Article published online: 2021-11-01

ORIGINAL ARTICLE

Determination of additional canals in maxillary first permanent molars in adult Nigerian population: Using *in vivo* and *in vitro* techniques

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ABSTRACT

Objective: To determine the prevalence of additional canals in maxillary first permanent molar in an adult population in Nigeria. **Materials and Methods:** This was a cross sectional study done using both *in vivo* and *in vitro* techniques. A total of 156 teeth were used; 50 for the *in vivo* and 106 for the *in vitro* study. Dental loupes and gentle troughing of the pulpal floor was done, to look for additional canal in the *in vivo* study, while the teeth *in vitro* study were sectioned at three levels after impregnation with a dye and magnifying glass was used to look for additional canals. **Results:** In the *in vivo* aspect of the study a total of 50 patients were treated, of this number 17 (34.0%) had additional canals, these were all found in the mesiobuccal roots. In the *in vitro* phase of the study 106 teeth were examined, sectioning at the cementoenamel junction revealed that 6 (5.7%) and 2 (1.9%) of the mesiobuccal and palatal roots had additional canals. Sectioning at the furcation and middle of the mesiobuccal, distobuccal and palatal roots revealed that 76 (71.1%) and 80 (75.5%) of the mesiobuccal roots respectively had additional canals. **Conclusion:** It can be concluded, from the clinical, as well as the laboratory aspect of this study that the incidence of additional canals in the maxillary first permanent molar, in this environment, is much higher than what was previously reported, and when these additional canals are present, they are usually found in the mesiobuccal root.

Key words
Additional canal, maxillary first permanent molar, microscopy, Nigerian, troughing

INTRODUCTION

The maxillary first permanent molars are very important in the dental arch and the clinician should strive to maintain them. They are the second most common carious teeth after the first mandibular molar and often undergo endodontic treatment or extraction.[1] Up to 21% of all extracted teeth are maxillary first permanent molars.[1] This tooth is among the first group of permanent teeth to erupt into the oral cavity and takes part in the development of functional occlusion and mastication of an individual. When this tooth is lost, the following problems can ensue; diminished function, 50% reduction in chewing efficiency of the patient, shifting of the load of mastication to the unaffected side, unhygienic condition of the unused side and continued eruption of the opposing tooth.

Access this article online	
Quick Response Code:	Website: www.ejgd.org
	DOI: 10.4103/2278-9626.105359

The maxillary first permanent molar is the most extensively investigated tooth in the field of endodontics.[2-7] Its anatomy has been the subject of many studies, especially its internal anatomy. Knowledge of the size, morphology and variation of the root canals of maxillary first permanent molar are useful in visualizing the pulp cavity during endodontic treatment. The maxillary first permanent molar has three individual roots, mesiobuccal root, distobuccal root and palatal root, these roots form a tripod. The palatal root is the longest, has the largest diameter, and generally offers the easiest access. It can contain one, two or three canals[8-10] while the distobuccal root which is conical may have one or two canals.[8,9,11]

The mesiobuccal root has generated more research and clinical investigation than any other root in the mouth. It may have one, two or three canals.[12-15] Studies have shown that there is a second mesiobuccal canal located

in the mesiobuccal root, although its incidences varies with the type of study, the equipments used and the race studied.[10,16-20] This variation in its incidence no doubt reflects the difficulty in locating the second mesiobuccal canal.

The anatomical feature of the maxillary first permanent molar makes its treatment very technical. Studies have revealed that failure to detect, debride and obturate all the canals, especially the second mesiobuccal canal, of the maxillary first permanent molar during root canal treatment; will lead to treatment failure.[3,19,21,22] This study is therefore of great importance because it is necessary to establish the incidence of additional canals in maxillary first permanent molar in this environment, as this will help to improve treatment outcome. The objective of the study was to determine the prevalence of additional canals in maxillary first permanent molar in an adult population in Nigeria.

MATERIALS AND METHODS

All consecutive patients attending the Restorative dental clinic of the University of Benin Teaching Hospital and Dental Center of the Central Hospital, Benin City, Nigeria between December 2007 and May 2009 constituted the *in vivo* study population. These included all patients who gave informed consent after the objectives of the study have been explained to them, who had radiological and clinical evidence of pulpal pathology involving the maxillary first permanent molar and extracted maxillary first permanent molars of patients between ages 17-50 with intact roots and closed apices were used for the *in vitro* study. All patients who did not meet the inclusion criteria were excluded from the study. The sample size was calculated using the formula:[23] $N = Z^2Pq/d^2$ and a sample size of 156 teeth were used; 50 for the *in vivo* and 106 for the *in vitro* study. Ethical approval was obtained from both institutions.

A pilot study of 10 patients was done to calibrate the examiner and radiographer, by repeated measurements of the patients' maxillary first molars. Inter-examiner and intra-examiner variability was set at 0.7 and 0.8 kappa respectively.

In the *in-vivo* study, selected cases had conventional root canal treatment done. Initial pre-operative radiographs were taken, with the aid of film holder (Rirn Corp, Elgin IL) using the long cone paralleling technique (including parallax views) to determine the number of roots and canals present. Canals orifices were identified with sharp endodontic probes, surgical loupes (Advanced Dental Concepts, Madison, WI, USA). Gentle troughing of the pulpal floor palatally along the orifice of the mesiobuccal canal was done to identify the possibility of a second mesiobuccal canal or any other additional canal, with a slow speed hand piece and a half round bur. A size 10 K-file was introduced into the canal to determine the canal patency and a working length radiograph was taken, using the paralleling technique. Apex locator (Root ZX, J. Morita, and Kyoto) was used to take a second working length as an adjunct to the radiographic method.

In the *in vitro* study, all extracted teeth were root planed using a periodontal hoe and washed under running tap water for 2 h. The access cavity was prepared using a diamond round bur. Pulpal tissue was removed with size 10 K-files (DENTSPLY) and by storing in 5.25% sodium hypochlorite for 24 h to remove any remnant pulpal tissue and washed under running tap water. Using a gauge 25 needle, Indian ink was injected through the access cavity into the canal orifices and aspirated through the canals with a small-bore suction at the apex. The access cavity and apex was sealed with wax. The teeth were then stored in 10% formaldehyde until ready for use.

The teeth were later sectioned at three respective points, corresponding to the cemento-enamel junction, peak of the external outline of the furcation and the middle of the mesiobuccal, distobuccal and palatal roots, using a cutting disc (Schottlander, UK). The root canal was identified using size 10 K-files and the canal number noted for each sectioned piece. Data obtained from *in vitro* and *in vivo* studies was entered into a HP-Pavilion dv-2000 personal computer and analyzed using the Statistical Package for the Social Sciences (Chicago, SPSS; 2005 version 15.0).

RESULTS

In the clinical study the ratio of males to females was 1:1.8, the mean age of the participants was 29.5±9.8 years, the mean age was 30.6±10.4 years for males and 28.3±9.5 years for females. The diagnosis of all the treated teeth in this study was acute apical periodontitis. The right maxillary first permanent molar was more frequently affected (68.0%) than the left (32.0%). The *in vivo* study revealed that 33 (66.0%) of maxillary first permanent molar in the study had 3 canals, while 17 (34.0%) had four canals [Table 1].

Sectioning of the extracted teeth at the cementoenamel junction revealed that 100 (94.3%) and 6 (5.7%) of the teeth had 1 canal and 2 canals in the mesiobuccal root respectively while 2 (1.9%) of the teeth had 2 canals in the palatal roots, [Table 2]. Sectioning of the teeth at the furcation revealed 71.7% of the teeth had four canals at the furcation, with the mesiobuccal root having two canals, 28.3% of teeth had three canals at the furcation. In the palatal roots, 1.9% of the teeth had 2 canals [Table 3]. However, sectioning at the middle of the mesiobuccal, distobuccal and palatal roots revealed that 75.5% of the teeth had 2 canals in the mesiobuccal root, 1.9% of the teeth had 2 canals in the palatal root, and 100% of the teeth had 1 canal in the distobuccal root [Table 4].

DISCUSSION

Data from the *in vivo* aspect of this study revealed that more of the maxillary first permanent molars studied had three canals. The extra canal found in 34.0% of cases was found exclusively in the mesiobuccal root. The incidence of additional canals in this study was higher than that reported in an earlier study in Nigerian South Western population.[20] This could be due to the fact that surgical loupes and toughing technique was used in this study as modifications in endodontic access preparation. These modifications have been reported to facilitate the location of additional canals in the mesiobuccal root of maxillary first permanent molars.[24,25] However, the incidence of additional canal was lower than the incidence of 66.0% reported among Colorado dwelling American population,[26] and 48.0% reported among Kuwait is population.[27] This may be an indication that the presence of additional canals has racial variation.[5,10,28]

More additional canals were found in the *in vitro* technique and this may be because of the ease of manipulating the tooth outside the mouth. In the *in vitro* study additional canals were found in 1.9% of the palatal root. The incidence of additional canals in the palatal root was in consonant with the findings among South Western dwelling Nigerian population[20] but higher than 0.9% reported among Australian population[8] and lower than 33.3% reported among Turkish population.[9]

The prevalence of additional canals in the mesiobuccal roots (75.5%) reported in this study is higher than the 22% reported in a related study in South Western Nigeria.[20] This may be due to the fact that sectioning was done at 3 points in this study as opposed to 2 points sectioning in the compared study.[20] Also, the prevalence reported in this study was higher than the 42.7% reported by Otoh *et al.*[19] despite the fact that both studies sectioned at 3 points. This may be because Otoh *et al.*[19] did not impregnate the teeth with a dye before sectioning. However, this study is in agreement with the findings by Thomas *et al.*[8] among Australian population (74%), by Fogel *et al.*[29] among Canadian population (72%) and by Shahriar *et al.*[30] among Iranian population (71.1%) where surgical telescopes, headlamps, and a modified access preparation were used clinically to aid in the search for the canals.

Table 1: Number of canals found in the *in vivo* study of maxillary first permanent molars

Number of canals	Frequency *n*	Percentage
3	33	66.0
4	17	34.0
Total	50	100.0

Table 2: Number of canals found on sectioning at the cementoenamel junction

Roots	Number of canals		
	One *n* (%)	Two *n* (%)	Total *n* (%)
Mesiobuccal	100 (94.3)	6 (5.7)	106 (100.0)
Distobuccal	106 (100.0)	0 (0.0)	106 (100.0)
Palatal	104 (98.1)	2 (1.9)	106 (100.0)

Table 3: Number of canals found on sectioning at the furcation area

Roots	Number of canals		
	One *n* (%)	Two *n* (%)	Total *n* (%)
Mesiobuccal	30 (28.3)	76 (71.7)	106 (100.0)
Distobuccal	106 (100.0)	0 (0.0)	106 (100.0)
Palatal	104 (98.1)	2 (1.9)	106 (100.0)

Table 4: Number of canals found on sectioning the middle of the mesiobuccal, distobuccal and palatal root

Roots	Number of canals		
	One *n* (%)	Two *n* (%)	Total *n* (%)
Mesiobuccal	26 (24.5)	80 (75.5)	106 (100.0)
Distobuccal	106 (100.0)	0 (0.0)	106 (100.0)
Palatal	104 (98.1)	2 (1.9)	106 (100.0)

CONCLUSION

It can be concluded, from the clinical as well as the laboratory aspect of this study that the incidence of additional canals in the maxillary first permanent molar, in this environment, is much higher than was previously reported, and when these additional canals are present, they are usually found in the mesiobuccal root.

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How to cite this article: Oboro-Onuora HO, Onuora OI, Sede MA. Determination of additional canals in maxillary first permanent molars in adult Nigerian population: Using in vivo and in vitro techniques. Eur J Gen Dent 2012;1:166-9.

Source of Support: Nil, **Conflict of Interest:** None declared.