
Variations in The Number of Roots and Root Canals in Maxillary Second Molars- A Review of Literature

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Abstract: The dental professional should be familiar with the differences of number of root and root canal system anatomy, which at some aspects provides specific dental anomalies of tooth and helpful in analysing in the clinical field. The main aim for patients and doctors is to relieve pain and maintain natural teeth with similar morphology. Root canal therapy is mostly the treatment of choice for teeth with pulpal and periradicular affected teeth. Effective treatment is required for good mechanical and chemical cleaning and shaping and provides a compact obturation under aseptic conditions with an inert filling material. The major reason for endodontic failure is the existence of untreated canals. A detailed diagnosis of the root canal system anatomy is a requirement for effective treatment of root canals. This review shows incidence of root and root canal variations in maxillary second molars. The presence of root canal orifices helps in diagnosis of preoperative radiographs and examination of the pulp.

Keywords: Maxillary 2nd molar; Root canal morphology; Maxillary molar; Root canal; diagnosis; variation; abnormality

INTRODUCTION:

A review of the literature on the anatomy of the maxillary second molar shows that the standard anatomical shape of this tooth has three roots (Jeevanandan, 2017). The classic study had provided examples of differences in maxillary second molar anatomy as far back as 1925, which featured only three-rooted teeth. Many subsequent studies focus mainly on the occurrence of more than one canal in each root. Some divergence from this morphology may seem to have been considered an exception and therefore received very little attention. In addition, most papers concerned primarily the anatomy of the mesiobuccal root (Nosonowitz and Brenner, 1973) and Number of canals within this root and type of channel system (Sakamuri and Mallineni, 2018). For example, in studying 51 first maxillary molars and 32 second maxillary molars (Patel and Patel, 2012) concluded that 'the usual anatomy of the first and second maxillary molars is two channels in the mesiobuccal root. This argument presumes that there are three roots in every maxillary second molar. Though other authors observed that there were some variations (Fahid and Taintor, 1988). Only listed them in a row. There has been no further explanation or discussion of such variations. Several examples of differences in second molar root anatomy have been shown in the study of the prevalence of fused roots and C-shaped roots in maxillary molars in the Chinese population. But the anatomy of the related canal was not discussed. They addressed the root complex including, in general, root fusion in maxillary molars (Deveaux, 1999). Our team has rich experience in research and we have collaborated with numerous authors over various topics in the past decade (Deogade, Gupta and Ariga, 2018; Ezhilarasan, 2018; Ezhilarasan, Sokal and Najimi, 2018; Jeevanandan and Govindaraju, 2018; J et al., 2018; Menon et al., 2018; Prabakar et al., 2018; Rajeshkumar et al., 2018, 2019; Vishnu Prasad et al., 2018; Wahab et al., 2018; Dua et al., 2019; Duraisamy et al., 2019; Ezhilarasan, Apoorva and Ashok Vardhan, 2019; Gheena and Ezhilarasan, 2019; Malli Sureshbabu et al., 2019; Mehta et al., 2019; Panchal, Jeevanandan and Subramanian, 2019; Rajendran et al., 2019; Ramakrishnan, Dhanalakshmi and Subramanian, 2019; Sharma et al., 2019; Varghese, Ramesh and Veeraiyan, 2019; Gomathi et al., 2020; Samuel, Acharya and Rao, 2020)

DISCUSSION

Variation in number of roots

Studies for anatomical variations and abnormalities related to maxillary second molars are not so numerous. The maxillary second molar root canal system is complex and is difficult to treat. Typically a maxillary second molar has three roots (mesiobuccal, distobuccal, and palatal) each having one root canal (Paul, 2013). It can have up to three mesial channels, two distal channels and two palatal root channels. Most of the maxillary second molars have 3 root canals in 57% of the teeth while 4 root canals are present in 31.7% of the teeth. The 4th canal was found mainly in the teeth's mesiobuccal root (Table 1). There are some case reports in the maxillary second molar teeth showing two distinct canals in distobuccal and palatal (P) roots. The presence of fourth channel (MB) for maxillary second molar in-vivo ranges from 22.7 per cent to 50.7 per cent.(M, Purushotham and Sahoo, 2020). Just two channels recorded in 8.1 percent while only one root canal reported in 3.2 percent of the second molar maxillary teeth. Some other studies also indicate differences in the number of root canals in the maxillary second molar teeth, and their size. (Chhabra, 2013)

Table 1 : Comparison of findings of maxillary second molar root.

Study	Technique	Sample size	One root	Two Root	Three Root	Four Root	Five Root
(Jha, Nikhil and Jha, 2012)	CBCT	500	5%	20%	62%	11.4%	1.4%
(Zmener and Peirano, 1998)	Clearing	549	12.02 %	20.04%	64.67%	1.28%	2%
(Peikoff, Christie and Fogel, 1996)	CBCT	677	15.81 %	20.34%	60.12%	0.74%	3.34%
(Sakamuri and Mallineni, 2018)	CBCT	10226	11.11 %	21.86%	63.05%	0.98%	3%
(Vida et al., 2020)	Micro - CT	375	82.9 %	82.9%	15.5%	1.6%	-
(Graber, 1969; Paul, 2013)	CBCT	425	26.5 %	73.5%	-	-	-

Variation s in number of canals.

Such variation in the single-root and single-channel maxillary molar can be easily detected in routine x-rays. However, multiple preoperative x-rays can help us differentiate if two channels are present overlapping each other oral. The use of advanced diagnostic methods such as CBCT will help to rule out complex root canal anatomies where the X-ray is not definitive (Almeida-Gomes et al., 2007). Variation is reported less frequently in root canal anatomy of the maxillary molar having a single root and single channel(Kanyal et al., 2016). The literature review stated that the occurrence of a single root and single channel maxillary second molar was 0.5-3.1 per cent (Madjapa and Minja, 2018). The occurrence of 0.9 percent with a single root in the maxillary second molar was reported in an Indian population survey, but none with a single root canal was reported.(Gusiyska, 2010; Di Ventura et al., 2019)). Searching for a missing canal can result in iatrogenic mishaps, such as perforation or premature removal of the tooth(Table 2). This type of error can be avoided if a clinician has a general idea of the variations in the root canal system (Uslu, 2018). It can be achieved by detailed preoperative assessment of the root canal system with several angled root canals and the use of CBCT while providing contradictory opinions regarding the complex root canal system. In these situations, the use of magnifying loupes or a dental operative microscope can be very useful in performing the ideal treatment of root canals(Suresh, 2017).

Table 2 : Comparison of findings of maxillary second molar canals.

Study	Technique	Sample size	One canal	Two canal	Three canal	Four Canal
(Hazar, Sağlam and Hazar, 2017a,	Micro-CT	292	3.1%	6.9%	65.9%	24.1%

2017b))						
(Mittal and Malik, 2016)	Clearing	176	1%	8%	81.8%	9.6%
(Woodhouse, 1983)	CBCT	802	10.62%	10.71%	63.58%	15%
(‘Unusual Anatomy of a Second Maxillary Molar - a Rare fourRoot Configuration Case Report’, 2016)	CBCT	315	2.55%	52.87%	42.63%	1.9-

Necessity to analyse the variation:

False assumptions about the anatomy of the root canal of teeth can lead to misdiagnosis, inadequate debridement, step formation and instrument breakage during root canal care (Shafqat, Munir and Sajid, 2018). Problems encountered during endodontic treatment of permanent molar teeth indicate the need for increased knowledge of root canal system anatomy(Kanyal et al., 2016). The maxillary two-rooted second permanent molar teeth usually have three canals. Two root canals, with one root canal in the distal root, are found in the mesial root (Woodhouse, 1983). The prevalence of three root canals in maxillary permanent molar teeth was (Fahid and Taintor, 1988) reported at 78 per cent. The mesial root has two root canals with one apical in 40–45 percent of two-rooted maxillary second permanent molar teeth(Table 3). In vitro studies showed that the prevalence of two root canals in the distal root of permanent maxillary molar teeth was nearly 30%. A clinical study performed on 251 root canal-treated maxillary first permanent molar teeth of a subpopulation in Saudi Arabia reported that 6% of the teeth had three roots, 58% had three roots and 58% had three roots and 42% had three root canals (Mittal, Parashar and Patel, 2020) .

Table 3 : Root canal morphology of Maxillary Second molar (Vertucci classification)

Study	Technique	Sample Size	I	II	III	IV	V	VI	VII	VIII
(Ahuja, Ballal and Velmurugan, 2012)	Clearing	535	42.6 %	47.1 %	-	8.03 %	1.87%	0.93%	-	-
(Sakamuri and Mallineni, 2018)	Clearing	36	41.6 %	5.5%	4.7%	19.4 %	15.6%	13.8-	-	-
(Şımşek, Keleş and Bulut, 2013)	Clearing	38	78.95 %	13.16 %	5.56%	4.63 %	-	-	-	-
(‘Unusual Anatomy of a Second Maxillary Molar - a Rare fourRoot Configuration Case Report’, 2016)	CBCT	77	71.43 %	14.29 %	2.60%	3.90 %	7.78%	-	-	-
(Jeevanandan, 2017)	Clearing	644	63.48 %	16.06 %	0.30%	15.15 %	2.42%	0.15%	-	-
(Walsh and Smith, 1980)	CBCT	802	36.41 %	20.45 %	0.25%	40.65 %	2%	0.12%	-	-

Treatment of complication due to variation in root canals

Clinicians should be aware of anatomical variations in maxillary molar and be able to apply this knowledge in radiographic and clinical analysis. Variations in root canal anatomy are due to many of the difficulties found in root canal treatment. Only the treatment of uncomplicated multirrooted teeth includes knowledge of the most common anatomical structures and potential variations. Extra roots are an additional challenge (Gusiyska, 2010; Radwan and Kim, 2014). Typically premolars with three root canals can be successfully handled with a non-surgical endodontic method (Sinha et al., 2012). The buccal orifices are similar to each other in the first and second maxillary three-rooted molars, which can be difficult to find. The preparation, as suggested by a cut at the buccal-proximo angle from the entry of the buccal canals to the cavo-surface angle provides a helpful, T-shaped outline of access. For good root canal care, it is important to correctly reach all the root canals, clean and form, followed by a hermetic filling (Bansal et al., 2019). Except for the minor occurrence of maxillary molars with three canals and three roots, the possible anatomic configurations of maxillary molars are well known in the literature. Whenever there is an indication of a different anatomy, additional periapical X-rays should be exposed at a horizontal angle, either mesial or distal. This will be accompanied by thorough x-ray analysis (Badole et al., 2012).

Effective technique to analyse variation

CBCT :

The ideal method for accurately determining a tooth's root canal morphology is serial sectioning of the tooth which is not practical in clinical situations (Ramamoorthi, Nivedhitha and Divyanand, 2015). This makes illumination, careful interpretation of angled x-rays, proper preparation of access, detailed exploration of the dental map, uncovering the chamber floor, countering the floor, searching for bleeding spots, Use of ultrasonic instruments, lubricating and chelating agents, use of precise hand files and magnification by dental loupes and operating microscopes and more recent CBCT, micro-CT and spiral computed tomography (Ramanathan and Solete, 2015). The most important factor however is the clinician's awareness that these canal variations exist. These variations may result from many factors including ethnic origin (Siddique et al., 2019).

Radiograph :

The identification of additional root canals requires high quality preoperative radiographs and their thorough analysis (R, Rajakeerthi and Ms, 2019). The clinician should carefully trace the outline of the tooth and its interior in the radiograph with sufficient magnification ocular loops, magnifier viewer (Rajendran et al., 2019). Intersecting lines suggest there are additional roots or root canals (Hussainy et al., 2018). A general rule is that if the diameter of the mid-root image tends to be equal to or greater than the diameter of the crown image, the root canal shape of the tooth is more likely to differ recommended the application of two diagnoses (Nandakumar and Nasim, 2018). Radiographs, one of which was ortho-radial and the other taken mesially or distally by 30°, depending on the anatomical location of the tooth being examined (Kumar and Delphine Priscilla Antony, 2018). When a radiolucent line to the main channel is mesial or distal, an additional channel should be considered (Ravinthar and Jayalakshmi, 2018). If an x-ray shows a sudden narrowing or even a vanishing pulp space, the canal diverges at that point into two parts that may either remain separate or merge before reaching the apex (Noor, S Syed Shihaab and Pradeep, 2016)

Examination of the pulp chamber floor

The root canal network of molars with three root canals is distinguished by a broad lingual or palatal canal in the mesiobuccal and distobuccal root, and two smaller canals (Janani, Palanivelu and Sandhya, 2020). If only one eccentric orifice can be located, at least one more canal is present and the opposite side should be looked for (Teja, Ramesh and Priya, 2018). It is advised to use means of magnification (eye loops, microscope) and extra lighting (Jose, P. and Subbaiyan, 2020). A third channel should be clinically suspected when the pulp chamber does not appear to be aligned in its planned buccal-lingual relationship (Manohar and Sharma, 2018). Our institution is passionate about high quality evidence based research and has excelled in various fields ((Pc, Marimuthu and Devadoss, 2018; Ramesh et al., 2018; Ezhilarasan, Apoorva and Ashok Vardhan, 2019; Ramadurai et al., 2019; Sridharan et al., 2019; Vijayashree Priyadharsini, 2019; Mathew et al., 2020)

CONCLUSION

The typical three-rooted tooth is only one anatomical variant of the maxillary second molar tooth observed during root canal treatment. Variations in the maxillary second molar's root anatomy, which include fewer or greater numbers of roots than the three-root forms normally described, occurred much more frequently than previous reports would lead the practitioner to expect. This could give ideas on treatment planning and canal variation diagnosis thereby decreasing the root canal treatment failure rate. This study provides doctors with knowledge about the root number and canal variations.

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