Accuracy of three image techniques of measurement from cemento-enamel junction to alveolar crest in relation to clinical attachment level

Acurácia de três técnicas de medida da distância entre junção cemento-esmalte e crista óssea alveolar em relação ao nível de inserção clínica

Marcelo de Azevêdo Rios[1], Jacqueline Machado Gurjão Rios[2], Izabel Regina Fisher Rubira[3]

[1]*MDS in Periodontics – Federal University of Bahia, Assistant Professor Integral Clinic State University of Feria de Santana – Bahia, School of Dentistry;* [2]*MDS in Stomatology – Federal University of Bahia, Assistant Professor of Bahia Federal Institute – Technology in Radiology – Bahia;* [3] *MDS, DDS Oral Diagnosis – São Paulo University – School of Denstistry – Bauru – São Paulo;* [3]*Associate Professor – School of Dentistry – Bauru – São Paulol.*

Resumo

Este trabalho teve por objetivo estabelecer a correlação, comparação e acurácia de três métodos radiográficos e um clínico da medida da distância entre a junção amelo-cementária e a crista óssea alveolar de molares e pré-molares inferiores de pacientes portadores de perda óssea periodontal, os quais foram submetidos à sondagem do nível de inserção clínica e radiografias interproximais verticais das áreas de interesse. Apenas sítios com profundidade de sondagem maior ou igual a 5mm foram incluídos na amostra. Foram verificados 82 defeitos ósseos em relação à distância entre a junção amelo-cementária e a porção mais apical da crista óssea por meio de compasso de ponta seca, paquímetro digital e o programa Dentscan Dentview. Os resultados mostraram que usando o nível de inserção como padrão-ouro, o compasso de ponta seca teve maior acuidade (sensibilidade de 71% e especificidade de 84,5%), seguido pelo paquímetro digital (sensibilidade de 0% e especificidade de 82,8%) e pelo Dentscan Dentview (sensibilidade de 0% e especificidade de 75,9%).Todas as variáveis possuíram níveis excelentes de correlação, sendo que a melhor correlação ocorreu entre o paquímetro digital e o Dentscan Dentview (95,6%), além de apresentarem diferenças estatisticamente significantes entre si, exceto entre o nível de inserção clínica e o compasso de ponta seca. O sistema Dentscan Dentview facilitou a interpretação pela possibilidade de manuseio da imagem no computador.

Palavras-chaves: Diagnóstico por imagem. Processamento de Imagem Assistida por Computador. Interpretação de Imagem Radiográfica Assistida por Computador.

Abstract

This research aimed to determine the comparison, correlation and accuracy of three radiographic methods and one clinical method for measuring the distance between cemento-enamel junction and the alveolar crest in lower molars and bicuspids in patients with periodontal bone loss, who underwent clinical probing and vertical bite-wing radiographs. Only areas with probing depth greater or equal to 5 mm were included in the sample. The distance between cemento-enamel junction and the apical portion of 82-bone defect was verified through double-needle compass, digital caliper and the software Dentscan Dentview. The accuracy, correlation and comparison between clinical and radiological variables were recorded. The results showed that when the attachment level was the gold standard, the double-needle compass expressed the best accuracy (71% of sensitivity and 84.5% of specificity), followed by digital caliper (0% of sensitivity and 82.8% of specificity) and Dentscan Dentview (0% of sensitivity and 75.9% of specificity) regardless of testing variable or gold standard's location, more severe diseases were underestimated than overestimation of onset disease. The systems with digital resources showed greater measurement values than methods without digital resources. All the variables presented.

Keywords: Diagnostic Imaging. Image Processing, Computer-Assisted . Radiographic Image Interpretation, Computer-Assisted.

Background

Periodontal disease has a number of specific features, when compared with other illnesses, as a model of outbreak progression, a microbiological aetiology varying over time and local specificity, for example. These points, sometimes, can make the use of clinical and image methods harder to evaluate or predict diseases' activity. Regarding images, digital radiology is becoming increasingly easier to access, but conventional radiographs remains in use in a great number of dental offices in several countries, especially in Brazilian public health.

Usually, clinical attachment level (CAL) is applied to measure previous breakdown and disease activity. CAL is considered the distance between cemento-enamel junction and the deepest portion of periodontal pocket/sulcus. CAL is mean gold-standard to evaluate periodontal status in periodontal research over the time, but does not measure the space of connective tissue attachment, once its limit is the epithelial tissue of

periodontium. This way, a trans-surgical measurement, without flap, could be the best procedure to follow up periodontal tissue loss. The reliability of this proposal is not acceptable, but it can be fixed in spite of image approach.

A great number of papers have evaluated the power of many procedures and devices of image resources (LANNING et al, 2005; SCAF, MORIHISA and LOFFREDO 2007; Fukuda et al. 2008, JI et al 2010). Likewise, other important classical researches correlated clinical and image references, provided that CAL precedes alveolar bone loss, and both clinical and image protocols must walk together to guarantee great performance in diagnosis, prognosis and supportive therapy.(GOODSON, HAFFAJEE, SOCRANSKY, 1984; CLEREHUGH, LENNON, 1986; HAUSMANN et al., 1994).

Gedik et al. (2008) determined the relationship between loss of radiographic crestal bone height in panoramic, bitewing and periapical radiography and to probe the attachment loss after periodontal treatment. Radiographic and probing measurements were made at baseline and after one year. Measurements of the distance between the cemento-enamel junction and the alveolar crest were compared with probing crestal bone level and radiographic measurements before and one year after the procedures. The results of probing pocket depths level before and one year after subgingival curettage were different with the mean average being 1.18 +/- 1.51 mm. These changes were statistically significant (p < 0.05). Bitewing radiography showed the highest accuracy among radiographic methods in the assessment of the crestal bone level mean average 0.22 +/- 0.87 mm (p < 0.05). There was only a slight mean difference compared to panoramic radiography but this was statistically insignificant, mean average 0.20 +/-1.35 mm (p > 0.05), and the periapical radiography had the lowest accuracy of radiographic methods, changed mean average -0.14 +/- 1.19 mm (p > 0.05). In summary, we can say that both bitewing and panoramic radiography are preferred to periapical images for crestal bone assessment.

There is a common point of view throughout the literature about the usage of the bite-wing technique as the best one to evaluate the distance between cement-enamel junction and alveolar bone crest. A previous report by Schuller and Holst (1996) had already quantified the consistency of this measurement. Almost 856 bite-wing radiographs were obtained and examined twice by different examiners. The authors concluded that interproximal investigation can lead to a safe evaluation of the distance between CEJ and alveolar crest.

Gomes Filho et al (1999) aimed to verify inter and intra-examiner variations during the measurement of the distance among CEJ and alveolar crest in incisors and both upper and lower molars from a group of dentistry students. As a measure instrument the digital caliper and digital images were used. Only incisors did not register variations. These data received further

confirmation in the studies of Lanning et al (2005) and Grimard et al (2009), adding more image resources.

Kim et al., (2002) evaluated two different systems of computational analysis (LMSRT and FRIADENT) to estimate interproximal alveolar bone loss. Ninety radiographs were taken from 14 patients with untreated periodontal disease. Both the distance between CEJ and bone crest and CEJ and the bottom of the defect were taken during surgical approach and radiological examination. Regarding from CEJ to the bottom of the defect, both methods were equivalent, but from CEJ to bone crest, both methods overestimated the real distance around 1.5 to 2 mm.

Rebouças et al.(2000), using periapical radiographs of upper incisors, evaluated the accuracy of different measurement methods of the distance from CEJ and bone crest (digital caliper, double-needle compass plus endodontic ruler and Dentscan Dentview), compared with clinical attachment level. All the resources showed good correlation with the clinical data, however digital caliper and indirect digital image were the most accurate. In 2003, Khocht et al. confirmed these findings when carried out a study in bite-wing radiographs were digital images were more accurate than conventional ones.

As presented above, the aim of this study was to establish the accuracy, correlation and comparison between digital and conventional measurement methods from CEJ to alveolar bone crest in vertical bite-wing x-rays and the clinical attachment level.

Material and methods

Vertical bite-wing images were performed in a group of patients from State University of Bahia – School of Dentistry, with healthy molars and bicuspids, and probing depth > 5mm. A Trinity® type Willians periodontal probe, 4g of weight, was used to measure the clinical attachment level, and the images were taken under the following protocol: exposure time – 0,8 s; modified Hanshin film-holder device and Ultraspeed Kodak film (D speed); time/temperature develop method; 15 images 15 images per time.

A crystal liquid light-box viewer (VisualPlus®) was used to evaluate all the images. A standard mask was applied to the light-box to deploy light just only to the entire area of the film. A set of 10 images per time were displayed over the light-box, and the distance among CEJ to the bottom of the defect was measure although digital caliper and double-needle compass and endodontic ruler, helped by a magnifier lens (5X).

Next, all the images were digitalized to the Denscan Dentview software (APICA-Israel), and the same distance was recorded. The pattern of measurement of the distance between CEJ and the bottom of the defect was recommended by Hausmann et al (1989). Medium degree of density and contrast, and full image details were the standard protocol for image quality. Only radiographs

with clear definition of CEJ and the bottom of the defect were accepted to evaluation.

Only a single examiner evaluated all the images in both clinical and radiological moments. In addition, the observer did not know the previous values recorded to the methods used before. When a record of clinical attachment level or double-needle compass was located among two marks on the probe/ruler, the closer value was recorded. If it was located precisely at the middle, the higher one was registered.

Statistical analysis was performed by Kruskal-Wallis comparison test, and Spearmann correlations, at the level 95%. Accuracy indicators were applied, keeping clinical attachment level as a gold standard. For convenience, values lower than 5 mm were considered as slight disease, and higher as severe disease.

Results

Tables 1 and 2 showed Spearmann correlations and Kruskal-Wallis comparison test, respectively. Excellent positive correlation levels were achieved among all the variables, but Dentscan-Dentview and digital caliper exhibited the greatest one (95.6%). Except between double-needle compass and clinical attachment level, all pairwise evaluated showed statistical difference between each other. Graph 1 shows the accuracy indicators.

During the test of the double-needle compass, a sensitivity of 91.7% and a specificity of 8.5% were achieved. In other words, in a set of 100 values obtained from the gold standard (clinical attachment level) in appoint slight disease (d"5mm), the double-needle compass was able to identify correctly in almost 92 opportunities. On the other hand, the same device was capable of establishing as severe disease (>5mm) about 84.5% of the cases.

At the same evaluation, digital caliper presented high specificity (82.8%) and low sensitivity. Denscan Dentview showed a very similar performance to the digital caliper, without sensitivity and great specificity (75.9%).

TABLE 1 – Correlations among variables (Spearmann correlations' test)

	Double-needle compass	Digital caliper	Dentscan Dentview
Clinical attachment level	0.895	0.941	0.943
Double-needle compass		0.910	0.920
Digital caliper			0.956

TABLE 2: Kruskal-Wallis comparison test

VARIÁVEIS	Compasso de ponta seca	Paquímetro digital	Dentscan Dentview
Nível de inserção clínica	Negativo	Positivo	Positivo
Compasso de ponta seca		Positivo	Positivo
Paquímetro digital			Positivo

Negative for p <0.05 and positive for > 0.05

In terms of predictive values, the double-needle compass was the only device that showed a positive predictive value (7.0%), its negative predictive value was 96,1%, the digital caliper with 66.7% and Denscan Dentview with 64.7%.

The amount of false-positive was lower for the double-needle compass (29%), and maximum to both digital caliper and Dentscan Dentview (100%). Double-needle compass exhibited the lower number of false-negative (3.9%), and moderate to digital caliper and Dentscan Dentview (33.3% and 35.3%, respectively).

It was observed a general tendency of digital methods to show more losses than non-digital resources. In addition, an underestimation of severe disease was more evident than an overestimation of slight disease, independent on the variable evaluated.

Discussion

Clinical attachment level is the major clinical parameter in Periodontology, and is considered as a
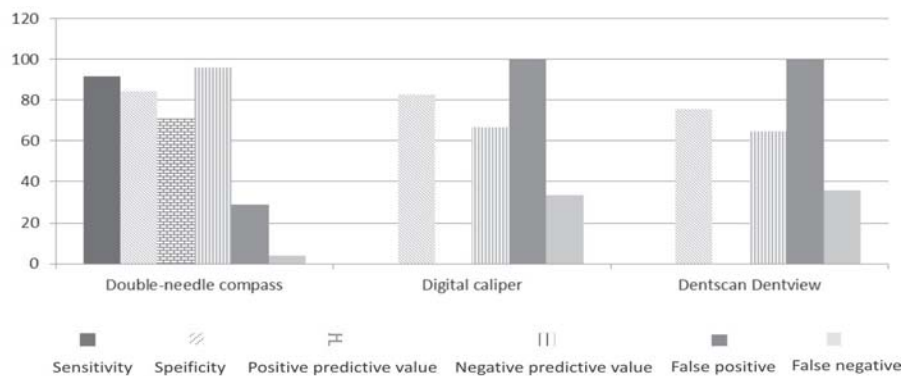
Graph 1 – Accuracy indicators

classical and reliable gold standard for short and long term evaluations (RHEU et al, 2011). However, it is not possible to measure accurately the space of connective tissue attachment solely with clinical attachment level, so this is where x-ray examination can fulfill this lacunae.

Several studies throughout the scientific literature tested techniques and devices to measure the distance between CEJ and alveolar bone crest (REBOUÇAS, 2000, EICKHOLZ and HAUSMANN, 2000, KIM et al., 2002, GEDIK et al., 2008, TEEUW et al, 2009), in search to discover the best method to correlate to clinical data. During this work, the authors had tested the double-needle compass, digital caliper and Dentscan Dentview indirect digitalizer, for their accuracy related to the clinical attachment level.

A comparison of the variables showed a statistically significant difference among all associations, except between clinical attachment level and the double-needle compass. A reasonable explanation for this result is the fact both methods have to be approximated during filling recording, drawing them closer to each other. The digital resources Dentscan Dentview and digital caliper, displaying one or two numbers on screen respectively, make it precise in short distances.

Hämmerle, Ingold and Lang (1990), in a classical report, demonstrated the clinical attachment level as the data which correlates very closely with surgical measurement. In addition, Eickholz and Hausmann (2000), Gedik et al. 2009 and Grimard et al 2009 pointed out that conventional x-ray examination understimated the distance between CEJ and the bottom of proximal periodontal defects, when compared with intra-operatory measurement. This way, in order to avoid an invasive method to evaluate CEJ-bottom of defect distance, electing the best image resource is an important approach to clinical routine.

We found a high level of positive correlation between all variables, meaning a strong tendency of all the variables to increase together. This fact suggests that any image method translates the clinical data, despite the numeric value recorded. Classical reports (MOLENDER, 1991) and recent ones (KIM et al 2002, Fukuda et al. 2008, JI et al 2010) corroborate with our findings.

Special attention must be given to digital systems, once, related to gold standard, the greatest incidence of false-negative (35.3%) was observed. This finding was obtained, probably, due to image manipulation on screen, which decreases human mistakes during evaluation. Digital resources tend to show more bone loss than non-digital devices. This achievement was previously described by Eickholz et al. (1998) and confirmed by Fukuda et al (2008), when they concluded that image resources underestimate the surgical data. However, the digital approach did it to a lower extent.

Vandenberghe et al (2010) compared conventional and digital images for periodontal diagnosis in two different moments and designs, evaluating neither intra-oral image receptor nor x-ray generator and concluded that in both conventional and digital periodontal imaging, it is important to delegate an overall attention not only to examiner performance, but also to all the side-tools related to the workflow of image interpretation.

In addition, in this current paper, a cut-point of 5 mm referred to probe depth was used just to guarantee that only pathological periodontal pockets would be included. Thus, much more an underestimation of severe disease (>5mm) than an overestimation of slight illness (d"5mm) was observed. These findings demonstrate a real possibility of a small determination of bone loss severity in patients with periodontal disease, leading to an undertreatment of the illness. In our country, the clinicians still use conventional radiographs in daily practice as their major radiological image framework, and must bear in mind that non-digital image resources may lead to a decision that compromises the treatment plan.

Conclusion

Based upon our results, it is possible to conclude:

1- The best accuracy was achieved by double-needle compass, followed by digital caliper and Dentscan Dentview.

2- Double-needle compass and clinical attachment level showed the highest correlation level.

3- All variables showed significant statistical differences between each other, except for double-needle compass and clinical attachment level.

4- The digital resources exhibited greater measures than clinical and non-digital image approaches.

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