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A Comparison Between Two Types of Radiographic Film for Accuracy of Measurements of Approximal Osseous Defects

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Abstract

Aim: The purpose of this study was to compare two types of conventional radiographic film: Ekta-speed plus and Insight (Eastman Kodak Co, Rochester NY, USA) for accuracy of measurements of approximal bone loss.

Methods and Materials: Four dried human mandibles with complete dentition were selected. Radiographic images were made with a standardized technique. Mesial and distal bone levels on the mandibular premolar and molar teeth were measured on the two types of radiographs (Ekta-speed plus and Insight) by nine observers. The data obtained by the observers were compared with the primary investigators' corresponding measurements, which served as "the ground truth" for this study.

Results: The results of the analysis of variance (ANOVA) demonstrated a significant difference for the Ekta-speed plus film ($p = .001$), but the difference was not clinically significant. The level of intra-rater reliability was high for the observers (0.969 to 0.990).

Conclusion: Performance of Ekta-speed plus and Insight films was found to be similar.

Keywords: Ekta-speed plus film, Insight film, approximal bone loss, measurements, periodontal

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Introduction

Radiographic diagnostic procedures are designed to provide information about the type, severity, location, and progression of periodontal diseases. The information obtained guides the clinician in treatment planning and follow-up assessment. Periodontal probing and introral radiography are widely used as diagnostic aids. Periodontal probing can be used to assess the presence of plaque and calculus, pocket depths, severity, and progress of the disease. Intraoral radiography provides information about hard tissue changes including interproximal bone loss, periodontal ligament space, widening, etc. Changes can be assessed by comparing radiographs taken over time.

Radiographic measurements are widely utilized as a substitute for direct clinical measurements requiring re-entry surgical procedures for follow-up outcome procedures.[1] Assessment of the approximal bone level from the radiographs provides important information to aid the clinician in making treatment decisions. Some factors affecting these decisions include radiographic technique, choice of the image receptor (type of film or digital sensor), and observer experience.

Currently, a variety of image receptors are available in the market; each are associated with certain advantages and disadvantages. In all cases it is important to obtain an image of diagnostic quality, while keeping the dose of ionizing radiation as low as possible.

Various intraoral dental films (Ultraspeed, Ektaspeed plus, and Insight film) have been tested in a number of studies, which have reported comparable diagnostic accuracy. Ultraspeed and Ektaspeed plus film types appear to be diagnostically acceptable[2,3,4] for the assessment of caries, periapical, and periodontal pathology. Moreover, Ektaspeed plus has the advantage of 50% reduction in patient radiation exposure compared with Ultraspeed film. The more recently (April 2000) introduced Insight film, provides the same diagnostic accuracy as Ektaspeed plus with approximately 20% further reduction in patient radiation dose in comparison to Ektaspeed plus film.[5,6] When compared to Ultraspeed, a very popular type of film in the US, Insight allows a reduction in patient exposure up to 60%. This film also accommodates a wider range of processing conditions.[7] Research in regard to Insight is limited due to the newness of this film type; in fact, no study was found in our literature search comparing Ektaspeed plus and Insight films for accuracy of approximal bone level measurements. Therefore, the goal of this in vitro investigation was to compare the two types of the above mentioned radiographic film when used for approximal bone loss evaluation.

Methods and Materials

Four dried human mandibles with complete dentition were selected for the study. The specimens had periodontal bone loss ranging from 2 mm to 8 mm with no damaged marginal alveolar bone or missing teeth. An orthodontic

wire was attached on the facial surface of the posterior teeth to create a reference point for future measurements. A plexiglass optical bench was used to fix the x-ray tube head, the soft tissue equivalent, the mandibles, and the x-ray film. A 40 cm source-to-object distance, 1 cm object-to-film distance, and a zero degree vertical and horizontal beam angulation were used.

In a pilot study a consensus panel, consisting of two experienced full-time faculty members from the Department of Oral Diagnosis and Radiology (an oral radiologist and a general dentist), decided upon image quality and selection of the exposure parameters (kVp, mA, and exposure time). The consensus panel reviewed a number of radiographic images made with different exposure settings and selected the most diagnostic ones. Based on these results, the exposure settings of the intraoral x-ray unit used (a Planmeca Proline, Helsinki, Finland) were set at 63kVp and 8mA. The exposure time selected was 40 impulses for the Ektaspeed plus film and 32 impulses for the Insight film.

Size #2 intraoral dental film was used to make the radiographs. A total of sixteen images were made on the four mandibles. Both right and left sides of each mandible were imaged. Eight radiographs were obtained with Ektaspeed plus film and eight using Insight film (two radiographic images per mandible with each type of film). All films were processed on the day of exposure using an automatic AT 2000 processor for 4.5 minutes and 82°F. Kodak Readymatic processing solutions were used. Darkroom quality control standards were followed throughout the radiographic procedures to ensure optimal processing conditions.

Radiographic Image Evaluation

The sixteen radiographs were initially assessed by the investigators who identified a total of 104 approximal sites of mandibular molars and premolars (right and left); 52 sites on radiographs made with Ektaspeed plus and 52 on Insight. Next, nine observers (four general dentists from the Department of Oral Diagnosis and Radiology and five periodontic residents were asked to evaluate the radiographs and measure alveolar bone loss on the selected mesial and distal sites. Verbal and written instructions were provided to the observers prior to each measurement session. Approximal bone loss was measured using an electronic digital caliper (Digimatic Caliper, Mitutoyo Corporation, Japan) from the orthodontic reference line to the most superior bone level visible on the radiograph. Use of digital calipers and measurement technique were demonstrated.

The observers viewed and measured only one type of radiograph in each session. Images were randomized for each observer. Observers were blind to film type evaluated in each session. Measurements were obtained over three sessions, with at least one week between each session to minimize the chance of recalling previous values and to reduce observer fatigue. A third session was held to assess the intra-rater reliability, during which observers re-read one randomly selected group of radiographs. All rating sessions took place in a quiet room with optimal viewing conditions. Lastly, approximal bone loss was measured in all sites by three calibrated investigators independently, and their readings were pooled in order to establish the investigators' mean for each site. This served as the "ground truth" or "the silver standard" measurement to which the observers' readings were compared.

Data Analysis

Approximal bone loss was measured on a total of 104 sites, 52 on radiographs made with Ektaspeed plus and 52 on Insight. For each site, the mean of the three investigator measurements (ground truth) and the mean of the nine observers were computed. Analysis of variance (ANOVA) with repeated measures was used to analyze the data; the within factors were film speed (Ektaspeed plus vs. Insight) and raters (investigators v. observers).

To assess intra-rater reliability, each of the observers repeated the bone loss estimation measurements on a randomly selected set of radiographs; four of the observers on Ektaspeed plus radiographs and five on Insight. Pearson's correlation co-efficient was used for intra-rater reliability assessment. The software program SPSS (version 11.5) (SPSS, Inc., Chicago, IL, USA) was used to analyze the data.

Results

Table 1 presents the means and standard deviations for measurements (in millimeters) from Ektaspeed plus and Insight films. ANOVA showed significant effects for film speed, $F(1,51) = 12.095$, $p < .001$, partial eta-squared = 0.192. In other words the observers' bone loss measurements on the Ektaspeed plus were significantly closer to those of the investigators than measurements on the Insight. Also, there were no significant effects for observers ($p=0.41$) or for the interaction of film speed with observers ($p=0.64$). An examination of the data in Table 1 shows values obtained for Ektaspeed plus film were consistently lower than for Insight film.

Film speed accounted for over 19% of the variance in the data. Measurements provided by observers did not differ significantly from those provided by investigators, suggesting training level did not have an impact on measurements. Neither investigators nor observers differed from one another as a function of film type. Intra-rater reliabilities for the observers ranged from 0.969 to 0.990, indicating a very high level of intra-rater reliability.

Discussion

The contribution of intraoral radiographs in the diagnosis of alveolar bone changes and especially detection of bone loss is, with out a doubt, important. Various techniques and radiographic image receptors (films or digital sensors) are used for this purpose; among them are the two films tested in this study, Ektaspeed plus and Insight, both manufactured by Kodak. Insight is the newest product, introduced only five years ago. Its advantage over Ektaspeed plus is a 20% reduction in the radiation dose to the patient. In addition Insight film holds speed and contrast in variable processing conditions.

This study compared the above films for accuracy of measurements in bone loss assessment and found Ektaspeed plus to be significantly better than Insight; the measurements provided by the observers on Ektaspeed plus were closer to

Table 1. Descriptive statistics

	Mean	Std. Deviation	N
Investigator mean, Ektaspeed plus	4.49	1.51	52
Observer mean, Ektaspeed plus	4.48	1.49	52
Investigator mean, Insight	4.58	1.52	52
Observer mean, Insight	4.56	1.48	52

*Measurements are in millimeters

the "ground truth" measurements than those the same observers provided on Insight. Despite this statistical significance, our data do not support the existence of a clinically significant difference between these films. In fact Table 1 shows the observers' error with Insight was on average 0.2 mm (4.58 mm-4.56 mm) when compared with the investigators' mean (ground truth), whereas the error with Ektaspeed was 0.1 mm (4.49 mm-4.48 mm). In other words the use of Insight radiographic film for bone loss measurements was less accurate by 0.1 mm on average in comparison to Ektaspeed, which seems to be negligible to us.

A number of workers compared Ektaspeed plus and Insight among other image receptors for radiographic image quality and diagnostic efficacy. Sheaffer et al.[8] (2002) compared observer measurement error and subjective ratings to the International Standards Organization. D-speed (Ultraspeed), E-speed (Ektaspeed plus), and F-speed (Insight) direct exposure dental x-ray films were used to determine endodontic working lengths. No significant differences were reported between the film types or observers. All three films were similar in objective and subjective ratings. Although we found statistically significant differences, it is unlikely that 0.1 mm is clinically significant.

In another study Nair and Nair[6] (2001) evaluated Kodak Insight film, Ektaspeed plus film, and Schick CMOS-APS detector for natural proximal caries detection. Ninety-two proximal surfaces of extracted unrestored teeth, 51 of which were carious, were evaluated. Ground truth was evaluated histologically, and the lesions classified as either enamel or dentinal. Eight observers read the radiographs using a five-point confidence rating scale to record their diagnoses. Results suggested none of the imaging modalities evaluated in this study differed in their diagnostic capabilities with respect to proximal decay detection, and the Insight film was as good as the other two sensors for this purpose.

The results of the above studies are more or less in agreement with ours indicating the overall diagnostic efficacy and accuracy of the two film types is comparable.

The results of this study may be an endorsement for Insight intraoral radiographic film due to the considerable reduction in radiation exposure in comparison to the other two types of film. Insight provides a 60% dose reduction when compared to the very popular Ultraspeed and 20% dose reduction compared with the Ektaspeed plus films. Ektaspeed plus film is no longer available from the manufacturer. For conventional intraoral radiography, both Ultraspeed and Insight films are available. For detecting alveolar bone loss, Insight film is recommended due to the advantages mentioned earlier.

Conclusions

Measurements of alveolar bone loss differed significantly between Ektaspeed plus and Insight films, although the difference was approximately 0.1 mm. Since the differences do not appear to be clinically significant, Insight film is recommended because of the reduced exposure. However, additional studies are warranted to further evaluate the diagnostic accuracy of Insight film.

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