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Evaluation of Different Methods for Obtaining Odontometry: Radiography, Digital Radiography and Electronic Apex Locator

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Abstract. Endodontic treatment, popularly known as root canal treatment, is a procedure that aims to eliminate infections inside the tooth and save teeth that would otherwise need to be extracted. Endodontics treats the internal part of the tooth, which includes the pulp. As it is an interdependent treatment, all its stages are interconnected and are essential for proper filling. Odontometry is a very important phase of endodontic therapy responsible for determining the length of the tooth. Many methods have been used in an attempt to clinically determine, with maximum precision, the length of the root canals. Several studies have already studied the different methods for obtaining odontometry, however, there is a lack of studies simultaneously comparing the three methods of determining odontometry (conventional, digital and electronic). Therefore, this study aimed to compare the accuracy of three methods: conventional radiography with the Spectro 70 KVp and 8 mA X-ray device (Dabi Atlante, Brazil) and E-Speed film (Kodak) at an exposure time of 0.2 seconds, digital radiography with CDR – computerized dental radiography (Schick Technologies Inc., NY, USA) and electronic odontometry with the Bingo 1020 apex locator (Forum). The results were analyzed by the chi-square test with Yates correction and a 95% confidence interval (95% CI). The method that obtained the best index was the electronic one, followed by the conventional and digital ones, presenting respectively the concordances of 55%, IC95% (31.5 - 76.9), 40%, IC95% (19.1 - 63.9) and 25%, IC95% (8.7 - 49.1) in comparison with the control group, with a statistically significant difference at the 5% level. The variations existing in the methods used indicate that the electronic apex locator was the one that presented the best concordance, being the most reliable, in relation to the control group. Funding Agency: CNPq

Keywords: Endodontics. Dental Radiology. Odontometry Methods. Digital Radiography.

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Avaliação de Diferentes Métodos para a Obtenção da Odontometria: Radiografia Convencional, Radiografia Digital e Localizador Apical Eletrônico

Resumo. O tratamento endodôntico, popularmente conhecido como tratamento de canal, é um procedimento que visa eliminar infecções dentro do dente e salvar dentes que, de outra forma, precisariam ser extraídos. A endodontia trata a parte interna do dente, que inclui a polpa. Sendo um tratamento interdependente, todas suas etapas se interligam e são primordiais para uma obturação adequada. A odontometria é uma fase muito importante da terapia endodôntica responsável pela

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determinação do comprimento do dente. Muitos métodos têm sido empregados na tentativa de se determinar clinicamente, com o máximo de precisão, o comprimento dos canais radiculares. Vários trabalhos já estudaram os diferentes métodos para obtenção da odontometria, entretanto, há carência de estudos comparando simultaneamente os três métodos de determinação de odontometria (convencional, digital e eletrônica). Portanto este trabalho visou comparar a precisão de três métodos: radiografia convencional com o aparelho de Raio X Spectro 70 KVp e 8 mA (Dabi Atlante, Brasil) e filme E-Speed (Kodak) no tempo de exposição de 0,2 segundos, radiografia digital com o CDR – radiografia dental computadorizada (Schick Technologies Inc., NY, EUA) e a odontometria eletrônica com o localizador apical Bingo 1020 (Forum). Os resultados foram analisados pelo teste do qui-quadrado com correção de Yates e Intervalo de confiança ao nível de 95% IC95%). O métodos que obteve melhor índice foi o eletrônico, seguido pelo convencional e o digital, apresentando respectivamente as concordâncias de 55%, IC95%(31,5 – 76,9), 40%, IC95%(19,1 –63,9) e 25%, IC95%(8,7 – 49,1) em comparação com o grupo controle, com diferença estatisticamente significante ao nível de 5%. As variações existentes nos métodos utilizados indicam que o localizador apical eletrônico foi o que apresentou melhor concordância, sendo o mais confiável, em relação ao grupo controle. Agência de Fomento: CNPq.

Palavras-chave: Endodontia. Radiologia Odontológica. Métodos de Odontometria. Radiografia Digital.

Evaluación de Diferentes Métodos para la Obtención de Odontometría: Radiografía Convencional, Radiografía Digital y Localizador de Ápice Electrónico

Resumen. El tratamiento endodóntico, conocido popularmente como tratamiento de conductos, es un procedimiento que tiene como objetivo eliminar las infecciones en el interior del diente y salvar dientes que de otra manera necesitarían ser extraídos. La endodoncia trata el interior del diente, que incluye la pulpa. Al ser un tratamiento interdependiente, todas sus etapas están interconectadas y son esenciales para un adecuado llenado. La odontometría es una fase muy importante de la terapia endodóncica encargada de determinar la longitud del diente. Se han utilizado muchos métodos para intentar determinar clínicamente, con la máxima precisión, la longitud de los conductos radiculares. Varios estudios ya han estudiado los diferentes métodos para la obtención de la odontometría, sin embargo, faltan estudios que comparen simultáneamente los tres métodos para determinar la odontometría (convencional, digital y electrónico). Por lo tanto, este trabajo tuvo como objetivo comparar la precisión de tres métodos: radiografía convencional con el dispositivo de rayos X Spectro 70 KVp y 8 mA (Dabi Atlante, Brasil) y película E-Speed (Kodak) a un tiempo de exposición de 0,2 segundos. , radiografía digital con CDR – radiografía dental computarizada (Schick Technologies Inc., NY, EE.UU.) y odontometría electrónica con el localizador de ápice Bingo 1020 (Forum). Los resultados se analizaron mediante la prueba de chi-cuadrado con corrección de Yates e intervalo de confianza del 95% (IC 95%). El método que obtuvo el mejor índice fue el electrónico, seguido por el convencional y el digital, presentando respectivamente concordancias de 55%, IC95%(31,5 – 76,9), 40%, IC95%(19,1 –63,9) y 25%, IC95% (8,7 – 49,1) en comparación con el grupo control, con una diferencia estadísticamente significativa al nivel del 5%. Las variaciones en los métodos utilizados indican que el localizador apical electrónico presentó la mejor concordancia, siendo el más confiable, con relación al grupo control. Agencia de Financiamiento: CNPq.

Palabras clave: Endodoncia. Radiología Dental. Métodos de Odontometría. Radiografía Digital.

INTRODUCTION

The success of endodontic treatment depends on the proper completion of all its stages, from a correct diagnosis to post-treatment monitoring.

Odontometry or conductometry is the phase of endodontic therapy responsible for determining the length of the tooth in order to establish the apical limit of instrumentation and the level of root canal filling, if the patient has caries and it reached the pulp, with a lot of pain for the patient (Reiss *et al.*, 2001; Elayouti, *et al.*, 2005; Noronha, 2024). The precise determination of the length of the canal is essential, since the emptying and chemical-surgical preparation of the canal in its entire extension, respecting the apical and periapical tissues, is essential for the success of endodontic treatment (Wolff *et al.*, 1999). Care in obtaining the working limit will avoid unpleasant consequences, such as the formation of steps in the canal wall, apical perforations, overinstrumentation, overfilling , induction of an inflammatory process in the periapical region and deficient or incomplete fillings (Ferreira *et al.*, 1999; Fan *et al.*, 2006).

Many methods have been used in an attempt to clinically determine, with maximum precision, the length of teeth and root canals, with the most widespread using radiographic methods (conventional and digital) and being subject to measurement variability. Brito et al. (1989) demonstrated that radiographic methods allow, in addition to determining odontometry, the observation of other important anatomical data, such as number, length, direction and volume of roots, periapical lesions and root resorption.

Conventional dental radiographs are obtained when a device emits X-ray waves, which sensitize a radiographic film placed in the patient's mouth. This technique has needed improvement in terms of the quality of the image obtained, radiation dose, time taken to produce the image and storage thereof. In addition, it provides a static image that cannot be significantly altered, requires chemical processing to develop the radiograph, which can lead to loss of information if not performed under ideal conditions, requires a relatively high radiation dose and is sensitive to variations in exposure time. In order to improve these limitations, digital radiographic techniques can also be used, which are obtained by means of a recently introduced direct digitalized image radiographic system, through which images are produced quickly and viewed almost instantly, since a sensor directly converts the X-ray energy to electronic signals through optical fiber. This system reduces radiation dosage by up to 93%, improves image quality due to its high definition, highlights the specific area, compensates for overlapping images and has features such as zoom, high relief, image rotation and different contrasts (Hedrick *et al.*, 1994; Lavalle & Wu, 1995; Garcia *et al.*, 1997; Versteeg *et al.*, 1997; Cedeberg *et al.*, 1998; Vale *et al.*, 1998; Kawaushi *et al.*, 2004).

In an attempt to further reduce patient exposure to X-rays and to obtain the length of the root canal more quickly and efficiently, electronic apex locators emerged from a study by Sunada (1962), in which he demonstrated that the electrical resistance between the periodontal ligament and the oral mucosa has a constant value that can be measured. The author proposed a method for determining the working length through the use of an electronic device, which essentially consists of a microammeter , a potentiometer and two electrodes. One of the electrodes is connected to the patient's oral mucosa and the other electrode (file) is placed inside the root canal. Once the device is calibrated, the file is carefully inserted into the canal until the microammeter indicates 40 microamperes , which means that the file has reached the apex.

Alves et al. (2003) mention the following advantages of apex locators: accurate; easy ; fast; reduces exposure to X-rays, especially in pregnant women and children; capable of detecting a perforation; and it is the only method capable of measuring up to the apical foramen, and not up to the radiographic vertex.

Regarding the disadvantages, ALVES et al. (2003) report: the technique requires special apparatus ; the execution of the technique and its accuracy depend on the electrical conditions of the canal; greater difficulty in teeth with a wide or open apex; inconsistent results in the case of vital pulp, except for the latest generation devices.

Many studies, such as those by KAWAUSHI et al. (2004), ELAYOUT et al. (2005) and FAN et al. (2006), have been carried out to study the different methods for obtaining conductometry , comparing separately the conventional radiographic method with the digital method or the conventional method with electronic odontometry . However, there is a lack of studies simultaneously comparing the three methods for determining odontometry (conventional, digital and electronic).

Therefore, the aim of this study is to compare the accuracy of three methods (conventional radiography, digital radiography and electronic apex locator) in determining the endodontic working length (odontometry).

DISCUSSION

The perfect completion of endodontic treatment requires a sequence of procedures that must be carried out within efficiency standards, as they are interdependent. When this does not happen, the following steps are compromised, resulting in a loss in the quality of endodontic therapy.

One of the phases of treatment that has received special attention from professionals is obtaining the working limit. Endodontic practice shows that this is one of the most difficult stages of treatment. The challenge encountered in calculating the working length lies in the location of the apical foramen.

Variations in shape and positioning make it difficult to detect by tactile sensitivity. Likewise, methods that use interpretations of radiographic images have limitations resulting from factors such as distortions and anatomical interferences.

Radiographic methods (conventional and digital) are the most widespread for performing odontometry , despite numerous studies, such as those by Palmer (1971), Machado (1981), Alves *et al.* (2003) having demonstrated that it is practically impossible to obtain radiographs without distortion.

In the search for greater precision in determining the apical limit, overcoming the limitations imposed by radiographic methods, devices (electronic apex locators) were developed that apply the differential principle to the passage of electric current through the dental structure/periodontal ligament, in order to establish the length of the root canals.

This study aims to compare the accuracy of conventional and digital radiographic methods and an electronic apex locator in determining the length of endodontic work (odontometry).

METHODOLOGY

Twenty human teeth will be used, healthy lower incisors, which have undergone extraction for various reasons. These teeth have approximate sizes and shapes, intact, straight roots, and fully formed apices.

Initially, the teeth will be numbered from 1 a20 on the proximal surface and will have their incisal edge regularized with a cylindrical diamond bur. After coronal opening and using a 0.5% sodium hypochlorite solution, the root canal will be explored with a #15 K file up to the opening of the apical foramen (Real Tooth Length - CRD). Once the level of the foramen (CRD) is reached, the instrument will be withdrawn by 1 mm, a measurement that corresponds to the Real Working Length (CRT). This measurement will be measured with a millimeter ruler and the value for each tooth will be noted on a specific form and corresponds to the control group.

The teeth will then be placed in alginate dies for endodontic measurements using radiographic methods (conventional and digital). For the conventional radiographic examination, we will use a Spectro 70 KVp and 8 mA X-ray device (Dabi Atlante), with periapical film . intraoral E-Speed (Kodak), with exposure time of 0.2 seconds. Development and fixing will be carried out manually, according to the manufacturer's recommendations.

Digital radiographic examinations will be performed with the CDR (Computerized Dental Radiography) device, Schick Technologies Inc., NY, USA, with an exposure time of 0.02 seconds. The CDR intraoral sensor will be used instead of the periapical radiographic film.

The focus-receptor distance will also be standardized, through the use of a radiographic positioner, for the periapical parallelism technique. The radiographic images will be taken from the vestibular surface of the teeth.

For the radiographic methods (conventional and digital), the Ingle odontometry method (1967) was chosen. Using this method, after the initial radiograph, the tooth is measured and the value (reduced by 2 or 3 mm, as a safety margin) is transferred to an endodontic file. The instrument is then inserted into the root canal and a new radiograph is taken, in which the distance between the tip of the instrument and the root apex is checked, adding or subtracting this value from the length of the instrument. This gives the real length of the tooth (CRD); from this, the real working length (CRT) is defined, which is nothing more than the CRD minus 1 mm..

The Bingo 1020 apex locator (Forum , Israel) will be used to evaluate the electronic apex locator. Measurements will be performed by connecting one electrode of the device to a K-file. The other electrode of the device (labial loop) will be inserted into the alginate laterally to the tooth to be measured. The position of the apical foramen will be read by inserting the file and moving it slowly apically until it registers 1 mm on the device display.

All teeth will be subjected to conventional, digital and electronic conductometry methods, totaling 80 odontometries, 20 manual odontometries , control group, 20 odontometries obtained by conventional radiography, 20 odontometries obtained by digital radiographs and 20 odontometries obtained by electronic apex locator.

These odontometries obtained with the different methods will be recorded and tabulated for comparison with the measurements of the control group, totaling 80 data (Table 1). These data obtained will then be subjected to statistical analysis.

Table 1 – Results of the research methods

Tooth	Control Group (CRT)	Odontometry Conventional	Odontometry Digital	Odontometry Electronics
1	22	22.5	22.5	22
2	20	19.5	19.5	20
3	20.5	20	20.5	20.25
4	20	20	20	20.5
5	18	19	17	18.5
6	20.5	20.5	19.5	20.5
7	20	19.5	19.5	20.25
8	21	21	20	21
9	21	20	20	21
10	18	17.5	17	18
11	21.25	21	21	21.25
12	20	20	19	20
13	21	21	20	21.75
14	22	22	22	22

15	20.25	20	20	20.25
16	18	18	18	18.25
17	17	18	17.5	18.25
18	17	17	17	17
19	18.5	19	18	19
20	19	18	18.5	20

Source: Own authorship.

CONCLUSION

The results were analyzed using the chi- square test with Yates correction and a confidence interval of 95 % (95% CI). The method that obtained the best index was the electronic one, followed by the conventional and digital ones, presenting respectively the concordances of 55%, 95% CI (31.5 - 76.9), 40%, 95% CI (19.1 - 63.9) and 25%, 95% CI (8.7 - 49.1) in comparison with the control group, with a statistically significant difference at the 5% level. The variations in the methods used indicate that the electronic apex locator was the one that presented the best concordance, being the most reliable, in relation to the control group.

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To my wife Bruna, my son David, my father Joao e my mom Ana. Love you all.

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