

ORIGINAL ARTICLE

ROOT CANAL CONFIGURATION OF MAXILLARY FIRST PREMOLAR TEETH IN A SUBPOPULATION OF PESHAWAR USING TOOTH CROSS-SECTIONING METHOD; AN INVITRO STUDY

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Background: Knowledge of tooth morphology is obligatory for achieving success in dental treatment. The root canal configuration of maxillary first premolar (MFP) has been shown to be highly varying. The study was conducted to assess the canal configurations in the roots of upper first premolars within a sample population of Peshawar with the help of tooth cross-sectioning method. **Methods:** The extracted 250 maxillary first premolars had undergone access cavity preparation after cleaning and pulp was removed from each individual tooth. The root canals were located in the pulp chamber floor and then India ink was injected in to their orifices. When the canals get stained the roots were cross-sectioned at three levels to assess the configurations of root canals using a categorization method devised by Weine. SPSS version 19 was used to analyze the data. A *p*-value of less than 0.05 was considered statistically significant. **Results:** Among 250 maxillary first premolars, the common root canal configuration was Weine's type-IV in 30.4% and type-III in 30.0% teeth. Weine's type-I and type-II were observed in 24.8% and 8.8% premolars, respectively. Variable root canal configurations were seen in 6.0% teeth. Apical delta was found in 1 (0.4%) tooth. A highly statistically significant difference was observed when root canal configuration was compared with external root morphology. **Conclusion:** Weine's type-IV and type-III root canal configurations were frequently observed in maxillary first bicuspid.

Keywords: Root canal configuration; Weine's classification; Maxillary first premolars; Tooth sectioning

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INTRODUCTION

Endodontic treatment is an important step of extensive, standard dental treatment.¹ For effective endodontic procedure, one must successfully clean and shape the root canal, effectively obturate it, and perfectly restore the crown.² This can only be achieved with complete knowledge about the morphology of internal surface of teeth. A dental practitioner must know the morphology of pulp cavity of the tooth to be treated.³ This awareness can help in locating the canals and consequent treatment.³ However, internal anatomy of tooth differs greatly in various populations or within a single population in different persons, therefore, accurate knowledge of the internal anatomy of dentition and their morphological variation is necessary for effective endodontic treatment.⁴

In dentistry, one among the most problematic tooth to be treated endodontically is the maxillary first premolar (MFP). It shows many variations in the anatomy of root surface and endodontic morphology.⁵ Some of the most widely described differences in the upper first bicuspid include differences in the number

and type of root and canals.⁶ The number and configurations of canals in one, two (bifurcated/laminated) and three rooted specimens of upper first bicuspid may vary individually depending on their backgrounds.⁷ Atieh⁸ performed a study on Saudi population and reported that 8.9% maxillary first premolars had Weine's Type-I, 26.8% had Weine's Type-II and 63.0 % had Weine's Type III root canal configuration.

Previous studies show that different techniques have been used to assess the morphology of root canal. Various techniques that have been used to evaluate internal anatomy of the root including, decalcifying, making sections, x-rays, computer aided procedures and replicating technique, etc.⁹ But among these root canal staining and cross-sectioning method is less costly, easy to conduct and does not require any complex modern expensive machines.¹⁰

Identification of the internal anatomy of root is crucial clinically, as it will help dental practitioners in depletion of errors during endodontic therapy. As no previous studies have evaluated the prevalence of endodontic configuration in any dentition in Peshawar

population, therefore, this research aimed to examine the root canal configuration of permanent upper first bicuspid teeth in a selected population of Peshawar using a tooth cross-sectioning technique.

MATERIAL AND METHODS

This cross-sectional study was conducted at Oral Biology department of Peshawar Dental College, Peshawar. The Institutional Review Board (IRB) of the Peshawar Medical and Dental College approved the study. A sample of consecutive extracted 250 upper first premolars with undamaged coronal and radicular anatomy were included in this study. The teeth were already extracted for periodontal or orthodontic reasons. All patients signed a written informed consent to allow their teeth to be used for research purpose in this study. The teeth were collected over a period of 9 months, i.e., from April, 2016 to December, 2016.

After extraction, all the teeth were washed. To remove any organic debris, the teeth were placed in 5.25% sodium hypochlorite solution for 30 minutes. Teeth with calculi were cleaned with the help of ultrasonic scaler. After cleaning they were kept in formalin (10%) solution. Morphology of outer surface of all the teeth were examined visually and their findings were noted. Based on the number and form of the root, specimens were divided into three groups; i.e., one-rooted, two rooted, and three rooted premolars.

A small hole was prepared as access to the pulp chamber in centre of the coronal surface of the tooth. When the access cavity was prepared, the pulp was obliterated by keeping the specimens for 4 hours in sodium hypochlorite solution (5.25 %) and followed by

washing with tap water for two hours. After that, teeth were kept at room temperature for one day to dry out. Through the coronal surface of the crown, a waterproof black ink was administered inside the pulpal cavity. This was done through root canal irrigation syringe having a needle of twenty-seven gauge, so that the root canal system becomes distinctly visible. Ethanol-soaked gauze was then used to remove any excessive ink from the tooth surface. After staining they were bench dried for 2 hours. All the sample had been mounted on slow speed saw (TechCut4™ USA) with diamond cutting blade shown in Fig.1 and roots were sectioned at three points (coronal, middle and apical 1/3rds).¹¹

Standardized digital photographs of these root sections were taken from a distance of 10 cm and zoom (x2.5) shown in figure-2.

An oral biologist having experience of more than five years, evaluated the root cross-sections following Weine's¹² classification of root canal configuration (Figure-3). The observations that were recorded are mentioned below.

- **Weine's type-I** → one orifice, one canal, one foramen
- **Weine's type-II** → two orifices, two canals, one foramen
- **Weine's type-III** → two orifices, two canals, two foramina
- **Weine's type-IV** → one orifice, two canals, two foramina

SPSS 19.0 was used to analyse data. Chi square test at 5% level of significance was used to determine association



Figure-1: Sectioning of tooth root by saw

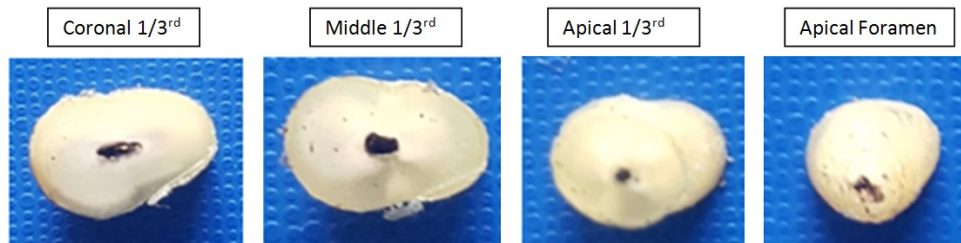


Figure-2: Digital photographs of root sections at three levels

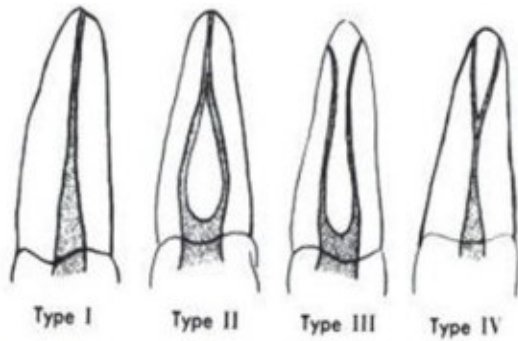


Figure-3: Weine's classification of root canal configuration

RESULTS

A sample of 250 extracted human teeth was observed for variation in root canal configuration of MFPs.

The commonly observed root canal configuration was Weine's type-IV found in 76 (30.4%) teeth and Weine's type-III was seen in 75 (30.0%) teeth. Weine's type-I root canal configuration was seen in 62 (24.8%) bicuspid and 22 (8.8%) premolars had Weine's type-II pattern. Few MFPs (n=15) bicuspid had variations from Weine's classification in their canal configurations. Five (2.0%) teeth out of these had canal pattern of 2 orifices, 1 canal and 1 foramen. Three (1.2%) had 1 orifice, 2 canals and 1 foramen and one (0.4%) tooth had 2 orifices, 1 canal and 2 foramina in its root canal system. Apical delta was found in 1 (0.4%) tooth. Five (2.0%) premolars had three roots and three orifices in floor of pulp chamber, three root canals and three separate apical foramina were seen (Table-1).

The data for the relationship of root number with their root canal configurations (Weine's Classification) is illustrated in Figure-4. Fifty-nine (52.7%) teeth had single root and Weine's Type I canal form in their root canal system. The two separate roots were purely of Weine's Type III in 57 (56.4%) teeth followed by Type IV in 44 (43.6%) teeth. The canal patterns found in three rooted teeth were different (Variation # 5) from Weine's classification (Tab.1 & Fig.4). Variations were prevalent in nine single rooted (8.0%) and in one out of two fused roots (3.1%) whereas no deviation was found in two separate root variety. The respective relationships of the various root canal configuration for all types of roots was statistically significantly different (p=0.001) as shown by Pearson Chi Square test (Figure-4).

Table-1: Frequency of root canal configurations of maxillary first premolars

Weine's Classification	Number of teeth (%)
Type 1	62 (24.8)
Type 2	22 (8.8)
Type 3	75 (30.0)
Type 4	76 (30.4)
Variation # 1	5 (2.0)
Variation # 2	3 (1.2)
Variation # 3	1 (0.4)
Variation # 4	1 (0.4)
Variation # 5	5 (2.0)
Total	250 (100.0)

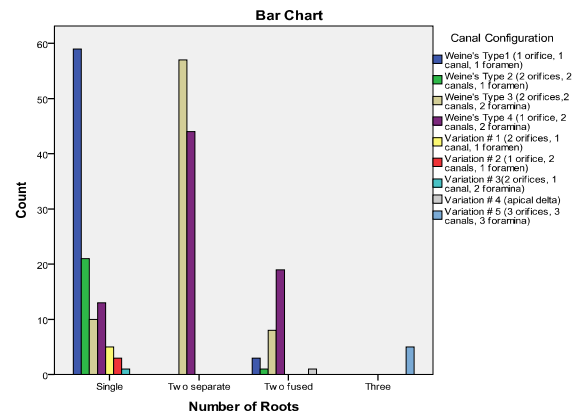


Figure-4: Relationship of root number with canal configurations of maxillary first premolars

DISCUSSION

A precise acquaintance of canal configurations of MFPs roots and their variation from normal morphology is mandatory for successful endodontic treatment.¹³ Root canal staining and cross-sectioning method had been used in this study because it was less costly, easy to conduct and does not require any complex modern expensive machines. Moreover, the actual path of the root canal was followed all the way from pulp chamber floor to apical foramen in order to give exact root canal configuration (Figure-3). A similar method had been adopted to detect the canal system of upper first premolar teeth in other studies as well.^{8,11,13}

In our study, Weine's classification had been used in its original form with no modifications because it was the only criteria which considered both canal orifices at pulp chamber floor and apical foramina at the same time. Also, most of the researchers who did in vitro root cross-sectioning had used it for determining canal shapes.^{8,13} In our study (Tab. 1), the findings were interestingly different from the afore mentioned studies regarding root canal shapes.^{8,13-15} The Weine's Types III and IV were observed in equal distribution, i.e.,30.0% and 30.4% respectively, among the total sample of 250 maxillary

first premolars. Weine's Type I was also in near range (24.8%) and Type II was identified in lower numbers (8.8%). Five (2.0%) teeth out of the total sample had three root canals, one canal in each root of the three rooted variety, was one of the common deviations (Variation # 5) among canal types in present study. This variation (3 orifices, 3 canals, 3 apical foramina) was described by Vertucci as Type VIII in his classification.¹⁶ The other common deviation from Weine's classification had 2 orifices at floor of pulp chamber, 1 canal within the root and 1 separate apical foramen (Variation # 1) was located in 5 (2.0%) bicuspid. Three (1.2%) upper bicuspid had another type of divergence from the normal anatomy having 1 orifice, 2 canals that exit as 1 foramen (Variation # 2) which was demonstrated as Type III in Vertucci's study.¹⁶ One other difference from Weine's classification in this study had 2 canal orifices followed by 1 canal and two apical foramina (Variation # 3) was observed in 1 (0.4%) tooth. These variations were attributed to the differences in evaluating procedure, sample size and classification system applied in this study.

In this study (Table-1), the most surprising difference (Variation # 4) was the presence of single canal that divides to form apical delta in the apical one third of the root in one (0.4%) premolar out of 250 teeth. The presence of apical deltas in maxillary first premolars ranged between 1.8–29.2% in literature.^{17,18} There was no apical delta reported in North Indian population in a study performed by Gupta *et al.*⁷ Likewise Turkish premolars also had no apical delta in their root canal configuration.¹³ The differences in origin and sample number of teeth may be responsible for this variation among the current study and the above-mentioned ones.

In the present setting (Figure-4), a highly significant statistical difference ($p < 0.05$) was observed when MFPs root number was compared with root canal configurations. It was prominent that MFPs having single root showed larger difference in root canal configurations as compared to two and three rooted forms. These findings were in accordance with the results of some earlier studies published in the literature.^{17,19}

The maxillary first premolars showed a great variation with respect to root canal configurations. The endodontists should keep these variations in mind while doing root canal treatments (RCTs) and handle these difficult canal morphologies by using their knowledge and available tools. For locating and negotiating such variable root canals, multiple guidelines and tools are available in literature like cautious reading and understanding of radiographs, access cavity of proper shape and size, watchful inspection of the floor of the pulp chamber to locate

orifices of the canals, use of magnifying tools such as dental loupes for clear visibility of the operating area.^{20,21}

One of the limitations of this study was that it was an in-vitro study that could not help the general dental practitioner at the time of performing procedure in intact maxillary first premolar inside the oral cavity.

CONCLUSION

Within the limitations of this study, the following conclusions could be made:

- Maxillary first premolars (MFPs) frequently showed Weine's type-IV and type-III root canal configurations as compared to Weine's type-I and type-II.
- Single rooted teeth showed more variations in their root canal configurations followed by two-fused rooted specimens.

AUTHORS' CONTRIBUTION

MAK: Conception of idea, literature search, write-up. FA: Conceptualization of study design. NA: Data interpretation. SA: Data collection, data analysis. IK: Critical appraisal. YJK: Final proof reading.

REFERENCES

1. Tabassum S, Khan FR. Failure of endodontic treatment: The usual suspects. *Eur J Dent* 2016;10(1):144–7.
2. Patnana AK, Chugh A. Endodontic management of curved canals with protaper next: A case series. *Contemp Clin Dent* 2018;9(Suppl 1):S168–72.
3. Baroudi K, Kazkaz M, Sakka S, Tarakji B. Morphology of root canals in lower human premolars. *Niger Med J* 2012;53(4):206–9.
4. Kulkarni V, Duruel O, Ataman-Duruel ET, Tözüm MD, Nares S, Tözüm TF. In-depth morphological evaluation of tooth anatomic lengths with root canal configurations using cone beam computed tomography in North American population. *J Appl Oral Sci* 2020;28(1):e20190103.
5. Sulaiman AO, Dosumu OO, Amedari M. Maxillary first premolar with three root canals: a case report. *Ann Ib Postgrad Med* 2013;11(2):105–8.
6. Mashyakhy M, Gambarini G. Root and root canal morphology differences between genders: a comprehensive in-vivo CBCT study in a Saudi population. *Acta Stomatol Croat* 2019;53(3):231–46.
7. Gupta S, Sinha DJ, Gowhar O, Tyagi SP, Singh NN, Gupta S. Root and canal morphology of maxillary first premolar teeth in north Indian population using clearing technique: an in vitro study. *J Conserv Dent* 2015;18(3):232–6.
8. Atieh MA. Root and canal morphology of maxillary first premolars in a Saudi population. *J Contemp Dent Pract* 2008;9(1):46–53.
9. Maghfuri S, Keyhani H, Chohan H, Dakkam S, Atiah A, Mashyakhy M. Evaluation of root canal morphology of maxillary first premolars by cone beam computed tomography in Saudi Arabian southern region subpopulation: An in vitro study. *Int J Dent* 2019;2063943.
10. Assadian H, Dabbaghi A, Gooran M, Eftekhar B, Sharifi S, Shams N, Najvani AD, Tabesh H. Accuracy of CBCT, digital radiography and cross-sectioning for the evaluation of

- mandibular incisor root canals. Iranian Endod J 2016;11(2):106.
11. Khedmat S, Assadian H, Saravani AA. Root canal morphology of the mandibular first premolars in an Iranian population using cross-sections and radiography. J Endod 2010;36(2):214–7.
 12. Weine FS, Healey HJ, Gerstein H, Evanson L. Canal configuration in the mesiobuccal root of the maxillary first molar and its endodontic significance. Oral Surg Oral Med Oral Pathol 1969;28(3):419–25.
 13. Özcan E, Çolak H, Hamidi MM. Root and canal morphology of maxillary first premolars in a Turkish population. J Dent Sci 2012;7(4):390–4.
 14. 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. Dent Traumatol 1999;15(2):65–7.
 15. Lipski M, Wozniak K, Lagocka R, Tomasik M. Root and canal morphology of the first human maxillary premolar. Durham Anthropol J 2005;12:2–3.
 16. Vertucci FJ. Root canal anatomy of the human permanent teeth. Oral Surg Oral Med Oral Pathol 1984;58(5):589–99.
 17. Pineda F, Kuttler Y. Mesiodistal and buccolingual roentgenographic investigation of 7,275 root canals. Oral Surg Oral Med Oral Pathol 1972;33(1):101–10.
 18. Weng XL, Yu SB, Zhao SL, Wang HG, Mu T, Tang RY, *et al.* Root canal morphology of permanent maxillary teeth in the Han nationality in Chinese Guanzhong area: a new modified root canal staining technique. J Endod 2009;35(5):651–6.
 19. Abella F, Teixidó LM, Patel S, Sosa F, Duran-Sindreu F, Roig M. Cone-beam computed tomography analysis of the root canal morphology of maxillary first and second premolars in a Spanish population. J Endod 2015;41(8):1241–7.
 20. Cantatore G, Berutti E, Castellucci A. Missed anatomy: frequency and clinical impact. Endod Topics 2006;15(1):3–31.
 21. Vertucci FJ. Root canal morphology and its relationship to endodontic procedures. Endod Topics 2005;10(1):3–29.

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