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ORIGINAL RESEARCH

Comparison of Accuracy of determining the Distance between Alveolar Crest and Cementoenamel Junction in Digital Radiography with Scanora and DentalEye Software Programs

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ABSTRACT

Aim: To compare the accuracy of determining the distance between alveolar crest and cementoenamel junction (CEJ) in digital radiography with two image processing software programs.

Materials and methods: In this *in vitro* study, 63 sites in a dried human mandible underwent digital periapical radiography. The distance from the alveolar crest to the CEJ was calculated using DentalEye and Scanora software programs and compared with the standard mode (measured on the skull). Statistical analysis was performed with analysis of variance (ANOVA) and paired t-test using Statistical Package for the Social Sciences (SPSS) 23 at α = 0.05.

Results: There were significant differences in the distances between CEJ and the alveolar crest at the mesial surfaces as measured by the three techniques in standard mode, using DentalEye and Scanora (p-value ≤ 0.03) softwares; however, there were no significant differences between the results on distal surfaces (p-value = 0.248).

Conclusion: Under the limitations of the present study, the measurements made to determine the distance from the CEJ to the alveolar crest with DentalEye and Scanora, relative to each other, and relative to the standard mode, were accurate only on distal surfaces of teeth.

Clinical significance: Digital dental software programs are useful assets that can enhance the diagnosing ability and reduce the need of taking extra images.

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INTRODUCTION

Periodontitis is an inflammatory disease of the supporting tissues of teeth, which destructs periodontal ligament and alveolar bone, forms gingival pocket, and induces gingival recession that lead to tooth hypermobility because of apical transition of junctional epithelium on root surface. Periodontal disease affects interdental alveolar crest which alters lamina dura's radiographical view, crestal radiodensity, shape and size of bone marrow, and height and contour of the crestal bone. Crestal bone may be positioned horizontally, vertically, or in an angular position to the long axis of the tooth. Several techniques are used to diagnose periodontal diseases. Dental radiography is one of the most accurate ways to determine prognosis and choose a suitable treatment plan.[1]

Digital radiographic device was invented in the 1970s and has been rapidly replacing the conventional radiographic devices ever since.[2,3] Digital devices have noticeable advantages over conventional devices, such as better view of anatomical structures and more accurate diagnosis due to noise reduction system.[4] Conventional films have been replaced with digital plates and exposure time has been reduced 90% of the conventional exposure

time, where images are processed rapidly and can be viewed in higher resolution.[2,3,5] Digital plates are more sensitive to X-ray than conventional films, so exposure time is reduced by 50 to 80% of normal time, which leads to less absorbed dose of the patient.[6]

Various software programs are used in digital imaging that uses different methods for adjusting edge sharpening, image contrast, gray scales, image inversion, and color enhancement of the image.[7]

Scanora software has been introduced to enhance the quality of digital imaging with special features like noise reduction and the ability to reconstruct three-dimensional (3D) views.[8]

Welande et al[9] studied digital images using DentalEye software and showed that this software can elevate radiographical perception of images and it can be used for brighter images, which leads to shorter exposer time for the patient.

Khocht et al[10] showed that digital radiographies can reveal more bone resorption sites than conventional radiographies. In this study, Shick software was used and images were magnified 100 times.

Mehdizadeh et al[11] compared the accuracy of measurement of the distance from CEJ to the bone crest in conventional and digital radiographies. This study showed that the accuracy of digital radiographies is comparable to conventional ones.

Li et al[12] compared digital images processed with visual response algorithm with F speed conventional films and could not find any significant differences in accuracy of determining the level of the crestal bone.

Kaeppler et al[13] compared photo stimulable phosphor plate (PSP) with conventional films for evaluating periodontium. They found out that Digora digital system is more suitable for evaluating periodontium and implant sites.

Eickholz et al[14] showed that modification of digital images with digital filters cannot raise the level of accuracy of crestal bone level measurement statistically.

Since radiography is a complementary asset to diagnose and treat periodontal diseases and surgical measurement of the crestal bone can be unpredictable, radiographic images are used to determine the crestal bone level.[15]

Since digital imaging is dominating dental offices rapidly and digital software programs are used as a basis for these devices, comparing the accuracy of these software programs seems reasonable.

The aim of this study is to determine and compare the accuracy of measurement of the distance between CEJ and alveolar crest in digital imaging using DentalEye and Scanora software programs (Figs 1 and 2).

MATERIALS AND METHODS

This *in vitro* experimental study was performed in Faculty of Dentistry of Isfahan University of Medical Science. A total of 11 dried human mandibles was chosen and premolar and molar teeth were fixed in their sockets with wax. All teeth CEJs were completely identifiable, and 63 different proximal areas with different amount of crestal bone resorption were chosen. A place in lingual aspect of mandibles was made with wax for digital sensors. A trial exposure was done to make sure of accuracy of methods and procedures.

In the trial exposure, 25 charge coupled devices (Soredex/Progeny, USA) were used to take digital periapical radiographies. The voltage and amperage of the device was set as 60 kVp and 8 mA respectively. Parallel technique was used in this study to take accurate images.

In all radiographies, an X-ray tube was placed 3 cm away from digital films and a 4 mm metallic ball was placed adjacent to crestal bone to make sure of equivalency of magnification.

Based on trial exposure, the exposure time for DentalEye (s-17a58 Sundberg, Sweden) and Scanora (Soredex, Finland) software programs was processed to modify attenuation of X-ray beam. To do so, the crestal bone site was selected with mouth cursor and "modification of X-ray beam attenuation" was chosen.

Evaluation of Radiographies

Digital images were shown on a Sony (GN/B/S/PSR26) laptop. Brightness and contrast of the monitor was set in standard form before viewing images. Monitor's resolution and color quality was set as 1280 × 800 pixels and 32 bits respectively. Then digital images were coded with numbers and a radiologist was asked to measure the distance from CEJ to alveolar crest using DentalEye and Scanora software programs. Measuring of distances was done in a dark room.

Measurement on Dried Mandible

Vertical distance between CEJ and crestal bone was measured using Williams dental probe (Michigan, USA) on dried mandible. The collected data were used to compare the accuracy of digital software programs measurements. Finally, one-way analysis of variance (ANOVA) test and paired t-test was performed on data from digital and manual measurements using SPSS 23 (SPSS Inc., Chicago, USA) ($\alpha = 0.05$).

RESULTS

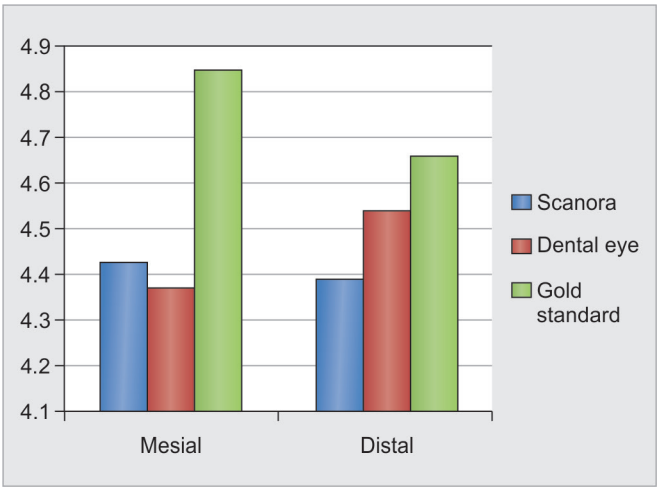
The current study was performed on 63 sites on 11 dried human mandibles with different crestal bone resorptions. Table 1 shows the average and standard deviation (SD)

Table 1: Average and SD of the distance between CEJ and crestal bone based on measuring technique (based on ANOVA test) (based on results from current study)

Proximal surface	*Method*	*Mean ± SD (mm)*	*p-value*
Mesial	Scanora	4.43 ± 2.16	
	DentalEye	4.37 ± 2.18	<0.001
	Standard	4.85 ± 2.39	
Distal	Scanora	4.39 ± 2.14	
	DentalEye	4.54 ± 2.23	0.248
	Standard	4.66 ± 2.37	

Table 2: Averages and SDs based on t-test (based on results from the current study)

Proximal surface	*Method*	*Mean (mm)*	*SD*	*p-value*
Mesial	Scanora/DentalEye	0.05	0.17	0.03
	Scanora/Standard	–0.42	0.87	0.002
	Standard/DentalEye	–0.48	0.87	0.000
Distal	Scanora/DentalEye	–0.15	1.21	0.06
	Scanora/Standard	–0.27	0.61	0.40
	Standard/DentalEye	–0.12	1.35	0.54



Graph 1: Distance between alveolar crest and the CEJ on mesial and distal surfaces

of the distance of CEJ and alveolar bone crest in proximal areas in all examinations.

Graph 1 shows the distance between alveolar crest and the CEJ on mesial and distal surfaces.

One-way ANOVA test showed a statistically significant difference between data of the mesial surface of teeth ($p<0.001$). Paired t-test was performed and it showed significant differences individually (Table 2).

But the results obtained from ANOVA test and t-test could not show any statistically significant difference on distal surface of teeth (p-value = 0.248).

DISCUSSION

Intraoral images are most common X-ray images which are used to evaluate the periodontal and bone-level status. Due to numerous benefits of digital radiography, specialists have tried to enhance image qualities with the aid of different software programs.[16]

Many authors believe that digital radiographies facilitate diagnosis of dental diseases.[12,13] Digital software programs allow dentist to enhance image quality, and many studies have shown that digital imaging is more useful than conventional imaging to determine the marginal bone level.[11]

Welande et al[9] declared that DentalEye software can improve the ability of diagnosis based on digital images.

The current study showed that measurements of distances on teeth surfaces were less than the standard amount, but the difference is only significant on mesial surfaces (p-value < 0.001). Welande et al's study showed same results as the current study on distal surfaces (p-value > 0.05) (Table 2).

Li et al[12] compared the digital images processed with dental software programs and F-speed conventional films for determining marginal bone level. The results showed that there were no significant differences between different software programs and the differences between digital and conventional images were not significant.

Grimard et al[17] compared the cone beam volumetric tomography (CBVT) images with digital periapical images on 35 sites before and after bone transplant. Results revealed that CBVT images are more accurate than digital periapical images but differences were not statistically significant.

Gundappa et al[18] compared the conventional and digital images with ultrasound images to diagnose periodontal disease. They suggested that conventional and digital images can equally diagnose periodontal lesions while ultrasound system underestimates the size of lesion.

Tsesis et al[19] compared the ability of conventional and digital radiography in diagnosing vertical root fracture which showed no significant difference.

Scaf et al[20] compared the amount of simulated periodontal bone loss between dedicated and nondedicated software programs. The declared that there were no significant differences between these software programs but underestimate the amount of bone loss.

The underestimation of bone loss is in harmony with results of current study, especially on mesial surface of tooth.

Vandenberghe et al[21] compared the accuracy of cone beam computed tomography (CBCT) and digital intraoral images in determining the bone level in periodontal disease. They declared that CBCT is more accurate that intraoral images. Over- and underestimations were 50% each in digital intraoral images.

The difference between current study and previous studies could be as a result of anatomical and racial differences of mandibles in this study.

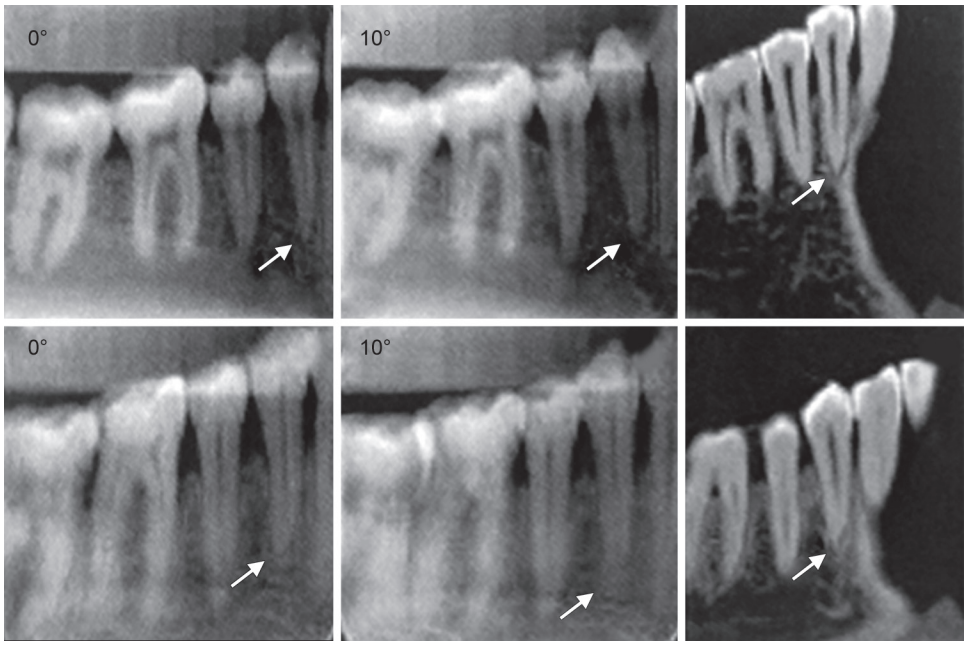


Fig. 1: Radiographs evaluated with Scanora software program and its filters

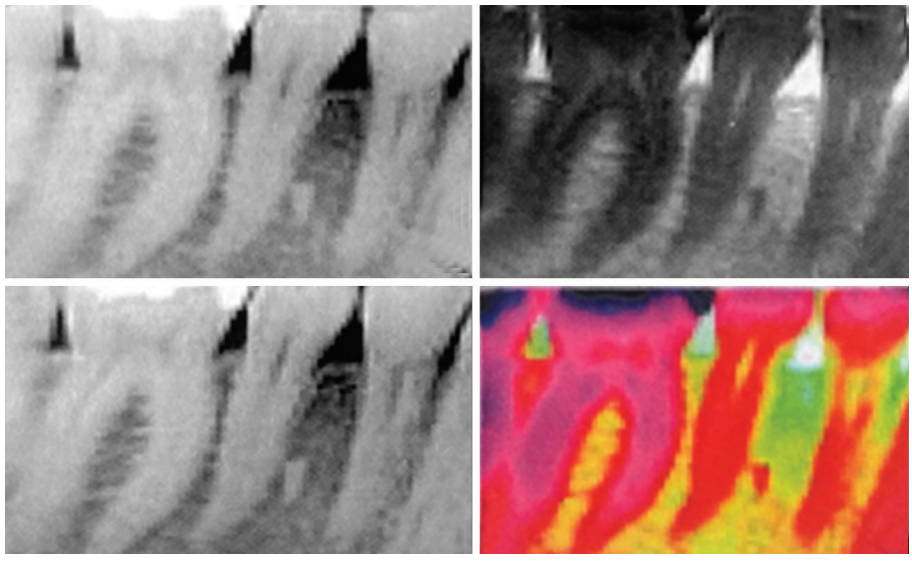


Fig. 2: Radiographs evaluated with DentalEye software program and its filters

We suggest that another study comparing conventional radiography, digital radiography, CBCT, and standard measurement with more samples is better to be performed.

CONCLUSION

Based on the current study, measurement of the distance from CEJ to the height of the crestal bone using Scanora and DentalEye software programs is only accurate on distal surface of teeth.

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