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Comparative Study of Accuracy of Digital Radiography and Digital Subtraction Radiography in Detection of Simulated Lesions on Alveolar Crest of Dried Human Mandible

Zamani Naser Asieh, Hekmatian Ehsan and Sadraie Vahid Dentist
Department of Dental Radiology, School of Dentistry,
Isfahan University of Medical Sciences, Iran

Abstract: Several studies have shown that, there are some advantages of Digital Radiography compared with conventional radiography. Many studies have been performed with the aim of improving radiographic interpretation through modern computerized technology. It has been shown that diagnostic accuracy improved when overlaying structure can be removed by subtraction technique and then this technology evaluate ability to detect periodontal lesion. In this experimental study that was done in radiology department of Isfahan, dental school, 5 block of dried mandible established in abutments. A digital sensor and X-ray tube were established on the another abutment too. Radiographs were made from 26 alveolar crestal regions as primary Radiographs using Kvp = 70 and t = 0.01s. With a round bur artificial periodontal lesions, were simulated on 16 crestal regions out of 26, then second radiagraphs were made from all 26 crestal regions, whitout any changes in position of X-ray and tube. Two radiographs were subtracted by a soft ware. Radiography and subtraction radiography were compared by 2 post graduate students of periodontic. Results analyzed with statistical methods and SPSS soft ware. The willcoxon test was applied for assessment of statistically significant differences with respect of sensitivity, specificity and positive diagnostic value in diagnosis of crestal changes in digital image and subtracted digital images. Accuracy of digital subtraction radiography (DSR): sensitivity and specificity was better than conventional digital radiography. The digital subtraction method may be useful in the quantification of Alveolar bone loss in clinic, more studies about advantages and disadvantages of DSR is recommended.

Key words: Alveolar bone loss, digital subtraction radiography, digital radiography, dried human mandible

INTRODUCTION

Periodontal lesions often progress slowly, so they can not be easily evaluated with sequentially obtained radiographs (Heo and Lee, 2001).

Digital Subtraction Radiography (DSR) is a method that can increase the diagnostic accuracy (Reddy and Jeffcoat, 1995).

Subtraction image is performed to suppress background features and to reduce the background complexity, compress the dynamic range and amplify small differences by superimposing the seconed image obtained at different times (Vandre and Webber, 1995; Woo and Zee, 2003).

Subtraction radiography was introduced to dentistry in 1980s (Grondahl *et al*., 1983). It was used to compare standardized radiographs taken at sequential examination Visits. All unchanged structures were subtracted and these areas were displayed in neutral gray shade in the subtraction image; while regions that had changed, were displayed in darker or lighter shade of gray (Wenzel *et al*., 2000).

DSR has made a significant improvement in detection of early periodontal lesions. It increases the detection of density changes in bony structures and significantly improves the sensitivity and accuracy of the evaluations. With conventional radiography or conventional digital radiography a change in mineralization of 30-60% is necessary to be detected by an experimented radiologist (Southard and Southard, 1994) also lesions restricted to cancellous bone could not be detected because of it's less mineral contents than the cortical bone. But with DSR the alveolar bone changes of 1-5% per unit volume can be detected (Wengraf, 1964; Ortman and Dunford, 1985).

This technique is used in periodontal diagnosis because of it's potentially high sensitivity to detect at least 0.49 mm in depth of cortical bone (Ortman and Dunford, 1985; Lang and Hill, 1977).

Corresponding Author: Zamani Naser Asieh, Department of Radiology, School of Dentistry,
Isfahan University of Medical Sciences, Iran

For a successful DSR reproducible exposure geometry and also identical contrast and density of the serial radiographs are essential.

By using a aming device we can keep the position of film and tube constant.

The aim of this study was to determine and compare the sensitivity and specificity of seqential Periapical digital radiography and digital subtraction radiography in detection of simulated alveolar crestal lesion in dried human mandibules.

MATERIALS AND METHODS

In this experimental study that was done in radiology department of Isfahan Dental school, 5 dried human mandibles were prepared. These mandibles were used as objects to be imaged. Soft tissue was simulated by dental wax in one rope layer thickness.

Twenty six crestal regions were chosen on these 5 mandibles. Artificial periodontal lesions up to 0.5 mm depth were simulated by # 2, # 4 round dental burs on 16 crestal regions out of 26.

Standardized preapical Digital images were obtained before lesions were created (as primary or unaltered images) and after each lesion was created (as secondary or altered images).

A dental x-ray machine was used for preparation of digital images (plan meca co. Finland) using CCD Sensor. (Sorodex co. Finland).

The exposure parameters were as follow:

70 kvp at 8 mA with 0.01 S

The primary images were prepared while the mandible was fixed on a flat place and the x-ray tube was placed on a stable stem made of plastic: a modification of XCP film holder, central ray was perpendicular to the film and crestal regions to be examined so that the procedure was reproducible.

The images were stored in the computer's memory and displayed on the monitor.

The second (altered) image was made after simulation of lesions at the same position as primary images were done. The exposure parameters were same as for primary Images.

The second images were also saved in computer's memory.

Two images were prepared from each unaltered crestal region, for preparation of unchanged subtraction images and for the overall research blindness.

The digital subtraction images were generated in the following manner.

The primary unaltered images from each crestal region was displayed on the monitor. Then the secondary altered image that was made after simulation of lesion (in each crestal region) was also displayed on monitor and was superimposed on the primary image to be subtracted from primary image.

The Signus software subtraction program was used so that when the 2 images were superimposed the unchanged anatomic areas were obscured leaving the altered crestal region on image (subtracted image).

All subtracted images were saved in computer's memory.

After preparation of all primary and secondary images and all subtracted images of each crestal region, pairs of primary and secondary images were arranged in 2 rows. Pairs of images representing no periodontal changes (from ten unaltereal crestal regions) were then included in the evaluation.

The subtracted images were also arranged randomly (Subtracted images of altered and unaltered images) and were stored on hard disc.

Two observers (Two post graduate students of periodontic) independently evaluated each paired image of primary and secondary image of each crestal region. After one week the subtracted images were evaluated for any change on crestal region.

The observers were given a brief orientation session to become accustomed to read image of both digital and subtracted digital images. At first the primary and secondary digital images were randomly displayed on monitor while the obsorvors answered a questionair, reading the presence or absence of each simulated lesion.

A confidence scale of 1-3 (1 = lesion definitely not present 2 = uncertian 3 = lesion definitely present) was used for purpose of esthatistical analysis for each paired of digital images.

For control of intra observers reliability after one week the digital subtracted images were evaluated at the same manner as digital image for presence or absence of lesions.

The willcoxon test was applied for assessment of statistically significant differences with respect of sensitivity, specificity and positive diagnostic value in diagnosis of crestal changes in digital image and subtracted digital images.

RESULTS

Twenty six primary digital radiographs were used only for subtraction techniques. In secondary Digital Radiographs 10 out of 26 were not changed (Unaltered)

Table 1: Scores of secondary altered digital radiographs

Observer	No lesion seen	Not certain lesion	Lesion seen	Total
First	5	2	9	16
Second	8	2	6	16
Total	13	4	15	32

Table 2: Scores of altered subtraction radiographs

Observer	No lesion seen	Not certain lesion	Lesion seen	Total
First	3	0	13	16
Second	3	0	13	16
Total	6	0	26	32

Table 3: Scores of secondary unaltered digital radiographs

Observer	No lesion seen	Not certain lesion	Lesion seen	Total
First	4	5	1	10
Second	3	4	3	10
Total	7	9	4	20

Table 4: Scores of unaltered subtraction radiographs

Observer	No lesion seen	Not certain lesion	Lesion seen	Total
First	10	0	0	10
Second	10	0	0	10
Total	20	0	0	20

and 16 out of 26 were made after creating a periodontal lesion (Altered). Subtraction Digital Radiographs also were divided to 10 unaltered and 16 altered groups.

Two observers scored both secondary digital radiographs and subtraction radiographs while blindness of altered and unaltered radiographs was considered. Willcoxon statistic test for paired data showed no significant difference between 2 observers ($p = 0.682$).

In 16 digital radiographs with periodontal lesions (Secondary Altered Digital Radiographs) 32 scores were made by 2 observers (Table 1).

In 16 subtraction radiographs with periodontal lesion (Altered subtraction radiographs) 32 scores were made by 2 observes (Table 2).

In 10 secondary unaltered digital radiographs 20 scores were made by 2 observers (Table 3).

In 10 unaltered subtraction radiographs 20 scores were made by 2 observers (Table 4).

Subtraction radiography had 81.25% sensitivity and 100% specificity in diagnosing periodontal lesions, with 0% false positive and 18.75% false negative answers; Where as digital radiography had 64.7% sensitivity and 63.6% specificity with 36.4% false positive and 35.3% false negative answers.

Due to K2 test there was a significant difference between two techniques as a point of view of both observers. (observer 1: $K2 = 16.283$, $df = 2$, $p<0.001$, observer 2: $K2 = 15.769$, $df = 2$, $p<0.001$).

DISCUSSION

Although, in previous studies subtraction radiography has been introduced as a powerful technique for diagnostic tasks, all of them has mentioned the problems of reproducing radiographs which is necessary in performing the subtraction techniques (Hekmatian *et al*., 2005). In our study we have no problem with reproduction of secondary radiographs because we had fixed the Tube on a stem and the position of film was also constant, our study was done *in vitro*. Reproducing radiographs in vivo may be difficult.

Prikka *et al*. (2000) found a significant difference between digital subtraction technique and radiography but he also has demonstrated that the technique is more time consuming and has difficulties. In our study we found that DSR is more time consuming than digital radiography but the information obtained from DSR was also more than digital radiography. Kinsey has established that patient position is too critical in subtraction radiography and may inhibit practical use (Hekmatian *et al*., 2005). It's obvious that subtraction radiography has advantages of digital imaging. Paurazas has published advantages and disadvantages of digital radiography. Subtraction radiography can detect subtle changes as low as 0.12 mm in cortical bone (White and Pharaoh, 2004). Our study showed that DSR was a good Tecniquce for detection of small bony lesion on crestal regions. Sensitivity and specificity were more in subtraction radiography comparing conventional digital radiography. K2 test showed significant difference between 2 techniques in this study.

But more researches and studies must provide clinical preference of the technique to other techniques, Because this Technique needs reproducible positioning of patient and sensor in the mouth. It is time consuming and difficult and this can make the results of studies to be different. Therefore, the use of this technique in clinic need more study. This study also presents new schemes for future studies.

REFERENCES

Grondahl, H.G., K. Grondahl and R.L. Webber, 1983. A digital subtraction technique for dental radiography. Oral. Surg. Oral. Med. Oral. Pathol., 5: 6-102.

Hekmatian, E., S. Sharif and N. Khodaian, 2005. Digital subtraction Radiography in Dentistry. Dental Res. J., 2 (2): 106-111.

Heo, M.S. and S.S. Lee, 2001. Quantitative analysis of apical root resorption by means of digital subtraction radiography. Oral. Surg. Oral. Med. Oral. Pathol. Oral. Radiol. Endod., 91: 369-373.

Lang, N.P. and R.W. Hill, 1977. Radiographs in periodontics. J. Clin. Periodontol., 4: 16-28.

Ortman, M.F. and R. Dunford, 1985. Subtraction radiography and computer assisted densitometric analyses of standardized radiographs: A comparison study with absorptiometry. J. Periodontal. Res., 20: 644-651.

Prikka, V.N. and B. Steffensen, 2000. Clinical validation of a new subtraction radiography technique for periodontal bone loss detection. J. Periodontol., 71: 598-605.

Reddy, M.S. and M.K. Jeffcoat, 1993. Digital subtraction radiography. Dent. Clin. North Am., 37: 553-565.

Southard, K.A. and T.E. Southard, 1994. Detection of simulated osteoporosis in dog alveolar bone with the use of digital subtraction. Oral. Surg. Oral. Med. Oral. Pathol., 77: 412.

Vandre, R.H. and R.L. Webber, 1995. Future trends in dental radiology. Oral. Surg. Oral. Med. Oral. Pathol. Oral. Radiol. Endod., 80: 471-478.

Wengraf, A., 1964. Radiologically occult bone cavities: An experimental study and review. Br. Dent. J., 117: 532-536.

Wenzel, A., P.N. Anthonisen and M.B. Juul, 2000. Reproducibility in the assessment of caries lesion behaviour: A comparison between conventional film and subtraction radiography. Caries Res., 34: 214-218.

White, S.C. and M.J. Pharaoh, 2004. Oral Radiology and interpretation. 5th Edn. St louis: Mosby, pp: 225-245, 314-325.

Woo, B.M.S. and K.Y. Zee, 2003. *In vitro* calibration and validation of a digital subtraction radiography system using scanned images. J. Clin. Periodontol., 30: 114-118.