

The Incidence of a Fourth Canal in Maxillary and Mandibular First Molars in a Group of Jordanians: A Clinical Study

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ABSTRACT

Objectives: The aim of this study was to clinically investigate the incidence of a fourth canal in maxillary and mandibular first molars in a group of Jordanians while carrying out routine endodontic practice without using any magnification or special lighting conditions.

Methods: Three hundred ninety nine patients were referred to the conservative clinic at Princess Aysha Bint Al-Hussein Medical Complex for endodontic treatment of maxillary or mandibular first molars from November 2008 till May 2009. Preoperative radiographs were taken for evaluation. The teeth included in the study were both clinically and radiographically examined for the number of root canals.

Results: A total of 399 patients (216 female and 183 male) were treated at the conservative clinic. The mean age of patients was 28.23 years, ranging from 13.0 to 66.0 years. Out of 399 teeth treated endodontically, 195 (48.9%) were maxillary first molars and 204 (51.1%) were mandibular first molars. Forty five teeth (23.08%) out of the 195 treated maxillary first molars had second canal (Mb2) in the mesiobuccal root; all the distobuccal and palatal roots had a single canal. Regarding the mandibular first molars out of the 204 treated teeth, 99 teeth (48.5%) had 4 canals; two mesial and two distal canals.

Conclusion: A fourth canal was found in about 23% of maxillary first molars and in about 49% of mandibular first molars. There is no consistency in the incidence of extra canals. This may be due many variations including the study design, the method of canal identification and the racial variations.

Key words: Incidence of a fourth canal, Mandibular first molars, Maxillary first molars.

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Introduction

The ultimate goal of root canal treatment is a thorough cleaning and shaping of all pulp spaces and the complete obturation of these spaces with an inert filling material.⁽¹⁾ Therefore, the knowledge of root canal anatomy of each tooth is

crucial in order to reach this goal.⁽²⁾

Sometimes a root canal can go untreated because the clinician fails to detect it. The inability to locate extra canals will result in failure of endodontic treatment.

Diagnostic measures are of great help in locating root canal orifices. These measures

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include obtaining and careful interpretation of multiple pre-treatment radiographs, adequate access and modification of the outline of the access cavity, exploration of the tooth's interior and exterior and examination of the pulp chamber floor with appropriate magnification and illumination.^(1,3)

The internal anatomy of the human teeth has been studied by many investigators using different techniques such as sectioning of teeth,^(4,5) clearing techniques,^(6,7,8) radiography,^(9,10) examination under operating microscope,⁽¹¹⁾ examination with a scanning electron microscope⁽¹²⁾ and cone-beam computed tomography techniques.^(13,14)

Locating the position and number of root canals can be difficult especially when the tooth being treated is malposed, heavily restored, or calcified.⁽³⁾

The maxillary first molar usually has three roots with a single canal located in each root except with the mesiobuccal root in which a second canal may be present. *In vitro* studies indicated this second mesiobuccal canal (Mb2) in 25%-95.2 % of extracted teeth.^(4,12,15) While *in vivo* studies have produced much lower figures 3.3%-73.2%.^(16,17) This apparently reflects the difficulty in locating the extra canals in clinical endodontic practice if unaided by the use of magnifying aids such as surgical loupes or a dental operating microscope.⁽¹⁸⁾

The mandibular first molar seems to be the tooth that most often requires root canal treatment.⁽¹⁾ The tooth usually has two roots (mesial and distal) with two canals in the mesial root and one canal in the distal.⁽¹⁾ The incidence of four canals in the mandibular first molar has been reported in the literature between 22%-59%.^(19, 20)

The study of root canal anatomy has endodontic as well as anthropological significance.^(21,22) It is well known that tooth anatomy varies according to racial origin.^(10,23) Therefore it is very important to be familiar with variations in tooth anatomy and characteristic features in various racial groups since such knowledge can aid in location and negotiation of canals, as well as their subsequent management.

The aim of this study was to clinically investigate the incidence of a fourth canal in maxillary and mandibular first molars in a group of Jordanians in routine endodontic practice

without using any magnification or special lighting conditions.

Methods

Three hundred ninety nine patients were referred to the conservative clinic at Princess Aysha Bint Al-Hussein Medical Complex for endodontic treatment of maxillary or mandibular first molars from November 2008 till May 2009. Preoperative radiographs were taken for evaluation (root morphology, number of canals and periapical status). The teeth that were included in the study were those teeth that required nonsurgical endodontic treatment. The included teeth were free of root resorption, had no calcifications or open apices. No retreatment cases were included in the study.

The endodontic procedures undertaken were as follows: Local anesthesia (Ubistesin Forte/ 3M ESPE, Seefeld-Germany) was administered. Under rubber dam isolation an access cavity was prepared with sterile high and low speed burs with water coolant. In maxillary first molars the outline of the access cavity was modified to a rhomboidal shape to improve visibility of the second mesiobuccal canal orifice while in mandibular first molars, the access cavity outline was modified to a more rectangular shape to expose the location of the second distal canal orifice. After the contents of the pulp chamber were removed, a sharp endodontic explorer was used to explore the developmental grooves carefully to locate the orifices of the canals. Copious amounts of 2.5% sodium hypochlorite irrigation were used.

The MB2 canal was considered present only when the canal could be traced and enlarged to a length of at least 1/2 or more of the main mesiobuccal canal. Pulp tissue was extirpated using barbed broaches (Nerve Broaches/ Alfred Becht-GmbH, Germany) or H-Files (Mani inc, Japan) the canals were flared with gates glidden drills number 2,3 and 4 (Mani inc, Japan). Periapical radiographs with different angles were taken for evaluation of the number of root canals and for confirmation of the working length after inserting size 15,20 or 25 K files (Mani inc, Japan) in the canals.

The teeth included were both clinically and radiographically examined by two specialist with more than 10 years of experience for the presence

of a second mesiobuccal canal in maxillary first molars and a second distal canal in mandibular first molars and the incidence of a fourth canal in maxillary and mandibular first molars was calculated.

Results

A total of 399 patients (216 females and 183 males) were treated at the conservative clinic at Princess Aysha Bint Al-Hussein Medical Complex from November 2008 till May 2009. The mean age of patients was 28.23 years, ranging from 13.0 to 66.0 years.

An overall of 399 teeth were treated endodontically. 195 (48.9%) were maxillary first molars while 204 (51.1%) were mandibular first molars.

Forty five teeth (23.1%) out of the 195 treated maxillary first molars had a second canal (Mb2) in the mesiobuccal root. All the distobuccal and palatal roots had a single canal. The 195 patients who had their maxillary first molars treated endodontically were 93 (47.7%) females and 102 (52.3%) males. Out of the 93 females 21(22.6%) had a 4th canal, whereas for the 102 males 24 (23.5%) had a fourth canal (Table I).

Regarding the mandibular first molar out of the 204 teeth, 99 teeth (48.5%) had four canals; two mesial and two distal canals. Of those 204 patients, 123(60.3%) were females and 81(39.7%) were males. The incidence of fourth canal was 51.2% in females and 44.4% in males (Table I).

Discussion

The cause of most endodontic failures is inadequate biomechanical instrumentation of root canal system.⁽³⁾ This can result from inadequate knowledge of root canal anatomy, because one can never know before treatment how many root canals are in a tooth. Together with diagnosis and treatment planning, knowledge of common root canal morphology and its frequent variations is a basic requirement for endodontic success.⁽¹⁾ This emphasizes the belief that it is easier to recognize a feature if one is already prepared to see it.

There is a lack of consistency in the reported incidence of 2nd mesiobuccal canal (Mb2) in maxillary 1st molars in the literature. The differences may be due to the study design

(clinical versus laboratory), method of canal identification (radiographic examination, root sectioning, canal staining and root clearing, examination with SEM or cone-beam computed tomography techniques) or true differences in the sample under investigation (racial variation). Table II shows the variation in the incidence of Mb2 in different studies with different variations.

In clinical practice, the location of the Mb2 in the maxillary 1st molar is always challenging. This canal usually originates lingual and slightly distal to the main Mb canal, but occasionally shares the same orifice with it.^(4,12) The canal is not always visible after access cavity preparation as it is often smaller and covered by calcifications.⁽⁴⁾ In the present study Mb2 canal in the maxillary 1st molar was located in 23.08% the result is in agreement with a study done on Saudi population by Al-Nazhan, who reported an incidence of 23.3%.⁽³⁰⁾ It is also within the range that has been reported by most investigators in clinical studies.^(16,17) Comparing to an *in vitro* study that has been done by Khraisat and Smadi, on Jordanian population the incidence is much lower.⁽²⁸⁾ This difference may be due to the study design because the incidence of additional canals in the Mb root of maxillary first molar has produced much higher figures in *in vitro* studies.^(4,12,15)

Investigators who have attempted both laboratory and clinical methods have reported a higher chance of finding two canals in Mb roots in the laboratory, highlighting the difficulty of finding the Mb2 canal clinically.^(5,7,16) Abiodun-Solanke *et al.* recorded the incidence of additional canal in maxillary first molar of Nigerian population and found in the laboratory phase of the study that 23% of the sectioned teeth had Mb2 while for the clinical phase of the study they found that only 3.3% of the treated teeth had Mb2.⁽¹⁶⁾ Limited access and visibility and non-constant location of the second canal as well as the risk of perforation may explain the lower incidence of having two canals in the mesial root of maxillary molars in clinical practice when compared with laboratory studies. Clinically, finding the Mb2 canal can be improved by modification of the outline of the access cavity, and by widening and deepening the groove running palatally from the major mesiobuccal canal orifices.

Table I: Incidence of fourth canal in maxillary and mandibular first molars

Maxillary first molar		No. of canals (%)		
		Female	Male	Total
	3 canals	72 (77.4)	78(76.5)	150(76.9)
	4 canals	21 (22.6)	24(23.5)	45(23.1)
Total no. of teeth		93	102	195
Mandibular first molar		No. of canals (%)		
		Female	Male	Total
	3 canals	60(48.8%)	45(55.6%)	105(51.5)
	4 canals	63(51.2%)	36(44.4%)	99(48.5)
Total no. of teeth		123	81	204

Table II: Incidence of fourth canal in maxillary first molar in previous published studies

Racial origin of sample	Study	Incidence of 4th canal (%)	Type of the study	Size of the Sample
Ting & Nga, 1992 ⁽⁵⁾	South East Asian	100	Laboratory (conventional endo.) Laboratory (root sectioning)	31 50
Fogel <i>et al</i> , 1994 ⁽²⁴⁾	Canadian	208	Clinical (DOM)	71.2
Imura <i>et al</i> , 1998 ⁽⁷⁾	Brazilian	42	Laboratory (before clearing) Laboratory (after clearing)	52.3 80.9
Wein <i>et al</i> , 1999 ⁽¹⁰⁾	Japanese	293	Laboratory (conventional endo.& radiographs.)	75.8
Stropoko, 1999 ⁽¹⁷⁾	American (Boston university)	1096	Clinical	73.2
Wasti <i>et al</i> , 2001 ⁽²⁵⁾	South Asian Pakistanis	30	Laboratory (canal staining & root clearing)	53
Schwaze, 2002 ⁽²⁶⁾	German	50	Laboratory (conventional endo & loops) Laboratory (conventional endo & DOM)	41.3 93.7
Alavi <i>et al</i> , 2002 ⁽⁸⁾	Thai	52	Laboratory (canal staining & clearing)	61.5
Teixeira, 2003 ⁽²⁷⁾	Brazilian	50	Laboratory (sectioning & staining)	29.5
Khraisat & Smadi 2007 ⁽²⁸⁾	Jordanian	100	Laboratory (canal staining & root clearing)	77.3
Abiodun-Solanke <i>et al</i> , 2008 ⁽¹⁶⁾	Nigerian	30 100	Clinical Laboratory (sectioning)	3.3 23
Al-fouzan <i>et al</i> , 2011 ⁽²⁹⁾	Saudi Arabian		Clinical	51.3
Present study	Jordanian	195	Clinical	23.1

Table III: Incidence of fourth canal in mandibular first molar in previous published studies

Study	Racial origin of sample		Size of the sample	Type of the study	Incidence of 4 th canal (%)
Wasti, <i>et al</i> , 2001 ⁽²⁵⁾	South Asian	Pakistanis	30	Laboratory (canal staining & root clearing)	50
Gulabivala <i>et al</i> , 2002 ⁽³⁸⁾	Thai		118	Laboratory (canal staining & root clearing)	30
Sert <i>et al</i> , 2004 ⁽¹⁹⁾	Turkish		200	Laboratory (canal staining & root clearing)	22
Ahmad <i>et al</i> , 2007 ⁽²⁰⁾	Sudanese		100	Laboratory (canal staining & root clearing)	59
Pattanshetti <i>et al</i> , 2008 ⁽³⁶⁾	Kuwaiti		110	Clinical	49
Chen <i>et al</i> , 2009 ⁽³⁷⁾	Taiwan, Chinese		183	Laboratory (canal staining & root clearing)	46
Al-Qudah <i>et al</i> , 2009 ⁽³⁵⁾	Jordanian		330	Laboratory (canal staining & root clearing)	46
Jang <i>et al</i> , 2012 ⁽³⁹⁾	Korean population	sub-	780	Clinical (Cone - beam computed tomography)	34.2
Present study	Jordanian		204	Clinical	48.5

The use of dental loupes and dental operating microscope (DOM) provides the clinician with superior lighting and magnification improving the ability to treat cases and finding extra canals.⁽³¹⁾ Buhrely *et al.* reported the incidence of a Mb2 canal when the teeth examined using traditional techniques to be 17.2% but with the use of operating microscope as a magnifying aid the incidence increased to 62.5%.⁽³¹⁾ The clinical studies adapting the surgical microscope in conjunction with a modified access cavity have reported a higher incidence of Mb2 canals.^(5,17,24) In this study no magnification aids were used due to inavailability, this may contributed to the low incidence of Mb2 in maxillary first molars due to the possibility of missing some extra canals. All the distobuccal and palatal roots of teeth received endodontic treatment had a single canal. This is similar to the findings in studies done by Wasti *et al.* and Alavi *et al.*^(8,25) However, other researchers reported contrasting results. Maggiore *et al.* reported cases of maxillary first molars with six canals: two in each root.⁽²⁾ Baratto- filho *et al.* and Shetty *et al.* reported cases of maxillary first molars with two palatal roots.^(32,33) Kottor *et al.* reported a case with three roots and seven canals (three canals in the mesiobuccal root, two canals in the distobuccal root and two canals in the palatal root).⁽³⁴⁾

Regarding the mandibular first molar, in this

study 48.5% of the teeth had four canals two mesial and two distal canals. The result is in agreement with the findings of Al-Qudah and Awawdeh, who reported that 47% of their specimens from Jordanian population had 4 canals.⁽³⁵⁾ It is also comparable to other studies done by Wasti *et al.*, Pattanshetti *et al.* and Chen *et al.*^(25,36,37) Table III shows some of the studies on the incidence of four canals in the first mandibular molar in different ethnic groups.

Some researchers reported unusual variation in the number of canals in mandibular first molars. Berna and Badanelli reported two cases where three separate canals existed in the mesial and distal roots of the first mandibular molar.⁽⁴⁰⁾

In clinical practice, the important factors which help in locating and treating extra canals are the clinician's awareness of their presence and the allocation of sufficient time and effort to locate and treat these canals using all the available useful equipments.

Conclusion

A fourth canal was found in about 23% of maxillary first molars and in about 49% of mandibular first molars. There is no consistency in the incidence of extra canals. This may be due many variations including: the study design, the method of canal identification and the racial variations.

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