SCANNING ELECTRON MICROSCOPIC EVALUATION OF THE ROOT APEX OF MANDIBULAR PREMOLARS

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ABSTRACT

This aim of this study was to evaluate the root apex of mandibular premolars regarding the presence of main and accessory foramina. The root apexes from fifty extracted mandibular single-rooted premolars were examined by scanning electron microscopy (SEM). The apical openings had their diameter measured and were identified as main or accessory foramina. Double blinded and calibrated examiners analyzed the SEM photographs and classified the premolar roots into three types, based on the presence and size of the apical openings. Type I: roots with a single main apical foramen and no accessory foramina; type II: roots with a main foramen and one or more accessory foramina; type III: roots with accessory foramina only. For the first premolar, 16 roots were classified as type I (48.48%), 4 as type II (12.12%) and 13 as type III (39.40%). For the second premolars, 10 roots were classified as type I (58.83%), 3 as type II (17.65%) and 4 as type III (23.52%). The high incidence of roots with accessory foramina only (type III), mainly in the first premolar, warns of the need for caution during working length determination and apical debridement.

Key words: mandibular premolar; root apex morphology; scanning electron microscopy.

MICROSCOPIA ELETRÔNICA DE VARREDURA DO ÁPICE RADICULAR DE PRÉ-MOLARES INFERIORES

RESUMO

O objetivo deste estudo foi avaliar o ápice radicular de pré-molares inferiores com relação à presença de forames ou foraminas. O ápice radicular de cinqüenta pré-molares unirradiculados humanos extraídos foram examinados pela microscopia eletrônica de varredura (MEV). As aberturas apicais tiveram seus diâmetros medidos e foram identificados como forames ou foraminas. Dois examinadores calibrados e cegos quanto aos grupos analisaram as micrografias em MEV e classificaram as raízes dos pré-molares em três tipos, baseadas na presença e tamanho das aberturas apicais. Tipo I: raízes com um único forame e nenhuma foramina; tipo II: raízes com um forame e uma ou mais foraminas; Tipo III: raízes somente com foramina. Para o primeiro pré-molar, 16 raízes foram classificadas como Tipo I (48.48%), 4 como tipo II (12.12%) e 13 como tipo III (39.40%). Para o segundo pré-molar, 10 raízes foram classificadas como tipo I (58.83%), 3 como tipo II (17.65%) e 4 como tipo III (23.52%). A alta incidência de raízes do Tipo III, principalmente no primeiro pré-molar, alerta para a necessidade de cuidados na determinação do comprimento de trabalho e exploração foraminal.

Palavras-chave: pré-molares inferiores, morfologia dos canais radiculares, microscopia eletrônica de varredura.

INTRODUCTION

Knowledge of the root canal system anatomy is a key factor in the success of endodontic therapy. The root apex requires special attention to foraminal location and establishment of the appropriate extension of instrumentation and filling. Great variation exists in root apex anatomy as well as in foramen position and location[1-4].

Mandibular premolars present highly complex anatomy and can present great difficulty during endodontic treatment[5]. Two recent comprehensive literature reviews of the root and root canal morphology of mandibular premolars[6,7] revealed that, for the first premolar, a single canal was present in 75.8% of the teeth, while two or more canals were found in 24.2% of the cases. For the second premo-

lar, a single root canal was present in 91.0% of the cases and two or more canals were found in 9.0% of the teeth studied.

Premolars can have accessory foramina in the apical region even when a single canal is present with the respective main apical foramen[2]. Several studies have demonstrated the complexity of the root canal morphology of mandibular premolars using clearing techniques[4,8], radiographs[9], stereoscopic analysis of apical cross-sections[10], optical microscopy[11] and scanning electron microscopy (SEM)[12]. Clearing[4,8] can determine the incidence of main canals and ramifications, but it cannot identify the main foramen and accessory foramina, which are more accurately observed by SEM[11,12]. SEM analysis of the external root surface allows the main foramen to be distinguished from accessory foramina by the diameter of the apical openings. Morfis et al.[12] assessed the number and size of the main apical foramina, their distance from the anatomic apex, and the existence and size of accessory foramina, using SEM. In a stereomicroscopic study, Green[11] examined 700 root apices of maxillary and mandibular posterior teeth, including 50 first and second mandibular premolars. Main and accessory foramina were classified based on their size. Apical openings with mean diameter of 350 µm (first premolar) or 300 µm (second premolar) were considered as main foramina, while apical openings with mean diameter of 200 µm (first premolar) or 150 µm (second premolar) were considered as accessory foramina.

The great anatomical variability of the apex of mandibular premolars has significant clinical relevance because it has direct influence on the cleaning and shaping of the root canal system. This scanning electron microscopic study evaluated the root apex of first and second mandibular premolars regarding the presence of main and accessory foramina.

MATERIALS AND METHODS

Fifty mandibular single-rooted human premolars extracted for orthodontic and periodontal reasons (33 first and 17 second premolars) were selected. The patients' age and gender were not considered for tooth selection. The teeth were cleaned and immersed in 2.5% sodium hypochlorite for 3 days, with daily changes, to remove organic tissue debris. After this period, the teeth were washed in running water and the roots were sectioned at 5 mm from the apex. The root segments were left to dry at room temperature and then mounted on metallic stubs and sputter-coated with gold (Hammer VI Sputtering System; Anatech Ltd, Alexandria, VA, USA). The apical 3 mm were examined with a scanning electron microscope (JSMT220A; Jeol, Tokyo, Japan) and SEM micrographs were taken at 50 X magnification. The apical openings had their diameter measured using the Image Tool software for Windows version 3.0 (UTHSCSA, San Antonio, TX, USA) and were identified as main or accessory foramina, based on the criteria described by Green[11]. Main foramina should present a minimum diameter of 350 µm in first premolars and 300 µm in second premolars, while apical openings measuring less than 350 µm in first premolars and less than 300 µm in second premolars were considered as accessory foramina. Two calibrated blinded examiners analyzed the SEM micrographs and classified the premolar roots into three types, based on the presence and size of the apical openings. Type I: roots with a single main apical foramen and no accessory foramina (Fig. 1); type II: roots with a main apical foramen and one or more accessory foramina (Fig. 2); and type III: roots with accessory foramina only (Fig. 3).

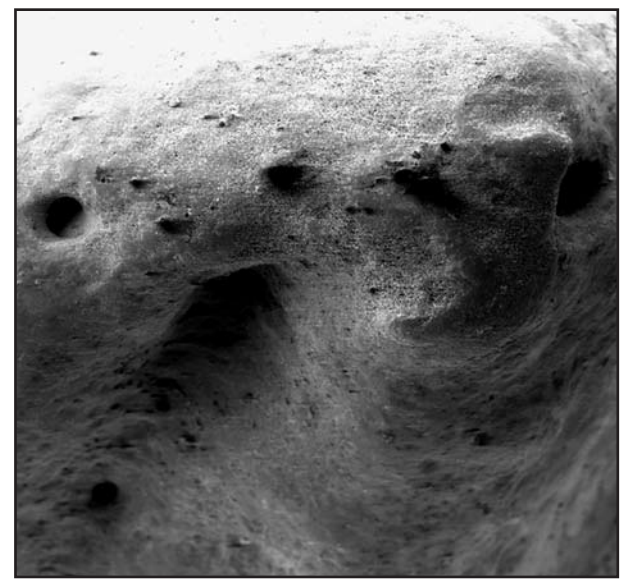

Fig. 1: SEM micrograph representative of Type I root apex (original magnification X50).

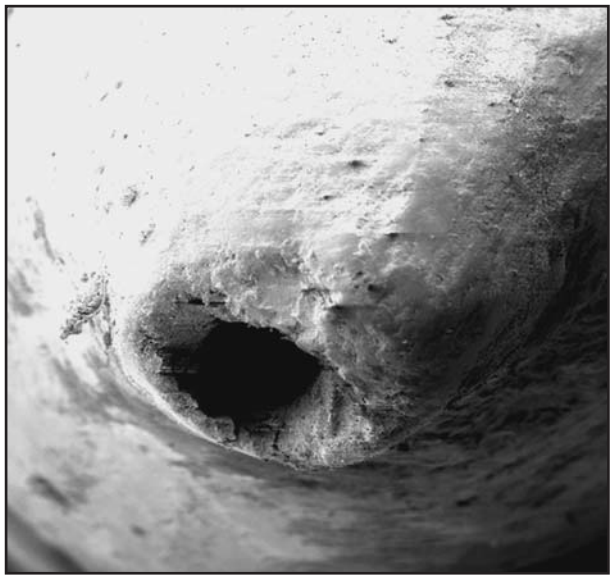

Fig. 2: SEM micrograph representative of Type II root apex (original magnification X50).

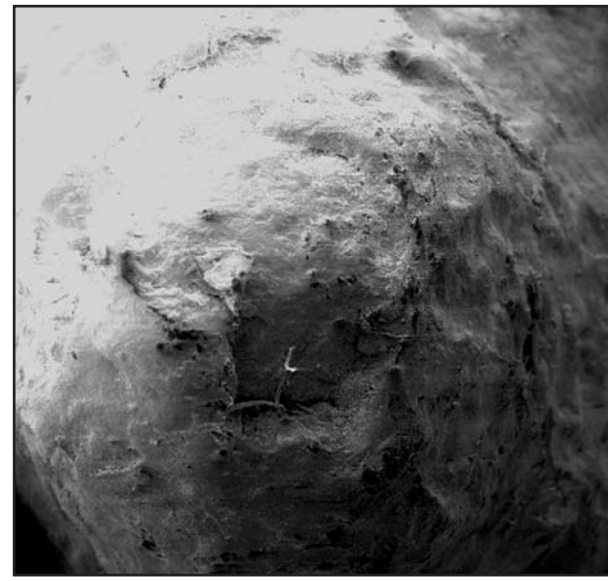

Fig. 3: SEM micrograph representative of Type III root apex (original magnification X50).

RESULTS

Results are presented in Table 1.

Table 1: Frecuency of different root apex morphology

	First Premolars		Second premolars	
	n	%	n	%
Type I	16	48.48	10	58.83
Type II	4	12.12	3	17.65
Type III	13	39.40	4	23.52

Type I: roots with a single main apical foramen and no accessory foramina.
Type II: roots with a main apical foramen and one or more accessory foramina.
Type III: roots with accessory foramina only.

DISCUSSION

Mandibular premolars exhibit a high degree of complex anatomy with a fine ribbon-shaped canal system that is usually difficult to access, clean and obturate. The anatomical variations generally occurring in these teeth create an additional challenge for the endodontist and influence the outcome of root canal therapy[6,7]. Several authors have reported that the endodontic treatment of mandibular premolars requires special attention[3,5,13-15].

Although SEM provides a more accurate examination of the root apex anatomy, its use for assessment of the apical openings is still scarce. Morfis et al.[12] analyzed the apices of human permanent teeth under SEM and found that the mandibular premolars had more complex apical morphology than other tooth types, with accessory foramina present in 84.95% of the roots. The results of the present study confirm the complexity of apical anatomy. Type II and III roots were present in 51.52% and 41.17% of the first and second mandibular premolars.

The deposition of larger amount of cementum, hindering the identification of accessory foramina and main apical foramen may occur[16]. Clinically, the determination of the extension of instrumentation and apical debridement may be challenging in type II and III roots. In these cases, some difficulty may also be encountered when using electronic apex locators because the presence of calcifications and accumulation of dentin chips can interfere with the accuracy of these devices[17-19]. Another important factor is the distance of the main apical foramen from the anatomic apex. Burch and Hulen[1] analyzed 100 roots of mandibular premolars and observed that 87% of them presented deviation of the main apical foramen from the anatomic apex: 25.3% to the buccal, 13.8 to the lingual, 27.6% to the mesial and 33.3% to the distal.

The results of the present study indicate that the predominance of roots with a single main apical foramen (type I) in both tooth types, and the high incidence of roots with accessory foramina only (type III), mainly in the first premolar, warn of the need for caution during routine endodontic procedures such as working length determination and apical debridement.

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