Revista Odonto Ciência
Journal of Dental Science

ORIGINAL ARTICLE

Rev Odonto Cienc 2014;29(2):53-56
http://revistaseletronicas.pucrs.br/ojs/index.php/fo
doi: http://dx.doi.org/10.15448/1980-6523.2014.2.22222

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Measures obtained from images acquired by a stereomicroscope and a desktop scanner

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Abstract

Objective: This study aimed to compare measures obtained from dental section images acquired by a stereomicroscope and a desktop scanner, and to determine whether there were differences between the two methods.

Methods: Fifty extracted human teeth were mesiodistally sectioned. Each section was photographed by stereomicroscopy and digitized by scanning at 230 dpi resolution. The Photoshop software was used to obtain horizontal and vertical measures of each section from images acquired by each of the two methods, with randomized repeated measurement of 20% of the sample cases.

Results: Initial and repeated measurements were correlated. Paired t test did not reveal any significant differences (α=5%) between them. Mean measures and standard deviations were: horizontal, stereomicroscope 8.89 mm±4.30 mm, scanner 8.89 mm±4.52 mm; vertical, stereomicroscope 4.42 mm±2.19 mm, scanner 4.43 mm±2.19 mm. Results of paired t test (a=5%) did not show any significant differences between the two methods either for horizontal (p=0.685) or vertical (p=0.299) measures.

Conclusion: The desktop scanner can be used in the place of a stereomicroscope in the acquisition of images of tooth sections with the purpose to obtain horizontal and vertical measures.

Key words: microscopy; dental photography; dental informatics.

Obtenção de medidas de imagens adquiridas em estereomiscroscópio e escaner de mesa

Resumo

Objetivo: Esse estudo teve por objetivo comparar medidas obtidas de imagens de secções dentárias adquiridas em estereomiscrópio e escâner de mesa, assim como determinar se existem diferenças entre os dois métodos.

Métodos: Cinquenta dentes humanos extraídos foram seccionados no sentido mésio-distal. Cada secção foi fotografada em estereomicroscópio e digitalizada em escâner de mesa com resolução de 230 dpi. O programa Photoshop foi utilizado para obter medidas verticais e horizontais das imagens de cada secção dentárias, adquiridas por ambos os métodos. Foram repetidas as medidas em 20% das amostras, selecionadas randomicamente.

Resultados: As medidas iniciais e as repetidas apresentaram correlação positiva e o teste t para amostras pareadas não revelou diferença significativa (α=5%) entre elas. A média das medidas e os devios-padrão foram: horizontal, estereomicroscópio 8,89 mm±4,30 mm e escâner 8,89 mm±4,52 mm; vertical, estereomicroscópio 4,42 mm±2,19 mm e escâner 4,43 mm±2,19 mm. Os resultados do teste t para amostras pareadas (a=5%) não mostrou nenhuma diferença significativa entre os dois métodos para as medidas horizontais (p=0,685) e verticais (p=0,299).

Conclusão: O escâner de mesa pode ser usado substituindo o estereomicroscópio na aquisição de imagens de secções dentárias para a obtenção de medidas verticais e horizontais.

Palavras-chave: microscopia; fotografia dentária; informática odontológica.

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Received: August 9, 2012
Accepted: November 5, 2013

Conflict of Interests: The authors state that there are no financial and personal conflicts of interest that could have inappropriately influenced their work.

Introduction

Histological examination, using microradiography or microscopic examination of tooth sections or series of sections, is the criterion standard for in vitro research that evaluates the performance of other diagnostic methods, particularly those for the diagnosis of caries [1,2]. Their disadvantages are their high cost and the long time and great effort required for their performance [3].

The use of different diagnosis validation methods may lead to different results, and thus affect the accuracy of the tests used for evaluation [4,5]. The comparison of two histological methods, hemisectioning and serial tooth sectioning, revealed that they differ in terms of performance in detecting carious lesions [6], which may be explained by the fact that in serial tooth sectioning it is possible to accurately determine which section shows the greatest lesion depth on a certain surface. Hemisectioning is a less accurate method because the sectioned area on each tooth half does not always correspond to the region of greatest depth of the carious lesion.

The examination of dental structures by means of stereomicroscopic image acquisition is still used in several situations [7-11]. However, a stereomicroscope is not always available, and the images acquired by stereomicroscopy have to be adjusted for magnification.

Desktop scanners are affordable devices that can also be used to digitize documents in dental practice. The choice of resolution should take into consideration image quality, hard disk space for storage, length of time for procedure, and time required for electronic file transmission [12]. No significant differences were found when 1200, 900, 600 and 300 dpi resolutions were compared in the evaluation of optical density of radiographs [13].

The use of a desktop scanner instead of a stereomicroscope may be an option to simplify procedures and reduce costs of numerous studies. Therefore, the purpose of this study was to compare measures obtained from dental section images acquired by a stereomicroscope and a desktop scanner, and to determine whether there were differences between the two methods.

Methods

This study was approved by the Ethics in Research Committee of the School of Dentistry, Universidade Federal do Rio Grande do Sul, Brazil, under number 58/04.

Fifty extracted human molar and premolar teeth were used. The teeth were sectioned mesiodistally with a diamond disk (Buelher, Lake Bluff, IL, USA), and sanded until all grooves resulting from sectioning were eliminated. The same teeth had already been used for previous studies. The 100 sections were stored separately in saline solution. To detect a 0.05 mm difference with a 5% significance level and a power of 90%, a sample size of 93 sections was necessary.

Each tooth section was mounted on a wax block (Clássico Artigos Odontológicos, São Paulo, SP, Brazil) to standardize their position, with the smooth sectioned surface facing the observer. The blocks were placed under the stereomicroscope one by one, and images were acquired at 0.63× magnification. A millimeter ruler was placed at the same height on the smooth side of all the sections to be used as a measurement reference later. Images were acquired in digital format with a Kodak Easy Share CX 6330 (Eastman Kodak Co., Rochester, NY, USA) camera, 3.1 megapixels CCD sensor, 3× optical zoom, 230 dpi resolution, and RGB color mode.

Images of the same specimens were digitized in an Epson Perfection 2450 (Epson, Long Beach, CA, USA) desktop scanner with automatic adjustment for brightness and contrast, 230dpi resolution, and RGB color mode.

The two images of the same tooth, acquired by the two different methods under study, were imported into the Photoshop 7.0 (Adobe Systems, San Jose, CA, USA) software, placed side by side, and rotated until the long axis of the tooth had the same orientation. The images of the molar teeth were rotated until the tip of the cusps touched a horizontal line used as reference. The images of the premolar teeth were rotated until the long axis of the root canal was parallel to a vertical reference line (Figure 1). The images acquired by stereomicroscopy were adjusted for the magnification using the millimeter rule as reference. All the image files were stored as JPEG at 3:1 compression ratio.

An observer used the Photoshop measure tool to obtain horizontal and vertical measures of each section – thickness of enamel and/or dentin, and size of restorations, cavities or pulp chamber.

To test method and observer reproducibility, image acquisition and measurement of 20% of the sample specimens were repeated. Initial and repeated measures (N=20) were analyzed with the Pearson correlation and the paired *t* tests. Means and standard deviations of horizontal and vertical measures of each group (SM = stereomicroscopy; DS = desktop scanning) were compared with the paired *t* test.

Results

Table 1 shows that there was a significant correlation between means of repeated measurements in 20% of the sample specimens, revealing near perfect observer agreement in relation to the two methods. The comparison of initial and repeated measurements revealed that horizontal and vertical measures obtained by the different methods were not significantly different (paired *t* test; significance level = %) (Table 2).

Means and standard deviations of horizontal and vertical measures obtained by the two methods are shown in Table 3. Mean horizontal measures were: SM=8.89 mm±4.30 mm; and DS=8.89 mm±4.2 mm. Mean vertical measures were: SM=4.42 m±2.19 mm; and DS=4.43 mm±2.19 mm Results of the paired *t* test (α=5%) did not reveal any significant differences in horizontal (p=0.685) or vertical (p=0.299) measures between the two methods.

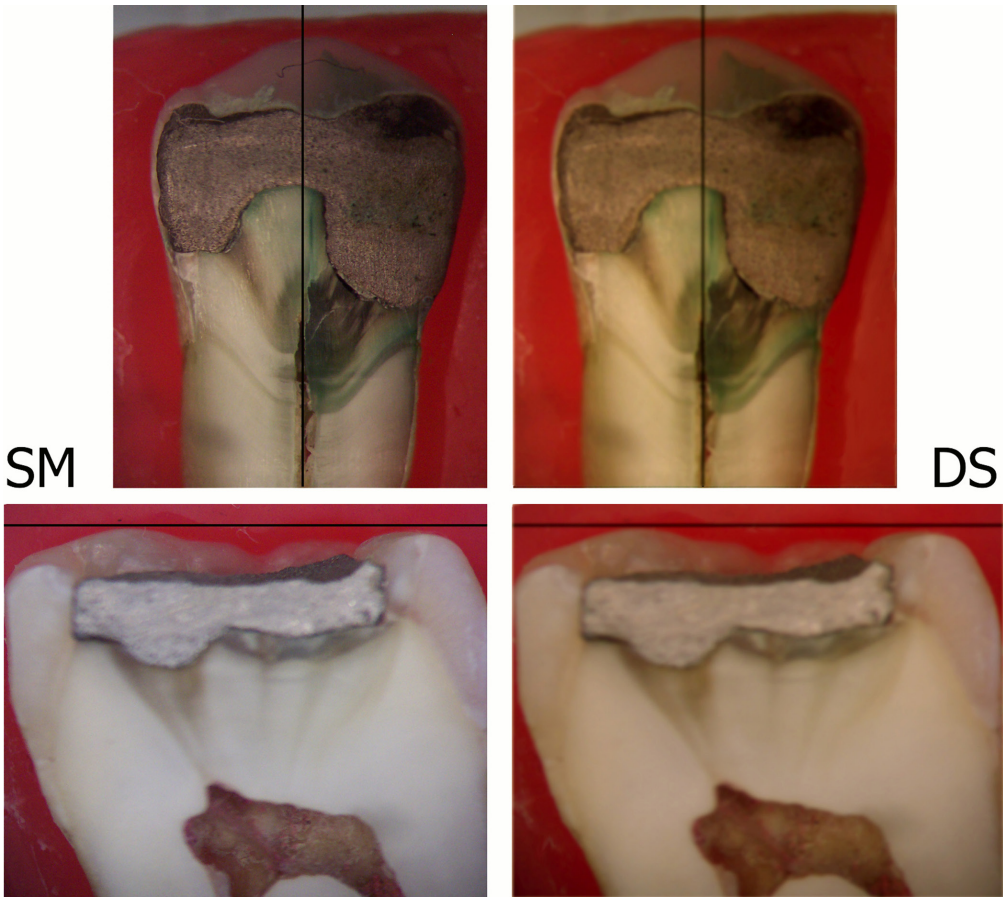

Fig. 1. Examples of alignment of the two images of the same tooth section acquired by stereomicroscopy (SM) and desktop scanner (DS).

Table 1. Correlation coefficient between measures obtained by two methods in the repeated measurement of 20% of the sample.

Method	Measurement	Pearson correlation coefficient
Desktop Scanning	Horizontal	0.999*
	Vertical	1.000*
Stereomicroscopy	Horizontal	0.948*
	Vertical	0.893*

* Significant correlation at a significance level of 1%.

Table 2. Comparison between mean measures obtained by the two methods in the two measurements of 20% of the sample.

Method/Measure	N	1st measurement		2nd measurement		p
		Mean	Standard deviation	Mean	Standard deviation	
Stereomicroscopy/Horizontal	20	10.70	3.71	10.37	3.96	0.251
Stereomicroscopy/Vertical	20	5.32	2.71	5.62	2.81	0.315
Desktop Scanning/Horizontal	20	10.67	3.67	10.66	3.65	0.591
Desktop Scanning/Vertical	20	5.33	2.68	5.31	2.63	0.453

p = significance level, paired *t* test.

Table 3. Comparison between mean horizontal and vertical measures obtained by the two methods.

Method/Measure	N	Stereomicroscopy		Desktop Scanning		p
		Mean	Standard deviation	Mean	Standard deviation	
Horizontal	100	8.89	4.30	8.89	4.25	0.685
Vertical	100	4.42	2.19	4.43	2.19	0.299

p = significance level, paired *t* test.

Discussion

This study used tooth hemisectioning instead of serial sectioning because its purpose was not to accurately determine the greatest depth of a lesion on a surface, but rather to compare measures obtained from images acquired by a stereomicroscope and a desktop scanner.

Teeth were stored in saline solution only to avoid dehydration, and the preservation of soft tissues or the maintenance of the physical properties of mineralized tissues was not considered.

In this study, the digital images were acquired at relative low resolution (230 dpi) for both methods because of the characteristics of the camera available for stereomicroscopy and so that image enlargement for display on the monitor was standardized. We can expect that higher resolutions would improve image quality and should be addressed in the future studies. The JPEG 12 (3:1 compression rate) format file have already proven to be reliable for the purpose of this study [14].

The Photoshop measure tool was used for horizontal and vertical measurements because it is easy to use and, mainly, because of the good measurement reproducibility by different observers at different times [15-17]. This also justifies the fact that the measures were obtained by only one observer in this study. The analysis of horizontal and vertical measures obtained by the two methods in the random repetition of 20% of the sample specimens did not reveal any significant differences between the first and second measurements, but showed that they were strongly correlated.

In a previous study, Larentis et al. [18] compared measures obtained from images acquired by stereomicroscopy and scanning, and found a significant difference in vertical measures between the two methods. The authors suspected that such difference might have been caused by the lack of standardization of the position of the same section under the stereomicroscope and on the desktop scanner since the tooth sections had not been mounted on wax blocks. Such difference might have been found only in vertical measures because they are greater than horizontal measures and, therefore, more likely to vary.

The use of a desktop scanner instead of a stereomicroscope could be an option that may simplify procedures and reduce costs of numerous studies. The acquisition of images by a scanner is faster and more easily standardized because all teeth can be digitized simultaneously in real size and using the same light intensity.

Conclusion

The desktop scanner can be considered as an option to acquire images of tooth sections with the purpose to obtain horizontal and vertical measures.

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