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Original Research Article

Anatomical analysis of the pulp chamber of artificial teeth

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Abstract

Introduction: The anatomy of root canals is very variable, with the presence of ramifications, side canals, accessory canals, and interconnections. Therefore, the knowledge of the internal tooth morphology has a fundamental importance for the localization and treatment of root canals, thus achieving success in endodontic treatment. In Endodontics, the preclinical teaching requires human teeth, but because of the current difficulty in obtaining them, the students have used artificial dental elements. **Objective:** This study aimed to evaluate the anatomy of the pulp chamber of artificial teeth, used in practical activities in Endodontics. **Material and methods:** Therefore, the artificial teeth were X-rayed through the digital system and the internal anatomy of the pulp chamber was measured through the Image Tool software. **Results:** The height of the mandibular pulp chamber: mandibular molar = 1.8 mm and maxillary molar = 1.32 mm; distance from the furcation to the pulp chamber floor: mandibular molar = 5.89 mm and maxillary molar = 7.24 mm; distance from the furcation to the pulp chamber's roof: mandibular molar = 7.61 mm and maxillary molar = 8.59 mm; distance from the tip of the buccal cusps to the furcation: mandibular molar = 14 mm and maxillary molar = 15 mm; distance from the tip of the buccal cusps to the pulp chamber's floor: mandibular molar = 7.9 mm and maxillary molar = 8.1 mm; distance from the tip of the buccal cusps to the pulp chamber's roof: mandibular molar = 6.2 mm and maxillary molar = 6.4 mm. The measures were homogeneous with maximum percentage variation of 26.5%. Also, the artificial teeth were similar to natural teeth, except for the relationship between the pulp chamber's roof and cementum-enamel junction. Thus, it is recommended the use artificial teeth with caution in preclinical teaching of Endodontics.

Introduction

The aim of the endodontic treatment is to achieve the adequate cleaning and antisepsis of the root canal system and the proper mechanical preparation, obtaining the taper shape towards the apex [1]. The morphology of the root canals is very variable, with side canals, accessory canals, and interconnections. Thus, the knowledge of this morphology is of fundamental importance to locate and treat of root canals [17]. Accordingly, the detailed view the pulp cavity is indispensable the study and practical learning of Endodontics practically [19], consequently leading to treatment success.

In Endodontics, the clinical practice requires previous laboratorial training in manikins with extracted human teeth, aiming at mimicking the real conditions in which the undergraduate will face during clinical practice. For that purpose, extracted human teeth are asked for the undergraduates to provide along with the list of materials and instruments before the laboratorial activities. However, currently, by adopting a minimally invasive dental practice and due to the absence of legal human tooth banks in most dental schools, to obtain human teeth very difficulty. Moreover, since 1997, the Brazilian law on organ donation advocates that teeth are organs and the donators have to sign a donors form [11]. Thus, nowadays, the use of human teeth in dental education comes up against ethical questions about its illegal trade, such as buying teeth in cemeteries and in private clinics. Furthermore, other relevant issue is to know which decontamination and storage procedures are being employed by the students, because some microorganisms can survive for a long period on extracted teeth and they may cause several infections [14]. To avoid or reduce the cross-contamination in using extracted human teeth in laboratorial activities, the dental schools developed guidelines on biosecurity and specific protocols for storage to avoid alterations [5, 3].

Therefore, artificial teeth made of opaque and colorless resin have been employed in the preclinical teaching of Endodontics [18]. For that purpose, these artificial teeth should reliably mimic the possible complexity exhibited by natural root canals. This study aimed to evaluate the pulp chamber of the maxillary and mandibular artificial first molar used in practical activities in Endodontics.

Material and methods

Ten mandibular and ten maxillary artificial first molars (IM do Brasil, São Paulo, SP, Brazil) were used. Each tooth received a number and the letter regarding a dental arch, that is, maxillary or mandibular (figure 1). The artificial teeth were adapted on a radiographic holder, in which a digital sensor (Kodak) was positioned. The x-ray device (Kodak 220) was matched to the radiographic holder to maintain a standardized position (figure 2). The exposure time was 0.107 s, and standard contrast control panel.

The following measurements were performed on the digital radiographs: height of the mandibular pulp chamber (measurement A); distance from the furcation to the pulp chamber floor (B); distance from the furcation to the pulp chambes roof (C); distance from the tip of the buccal cusps to the furcation (D); distance from the tip of the buccal cusps to the pulp chambers floor (measurement E); distance from the tip of the buccal cusps to the pulp chambers roof (measurement F) (figure 3). The measurements were obtained through Image Tool 3.0 software (figure 4).

Descriptive statistical analysis was performed using the mean of the obtained results.

Figure 1 – Artificial teeth: mandibular (I) and maxillary (S)

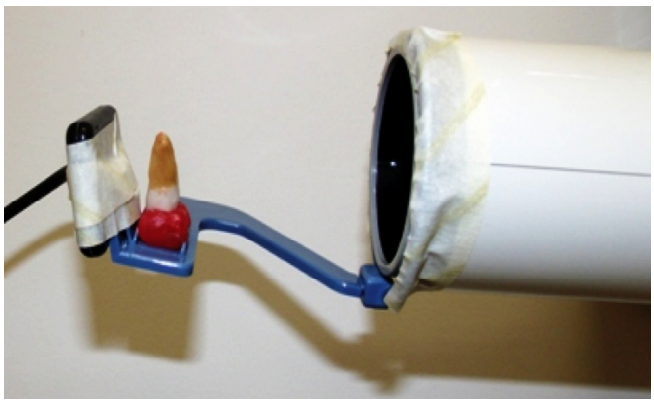

Figure 2 – Artificial teeth placed on the radiographic holder

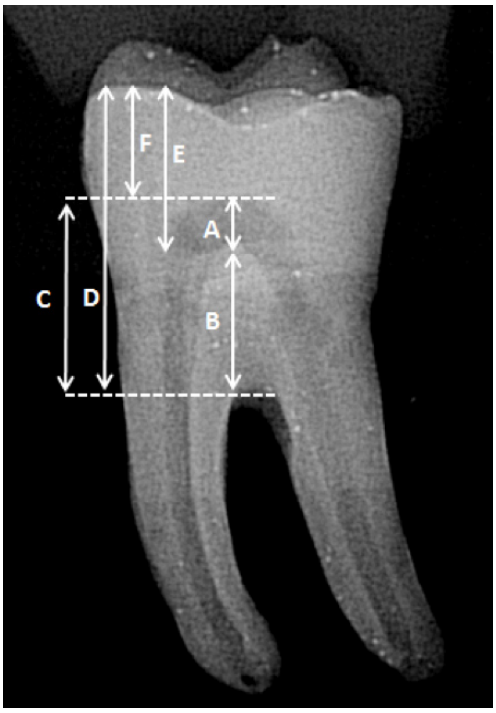

Figure 3 – Measurements A, B, C, D, E, and F

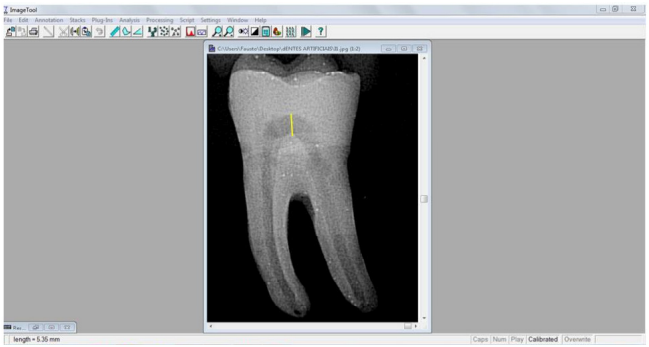

Figure 4 – Pulp chamber measurements through Image Tool 3.0 *Software*

Results

The mean values, standard deviation, and coefficient of variation of all measurements analyzed of the mandibular and maxillary molars are available in tables I and II. The measurements were homogenous with little variation. The height of the pulp chamber (measurement A) exhibited the greater percentage range (26.5%). The following tables (tables I and II) show the mean values in millimeters of the different analyzed distances of the artificial mandibular and maxillary molars.

Table I – Mean of the measurements (mm) for mandibular molars

n=10	A	B	C	D	E	F
Mean	1.80	5.89	7.61	14.00	7.99	6.27
SD	0.33	0,61	0.74	0.97	0.86	0.83
CV%	18.3	10,3	9.7	6.9	10.7	13.2

Values from A-F refer to the measurements seen in figure 3. CV% [SD/mean] is the percentage of variation observed for each measurement

Table II – Mean of the measurements (mm) for maxillary molars

n=10	A	B	C	D	E	F
Mean	1.32	7.24	8.59	15.07	8.10	6.44
SD	0.35	0.66	0.47	0.51	0.55	0.57
CV%	26.5	9.1	5.4	3.3	6.7	8.8

Values from A-F refer to the measurements seen in figure 3. CV% [SD/mean] is the percentage of variation observed for each measurement

Discussion

Teaching in the discipline of Endodontics requires knowledge of the internal and external tooth anatomy and the development of ability and sensitivity of the student to perform a satisfactory treatment. Due to the difficulty in obtaining natural teeth and with the purpose of facilitating the teaching / learning process in the endodontic preparation in preclinical activities, some authors raised alternatives such as: the replacement of one of the walls of the pulp chamber and root canal by colorless resin [8], the use of a colorless plastic tube with 30 mm of height and 0.8 mm of diameter [8], and the creation of root canals in colorless polyester [21] and epoxy resins [2, 20]. In the latter, the student learns by visualizing the intra-channel procedures and uses a smaller number of extracted natural teeth. In addition to being used in the teaching of endodontic techniques, simulated channels have also been useful in scientific research [10, 15]. Other author attempted to reproduce models simulating natural teeth, mimicking the bone density of the mandibular and maxillary arches [7].

In Brazil, Nassri *et al.* [12] published a study in which they presented artificial teeth for the teaching of the discipline of Endodontia, made of opaque resin that mimics natural human teeth.. Nassri *et al.* [13] evaluated the morphological, physical, and radiographic features of these artificial teeth and observed their potential in replacing the natural teeth in preclinical training.

Concerning to the pulp chamber morphology of natural teeth, Deutsch and Musikant [4]

reported the measurement of the pulp chamber of 100 maxillary and 100 mandibular molars and provided information that may be used as a guideline for crown opening. Generally, the measurement from the cusp to the pulp chambers roof was approximately 6 mm, the measurement from the pulp chambers floor to the furcation was approximately 3 mm and the measurement of the pulp chamber height was from 1.5 to 2 mm. Moreover, the pulp chambers roof was at the same level of cementum-enamel junction in 97 to 98% for the maxillary and mandibular molars. The knowledgement of the pulp chamber morphology should be integrated with the information provided by the initial radiographic for the correct planning of the crown opening and access to the root canals. Based on this study of Deutsch and Musikant [4], we opted to similarly verify, the radiographic morphology of the pulp chamber of the artificial teeth available in the Brazilian dental market and compare the results.

Therefore, in the present study, we observed that the pulp chamber height of the maxillary was similar to the mandibular molars, with mean of 1.5 mm for both, compared to the natural teeth of the study of Deutsch and Musikant [4], who found 1.5 mm for the maxillary and 2 mm for the mandibular molar. However, the measurements from the furcation and the pulp chambers floor were different because the artificial tooth mean was of 5.5 mm for the mandibular molars and 7 mm for the maxillary molars; the natural teeth exhibited a mean of approximately 3 mm for both mandibular and maxillary molars. In the artificial teeth, in 100% of the times, the pulp chambers floor matched the cementum-enamel junction, differently from what was found in natural teeth that the pulp chambers floor was below the cementum-enamel junction [4, 16]. The fact that the pulp chambers floor is at the level of the cementum-enamel junction may confuse the undergraduate during the crown opening in artificial teeth.

What was most noticeable in the anatomy of the artificial teeth was the measurement B, which was very high, making the floor of the pulp chamber very high, at the cement-enamel junction level, which differs from the natural teeth. It was also observed, in some teeth, the presence of radiolucent images with the appearance of bubbles, resulting from the process of manufacturing the teeth.

It is worth noting that in the present study, only the radiographic aspect of the pulp chamber of the artificial teeth was evaluated, since it is the first contact that the professional has of the pulp chamber. However, future assessments of vestibulo-lingual and mesio-distal dimensions are required. It should also be emphasized the difficulty in comparing the results found due to the scarcity of studies in the literature

Conclusion

In general, artificial teeth are very similar to natural teeth, radiographically and externally. However, the artificial teeth should be used with caution in the preclinical teaching of Endodontics bue to the presence of bubbles, reduced pulp chamber, and large area between the floor of the pulp chamber and furcation region, which may with the teaching of Endodontic procedures. It is also understood that further studies such as the cross-sectional and longitudinal section of the artificial elements should be carried out to measure the diameter of the root canal, the diameter of the apex and the location of the root canal.

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