 1st premolars shows a varied diversity[17]. Table IV compared the results of the present study with other study findings for maxillary 1st premolars regarding root numbers.

In the present study, the majority (77.19%) of the maxillary first premolars was double rooted, 22.33% had two roots, and 0.5% had three roots. This was following with other studies done on the worldwide population as follows: Neelakantan *et al*[10] in the Indian population, Atieh et al (2008)[11] in the Saudi population, Lipski et al (2003)[14] in the Polish population, Vertucci and Gegayuff (1979)[21] in USA population. In contrast, in a similar study the majority of the single- rooted maxillary 1st premolars were found by Gupta *et al.*[19] in the Indian population, Dashrath *et al.*[8] in the Nepalese population, Tian *et al.*[12], Cheng and Weng[2], and Walker[22] in the Chinese population, and Peiris *et al.*[13] in the Sri Lankan population of Japan. Findings of roots number of maxillary 1st premolars of several studies are summarized in Table IV together with the findings of the present study.

Table IV: Table IV showed a comparatively in vitro study findings regarding root number of the maxillary 1st premolar

Author (year)	Origin	No. of teeth	One root (%)	Two roots (%)	Three roots (%)
Ingle (1965)[23]	USA		43	55	02
Pineda and Kuttler (1972)[24]	USA	259	43	54.6	2.4
Carms and Skidmore (1973)[25]	USA	100	22	72	6.0
Vertucci and Gegayuff (1979)[21]	USA	400	26	70	4
Pecora et al. (1991)[7]	Brazilian	240	55.8	41.7	2.5
Loh (1998)[15]	Singaporeans	957	49.4	50.6	00
Kartal et al (1998)[5]	Turkish	600	37.3	61.3	1.3
Chaparro et al (1999)[26]	Andalusian	150	40	56.7	3.3
Lipski et al (2003)[14]	Polish	142	15.5	75.4	9.1
Atieh (2008)[11]	Saudi	246	17.9	80.9	1.2
Awawdeh (2008)[17]	Jordanian	600	30.8	68.4	0.8
Neelakantan et al (2011)[10]	India	350	11.7	86	2.3
Ozcan (2012)[16]	Turkish	653	45.2	55.7	1.1
Dashrath (2015)[8]	Nepal	100	58	41	1
Dinakar et al (2018)[9]	India	225	52.88	44.88	2.22
Tian et al(2012)[12]	china	300	66	33	1
Peiris (2008)[13]	Sri Lanka	153	36	64	0.0
The present study	Bangladesh	1746	22.33	77.19	0.45

In the present study two canal- two foramina, type IV canal configuration type was the commonest type and it was 82.58% cases followed by two canals one foramen Type II in 14.66%. Root canal configuration Type I was found in 1.94% and Type VIII in 0.45% of teeth. Concerning root canal morphology, Type IV canal configuration was the commonest type in maxillary 1st premolars in all similar studies reviewed by Awawdeh et al[17] 79.7% cases, Vertucci et al[21] 62% cases, Peiris et al[13] (64%) cases, Dinakar et al[9] 66.51%.cases.

Findings of root canals number of maxillary 1st premolars of several studies are summarized in Table V together with the findings of the present study. Due to clinical significance, root canals number and configuration were evaluated along with roots number. During root canal treatment types I and type III canal type's preparation are relatively straightforward as these canals types had distinct canal from orifice to apex[17]. Type II and type IV canal type preparation are somewhat extended difficult as the canals are either joined together or divided into separate canals. Maxillary 1st premolars show a considerable degree of endodontic failures as a result of canal configurations and root number variations. The clinician should be careful during performing Endodontic treatment in Maxillary 1st premolars.

Table V: Table V showed comparatively in vitro study findings regarding root canals of the maxillary 1st premolar

Author (year)	Origin	No. of teeth	One canal (%)	Two canal (%)	Three canal (%)
Ingle (1965)[23]	USA		9	85	6
Pineda and Kuttler (1972)[24]	USA	259	26.2	73.3	0.5
Carms and Skidmore (1973)[25]	USA	100	09	85	6.0
Vertucci and Gegayuff (1979)[21]	USA	400	08	85	07
Pecora et al. (1991)[7]	Brazilian	240	17.1	80.4	1.7
Loh (1998)[15]	Singaporeans	957	49.4	50.6	00
Kartal et al (1998)[5]	Turkish	600	8.7	89.6	1.7
Chaparro et al (1999)[26]	Andalusian	150	40	88.6	3.3
Lipski et al (2003)[14]	Polish	142	2.1	88.6	9.2
Atieh (2008)[11]	Saudi	246	8.9	89.8	1.2
Awawdeh (2008)[17]	Jordanian	600	3.6	94.3	1.5
PEIRIS (2008)[13]	Sri Lanka	153	19.6	79.7	0.7
Ozcan (2012)[16]	Turkish	653	45.2	55.7	1.1
Dinakar et al (2018)[9]	India	255	9.76	87.2	2.32
The present study	Bangladesh	1746	2.28	97.24	0.45

The present study showed the position of the apical foramen at the apical root tip in 42.03% of cases (Table III). The present study findings are higher than previous study findings as their findings various from 11% to 60% [17, 24,27,28,29]. Radiographically apical foramen's eccentricity detection is hard especially if the position of apical foramen located buccally or lingually[17, 24]. For working length determination x ray solely is not reliable enough due to variation of the position of apical foramen[17]. Findings of locations of the apical foramen of maxillary 1st premolars in several studies are summarized in Table VI together with the findings of the present study.

Table VI: Table VI showed comparatively in vitro study findings regarding locations of the apical foramen in root maxillary 1st premolar

Study (year)	Teeth in Study	Type of Study	Apical Foramen at apex
Pineda & Kuttler (1972)[24]	282 (Mexico)	In vitro, radiograph	11
Vertucci, (1984)[27]	100 ((USA)	In vitro, clearing, Morphologic study	12
Çaliskan et al. (1995)[28]	100 (Turkey	In vitro; clearing, Morphologic study	33.3
Sert and Bayirli, (2004)[29]	200 (Turkey)	In vitro; clearing, Morphologic study	24
Awawdeh (2008)[17]	600 (Jordan)	In vitro; clearing, Morphologic study	60
The present study	1746(Bangladesh)	In vitro; clearing, Morphologic study	42.03

Root morphology and canal morphology variation in the present study in comparison to other studies primarily as a result of racial differences. For successful endodontic treatment sound knowledge regarding root and canal morphology is important along with radiological evaluation. Further research will be necessary using larger specimen numbers and more innovative procedures to evaluate root canal configuration.

V. CONCLUSION

Incidence of dual canal form of maxillary 1st premolar was higher in the present study than one and three root canal forms. The clinician needs to be conscious about the possibility of three canals in maxillary 1st premolar for successful endodontic treatment.

REFERENCES

[1]. Lai WH, Ho SC, Weng TY, Huang ST. Profile of nonsurgical root canal treatment under the National Health Insurance in Taiwan in 2006. J Dent Sci 2009; 4:187-190.

[2]. Chen G, Chang YC. Effects of liquid- and paste-type EDTA on smear-layer removal during rotary root-canal instrumentation. J Dent Sci 2011; 6: 41-47.

[3]. . Vertucci FJ. Root canal anatomy of the human permanent teeth. Oral Surg Oral Med Oral Pathol 1984; 58: 589-599.

[4]. Lee YY, Yeh PY, Pai SF, Yang SF. Maxillary first molar with six canals. J Dent Sci 2009; 4:198-201.

[5]. Kartal N, Ozcelik B, Cimilli H. Root canal morphology of maxillary premolars. J Endod 1998; 24: 417-19.

[6]. Kim E, Fallahrastegar A, Hur YY, Jung IY, Kim S, Lee SJ, et al. Difference in root canal length between Asians and Caucasians. Int Endod J 2005; 38:149-151.

[7]. Pecora JD, Saquy PC, Sousa Neto MD, Woelfel JB. Root form and canal anatomy of maxillary first premolars. Braz Dent J 1991;2: 87-94.

[8]. Dashrath K, Nisha A, Subodh S. Root morphology and tooth length of maxillary first premolar in Nepalese population. Dentistry 2015;5:324

[9]. Dinakar C, Shetty UA, Salian VV, Shetty P. Root canal morphology of maxillary first premolars using the clearing technique in a south Indian population: An in vitro study. International Journal of Applied & Basic Medical Research. 2018; 8(3):143-147

[10]. Neelakantan P, Subbarao C, Ahuja R, Subbarao CV. Root and canal morphology of Indian maxillary premolars by a modified root canal staining technique. Odontology 2011; 99:18-21.

[11]. Atieh MA. Root and canal morphology of maxillary first premolars in a Saudi population. J Contemp Dent Pract 2008; 9: 46-53.

[12]. Tian YY, Guo B, Zhang R, Yu X, Wang H, Hu T, et al. Root and canal morphology of maxillary first premolars in a Chinese subpopulation evaluated using cone-beam computed tomography. Int Endod J. 2012; 45: 996–1003

[13]. Peiris R. Root and canal morphology of human permanent teeth in a Srilankan and Japanese population. Anthropol Sci. 2008; 116:123–33.

[14]. Lipski M, Wozniak K, qagocka R, Tomasik M. Root and canal morphology of the first human maxillary premolar. Durham Anthropol J 2005; 12:2-3

[15]. Loh HS. Root morphology of maxillary first premolar in Singaporeans. Aust Dent J 1998; 43:399-402.

[16]. Ozcan E, Colak H, Hamidi MM. Root and canal morphology of maxillary first premolars in a Turkish population . J of Dent Sci 2012 Dec; 7 (4):390-394.

[17]. Awawdeh L, Abdullah H, Al-Qudah A. Root form and canal morphology of Jordanian maxillary first premolars. J Endod 2008; 34: 956-961.

[18]. Weine FS. Endodontic Therapy, 6th ed. St Louis, MO; London: Mosby; 2004

[19]. Gupta B, Tiwari B, Raj V, Kashyap B, Chandra S, Dwivedi N, et al. Transparent tooth model: A study of root canal morphology using different reagents. Eur J Gen Dent. 2014; 3: 66–70.

[20]. Ahmad IA, Alenezi MA. Root and root canal morphology of maxillary first premolars: A Literature review and clinical considerations. J Endod. 2016; 42:861–872.

[21]. Vertucci FJ, Gegauff A. Root canal morphology of the maxillary first premolar. J Am Dent Assoc 1979; 99:194-198.

[22]. Walker RT. Root form and canal anatomy of maxillary first premolars in a Southern Chinese population. Endod Dent Traumatol. 1987;3:130–134.

[23]. Ingle JI (1965) Endodontics. (1stedn), Lea and Febiger, Philadelphia.

[24]. Pineda F, Kuttler Y. Mesiodistal and buccolingual roentogenic investigations of 7,275 root canals. Oral Surg. 1972; 33:101–110.

[25]. Carns EJ, Skidmore AE. Configurations and deviations of root canals of maxillary first premolars. Oral Surg 1973; 36:880-886.

[26]. Chaparro AJ, Segura JJ, Guerrero E, Jimenez-Rubio A, Murillo C, Feito JJ Number of roots and canals in maxillary first premolars: study of an Andalusian population et al.. Endod Dent Traumatol 1999; 15:65-67.

[27]. Vertucci FJ. Root canal anatomy of the human permanent teeth. Oral Surg Oral Med Oral Pathol 1984; 58: 589 –599.

[28]. Caliskan MK, Pehlivan Y, Sepetcioglu F, Turkun M, Tuncer SS. Root canal morphology of human permanent teeth in a Turkish population. J Endod 1995; 21: 200 –204.

[29]. Sert S, Bayirli GS. Evaluation of the root canal configurations of the mandibular and maxillary permanent teeth by gender in the Turkish population. J Endod 2004; 30: 391– 839.