

Association between dentin thickness and presence of accessory foramina in human permanent mandibular molars

Luana de Nazaré Silva Santana¹, Luciana Brandão Freitas², Tamea Lacerda Monteiro²,
Thais de Mendonça Petta², Ana Cássia Reis-Costa³, Rafael Rodrigues Lima³

¹Dental Surgeon and Master's Candidate in Animal Science, Federal University of Pará, Brazil

²Undergraduate dental students, Federal University of Pará, Brazil

³Institute of Biological Sciences, Federal University of Pará, Brazil

Abstract

The roots and periodontal system in human dentition are closely correlated from the early stages of dental formation, maintaining this connection after teeth are established in the oral cavity through the apical foramen or other communications. **Aim:** Therefore, the aim of this study was to evaluate the correlation between the presence of foramina on the pulp chamber floor surface and in the furcation region and the thickness of dentin in this area. **Methods:** Forty sound permanent mandibular molars were submitted to scanning electron microscopy (SEM) to determine the presence of foramina on the pulp chamber floor and in the furcation region, and to correlate the presence of foramina with the variation in wall thickness in these regions. **Results:** The results showed a mean thickness of 2.16 mm for the teeth analyzed and a 25% frequency of foramina on the pulp chamber floor and 92.5% in furcation area, with only 22.5% showing foramina on both sides. The foramina found on both surfaces showed varied diameters and shapes and locations dispersed throughout the area. **Conclusions:** There was no significant difference between the mean thicknesses of teeth featuring foramina and those without foramina.

Keywords: pulp chamber floor, furcation region, foramina.

Introduction

The anatomic relationship between dental pulp and periodontium in the furcation region through foramina and accessory canals has prompted several research studies searching for possible pathologic consequences of this close communication¹⁻¹⁰. This aberrant contact between tissues in this region is the result of failed differentiation of odontoblasts due to defect formation in Hertwig's sheath⁴. Thus, these foramina can also contribute to the communication between periodontium and dental pulp.

Studies with primary and permanent teeth using scanning electron microscopy (SEM)⁶ and topographic analyses^{2,9-10} found a significant incidence of foramina in the furcation area. Moreover, some studies using a simple technique (light microscopy) observed the presence of accessory canals^{1,3-4,7-8}. One study compared

Received for publication: March 14, 2011

Accepted: October 11, 2011

Correspondence to:

Rafael Rodrigues Lima
Laboratório de Neuroproteção e
Neuroregeneração Experimental,
Instituto de Ciências Biológicas,
Universidade Federal do Pará
Rua Augusto Corrêa N. 1. Campus do Guamá
CEP: 66075-900. Belém – Pará, Brasil
Phone/Fax: 00 5591 3201 7891
E-mail: rafalima@ufpa.br
rafaelrodrigueslima@hotmail.com

the incidence of foramina in permanent and primary teeth, and found a greater incidence in primary teeth¹⁰.

In the literature, there are few data on the influence of pulp chamber floor surface thickness and furcation area on the presence or absence of foramina. Therefore, the purpose of this research was to determine the presence of foramina in the pulp chamber floor and furcation area of human permanent mandibular molars and correlate the presence of foramina with the variation of wall thickness in these regions.

Material and methods

Forty sound permanent mandibular molars belonging to the Tooth Bank of the Oral Histology discipline (Opinion 08/2009, Bioethics Committee of the College of Dentistry, UFPA) were examined. The crown and roots were sectioned transversely along the tooth axis with a double-faced steel disc 2 mm from the cemento-enamel in the direction of the crown and 3 mm in the direction of the root apex to obtain a reduction in the longitudinal axis in order to facilitate the later stages of evaluation. The samples were cleaned by immersion in 1% sodium hypochlorite (ASFER Indústria Química LTDA) for 5 min, and then in 17% EDTA (Farmácia-Escola, Federal University of Pará, Brazil) for 30 s. Samples were then subjected to a final rinse with distilled water in an ultrasonic bath (MS 200 THORNTON, Impec Eletrônica, São Paulo, SP, Brazil) for 30 s and dried at room temperature overnight. Following sample preparation, wall thickness between the pulp chamber floor and the furcation area was measured using a thickness caliper (JON Comércio de Produtos Odontológicos Ltda. São Paulo, SP, Brazil) accurate to the nearest 0.1 mm). Later, the samples were metalized and subjected to scanning electron microscopy (model LEO-1430/Laboratory of Scanning Electron Microscopy – LABMEV do Institute of Geosciences of UFPA), at 90 mA electron beam current, constant acceleration voltage of 15 kV and working distance of 10 mm. The SEM micrographs were analyzed under different magnifications, and the presence/absence of foramina on the pulp chamber floor and furcation area was recorded, divided the sample in two groups. The difference in mean thickness between the group of teeth with foramina on both surfaces and teeth without foramina on both surfaces was evaluated by Student's t-test.

Results

The foramina found on both surfaces showed varied diameters and shapes and locations dispersed throughout the area (Figures 1 and 2). The results showed a mean thickness of 2.15 ± 0.41 mm (SD) among the teeth analyzed. The data for the sample was evaluated by the Kolmogorov-Smirnov test, and a non-significant value of $p=0.804$ was obtained, confirming the normality of the sample.

The study recorded a frequency of 25% of foramina on the pulp chamber floor and 92.5% in the furcation region, with only 22.5% showing foramina on both sides.

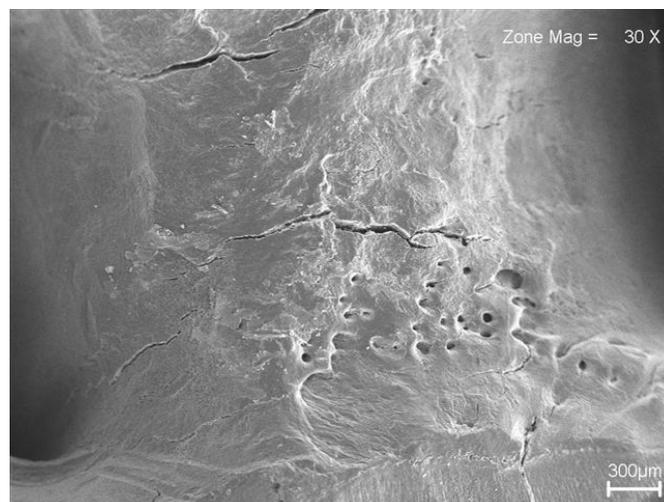


Fig. 1. SEM micrograph of foramina in the pulp chamber floor (Original magnification x30).

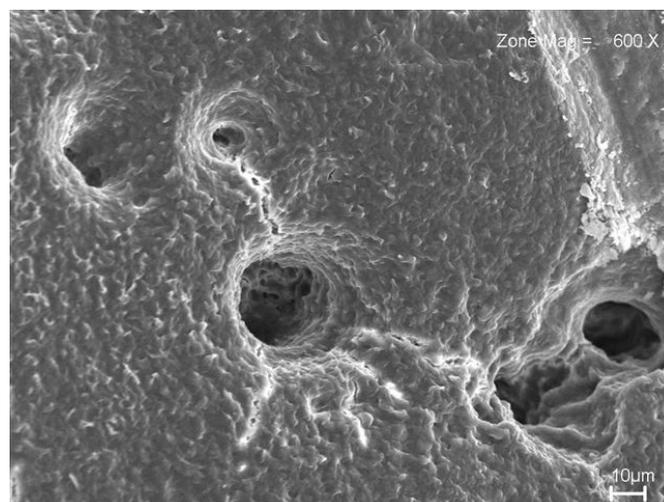


Fig. 2. SEM micrograph of foramina in the furcation region (Original magnification x600).

The difference in mean thickness between the group of teeth with foramina on both surfaces and teeth without foramina on both surfaces was evaluated by Student's t-test. There was no statistically significant difference for the pulp chamber floor ($t = -0.7587$ and $p = 0.4527$) or for the furcation area ($t = -0.5712$ and $p = 0.5712$). Hence, there was no difference in mean thickness between the teeth with and without foramina.

Discussion

These anatomic communications are of great clinical importance with regard to the periodontal-endodontic interrelation due to its role in the etiopathogenicity of endo-periodontal lesions¹¹⁻¹². Different investigations have examined the presence of pulpoperiodontal canals between the pulp chamber floor and the furcation area and evaluated the possible pathological consequences of this relation⁵.

In the literature, studies already exist showing the incidence of foramina in the furcation area and the pulp

chamber floor^{1-3,5-9}. In the present study, there were a larger number of foramina, both in the furcation area and on the pulp chamber floor, compared with previous investigations.

Kramer (2003)⁹ found a prevalence of 53% in the external furcation area and 25% in the internal furcation area using SEM analysis⁹. Burch (1974)² found 76% of foramina in the furcation area using a dissection microscope². Vertucci (1974)³ found 46% lateral canals in the furcation area and 13% on the pulp chamber floor using a dissection microscope³. Haznedaroglu (2003)⁸ found a 21% incidence of patent furcal accessory canals using a stereomicroscope⁸. However, in the current study, we found 25% of foramina on the pulp chamber floor and 92.5% in the furcation area, with only 22.5% showing foramina on both sides.

This result is probably due to the method used, in which organic content and inorganic residue were removed from the teeth by the combination of sodium hypochlorite, EDTA and ultrasonic bath. This resulted in satisfactory cleanliness, clearing the foramina and providing better visualization.

Thickness was not significantly influenced by the presence of foramina on the pulp chamber floor or in the furcation area. Furthermore, the higher frequency of foramina in the furcation area compared to the pulp chamber floor suggests the presence of blind foramina (accessory canals originating from the pulp floor and/or periodontium and ending in dentin without going on to another surface) or loop foramina (originating from the pulp floor and/or periodontium, going through dentin, and returning to pulp chamber or periodontium), which has already been described in another investigation¹³. Hence, in this study, even with 22.5% of the sample showing foramina on both surfaces, it is still impossible to confirm whether there is a real communication between these regions even in these teeth.

The dentin-pulp complex and periodontium are closely related since odontogenesis, maintaining this interconnection through the apical foramen. However, there are other accessory pathways of communication, such as lateral apical foramina or even foramina between chamber floor and furcation areas^{8,10}. These communications have great relevance in endodontic therapy, because their unsealing can result in the maintenance of accessory ways of communication, which, in the presence of an infection process, can facilitate its spread between the periodontium and root canal system, in both directions³.

From the obtained results, this study did not show a correlation between thickness and the presence/absence of foramina. Although a higher frequency of foramina was observed in the furcation area compared with the pulp chamber floor, it is not possible to infer that the frequency of foramina is associated with the frequency of communication between the surfaces, which suggests the formation of blind or loop foramina.

References

1. Lowman JV. Patent accessory canals: Incidence in molar furcation region. *Oral Surg Oral Med Oral Pathol.* 1973; 36: 580-4.
2. Burch JG. A study of the presence of accessory foramina and the topography of molar furcations. *Oral Surg Oral Med Oral Pathol.* 1974; 38: 451-5.
3. Vertucci FJ. Furcation canals in the human mandibular first molar. *Oral Surg Oral Med Oral Pathol.* 1974; 38: 308-14.
4. Gutman JL. Prevalence, Location, and Patency of Accessory Canals in the Furcation Region of Permanent Molars. *J Periodontol.* 1978; 49: 21-6.
5. Goldberg F. Accessory orifices: anatomical relationship between the pulp chamber floor and the furcation. *J Endod.* 1987; 13: 176-81.
6. Paras LG. An investigation of accessory foramina in furcation areas of primary molars: Part 1 – SEM observations of frequency, size and location of accessory foramina in the internal and external furcation areas. *J Clin Pediatr Dent.* 1993; 17: 65-9.
7. Wrbas KT. Microscopic studies of accessory canals in primary molar furcations. *J Dent Child.* 1997; 64: 118-22.
8. Haznedaroglu F. Incidence of patent furcation accessory canals in permanent molars of a Turkish population. *Int Endod J.* 2003; 36: 515-9.
9. Kramer PF. A SEM investigation of accessory foramina in the furcation areas of primary molars. *J Clin Pediatr Dent.* 2003; 27: 157-61.
10. Dammaschke T. Scanning Electron Microscopic Investigation of incidence, location and size of accessory foramina in permanent molars. *Quintessence Int.* 2004; 35: 699-705.
11. Chen SY, Wang HL, Glickman GN. The influence of endodontic treatment upon periodontal wound healing. *J Clin Periodontol.* 1997; 24: 449-56.
12. Pilatti GL, Toledo BEC. As comunicações anatômicas entre polpa e periodonto e suas conseqüências na etiopatogenia das lesões endo-periodontais. *Rev Paul Odontol.* 2000; 5: 38-42.
13. Zuza E. Prevalence of different types of accessory canals in the furcation area of third molars. *J Periodontol.* 2006; 77: 1755-61.