A comparison of conventional intraoral radiography and computer imaging techniques for the detection of proximal surface calculus

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Ⅰ. INTRODUCTION

Intraoral radiographs are valuable in identifying calculus that intensify periodontal disease especially for the proximal calculus.

With the advent of low cost, high performance computer, it became possible to explore the use of digital image processing techniques on routine dental X-ray images.[10,11]

There are already several digital radiographic systems, RVG(RadioVisioGraphy) by Trophy Radiology (Atlanta, GA, USA), Sens-A-Ray by Regam Medical Systems(AB, Sundsvall, Sweden), Vixa(Visualix) by the Gendex Corporation(Milwakee, WI, USA),and Flash Dent by Villa Sistemi Medicali(Bucciasco, Italy).[16,21,22]

Hidebot et al introduced four general-purpose image processing programs for the Apple Macintosh II computer.[14]

Ann Wenzel and his coworker in paris reported that in detecting the occlusal caries, digital images from RVG is somewhat superior to the conventional radiographs.[21]

Most oral radiologist employ film images that are interpreted on a lightbox or view box. We dentist are accustomed to the conventional film radiographs. But I think we must use the digital images for diagnosis of oral and maxillofacial diseases in near future. Now we have to adjust ourselves to the digital imaging on the monitor.[5] And we are needed the ability to transfer film based reading skills to a digitally based presentation.[5] And we also needed to building confidence in digital images and to familiar with the digital images.[5,13]

The aim of present investigation is to suggest economical hybrid system using personal computer and to compare the periapical radiographs and their displayed digital images for proximal calculus detection.

II. MATERIAL AND METHODS

168 intraoral radiographs which have proximal calculus were selected from the 210 set of a full mouth radigraphs of the dental college students. They were aged from 22 to 24.

The three observers were oral radiologists. They had experience in working with the system for digitization of conventional radiographs and in reading digitized radiographs on the monitor.

The radiographs were taken by GX-770(Gendex Corp. Illinois, USA) using the paralleling technique and the focus-film distance was 16 inches. The unit was set at 7- kVp and 7 mA. And the used films were Kodak Ektaspeed(E group).

Digitized images of periapical radiographs were obtained using a commercial film video processor FOTOVIX II-S(TAMRON, Japan)(Fig. 1). The optimal setting for brightness was controlled by the principal investigator.

The computer system was an IBM compatible PC(Intel 80486 30 MHz,8 M RAM SAMSUNG computer, Korea) with PCVision and frame grabber(Dooin, Korea)(Fig. 2). The 17" display CRT(SyncMaster 5G : Samsung) had a resolution of 1280 x 1024 pixels(0.26 mm dotpitch). The frame grabber provides for a 700 x 480 pixel image with 256 grey levels(8bits).

The digitized images were processed into grey by the soft ware PHOTOSTYLERS 1.1(Aldus, USA). The individual frame size was 25.04 cm x 17.17 cm(700 x 480 pixels) in the monitor and the file size was 329 Kb. The CRT(monitor) displayed the individual intraoral radiograph one frame by one(Fig. 3).

All radiographs were judged by three oral radiologists to determine the true radiographic status of proximal calculus. All viewing of the radiographs was done under uniform subdued lighting in a quiet, secluded room(reading room). The scoring criteria for the conventional radiographs and the digitized images were dichonomous, calculus present and not present.

If three observers agreed on the diagnosis of a particular calculus on the radiographic(film) images, then the diagnosis was considered true. If, however, only two, or less agreed then a consensus was reached in a plenary session.[15] The findings of the intraoral radiographs served as the validation criteria.

The digital images were viewed on a monitor in the same reading room under the same condition. The monitor was adjusted to optimal setting for brightness and contrast subjectively by the principal investigator. Three observers assessed independently the presence of proximal calculus in each tooth surface on the monitor.

True positive and false positive detection rate were calculated for each observer's scoring. Two-way analysis of variance was used to evaluate differences in likelihood rations between the observers.[9,12,17]

Ⅲ. RESULTS

Observers viewed 582 tooth surfaces from the 168 radiographs and recorded the proximal calculus findings of the film images and digitized images.

The calculus existing surfaces were 194 and the calculus free surfaces were 388. True positive and false positive detection rates for the each observer assessing calculus can be seen in Table I and Table II.

Table I. The outcomes for the three observers assessing proximal calculus.

	TP	FP	TN	FN
Observer 1	175	20	368	19
Observer 2	175	168	220	19
Observer 3	153	12	376	41

Table II. True-positive and false positive ratio for each observer assessing proximal calculus.

	TP	FP	TN	FN
Observer 1	0.90	0.05	0.95	0.05
Observer 2	0.90	0.43	0.57	0.05
Observer 3	0.79	0.03	0.97	0.11
Average	0.86	0.17	0.83	0.07

The sensitivity (true-positive ratio) ranged from 0.79 to 0.90(mean 0.86), and the specificity (false-positive ratio) ranged from 0.03 to 0.43(mean 0.17)

Ⅳ. DISCUSSION

The present investigation suggested economical hybrid system using personal computer and compared the periapical radiographs and their displayed digital images for proximal calculus detection.

The radiographs were collected from the dental students, but sex of the students was not considered, which may cause a bias in the present study.

The sharp explorer can be used for detecting calculus deposits. But radiographs are often valuable in identifying calculus especially for the proximal calculus.[11]

Generally speaking, the image processing can enhance the brigtness, contrast, and detail of image.[5] These facts can be merits of digital images over film images. But in this study we didn't apply any special image processing.

True positive ratio and false positive ratio are usually used for the evaluation of accuracy of diagnosis. Obviously, a good diagnostic examination has a high TP ratio and a low FP ratio. The ratio of the TP ratio to the FP ratio is known as the likelihood. In this study the 2nd observer has a low likelihood ratio.

The perception of the image is influenced by several factors. Some are integral part of the image itself, others depend on the image observer.[13] The 2nd observer was not a good discriminators of the proximal calculus on the monitor.

The rapid development of hardware facilitates many new imaging modalities. Not only can film be replaced by digital receptors, but completely new applications are possible now. Digital images can be achieved and retrieved immediately, they can be sent to places far away in seconds without loss of quality, and to some extent, automated procedures can provide decision support during the diagnostic process.[1,2,3,7,11,13-15,18-20]

Radiologists need a high bringhtness and high resolution display system that is comparable to the conventional film. It seems appropriate to mention the constraints imposed by the relatively narrow video dynamic range and the available 256 grey levels which had to be spread across the wide range of optical densities encountered in dental radiographs.

Since the information relevant to calculus & caries diagnosis is restricted to the relatively radiopaque portion of dental radiographs, it is logical that a conventional video image capture with 8 bit digitizer board is far from optimal for the task of calculus detection even when enhanced by common image processing operation.[6] It has been demonsrated by this study that the detection of proximal surface calculus on the digital images is somewhat inferior to the film-based images.

Dubrez et al[7] studied with high resolution digital analysis for the measurement of bone density. He utilized CCD scanner camera which provides up to 4096 grey levels(12 bit acquisition) and a spatial resolution of 4096 x 4096 pixels (kodak Eikonix Corp, Bedford, Mass, USA),Sun workstation, Laboimage software (each image requiring 4MBytes of storage space) the resolution of camera was 7μm. But the individual grain size in a Kodak ultraspeed film is 1μm (spatial resolution od conconventional video camera : 70μm, 256 grey level(8 bit acquisition)). But there is still lack of economical displays with both high brightness and high resolution.[4-6]

Various aspects of human visual system that affect the way in which gray levels are perceived are often taken advantage of in performing these enhancements. By subtracting a fixed amount from each gray scale level, an image is darkened. This improves image contrast. People can more readily detect intensity changes in darker images than in lighter images.[14] Edge enhancement improves visual detection.[14] Wenzel and his coworker(in Paris)[21] reported that in detecting the occlusal caries, contrast enhancement tended to perform more accuately. But in this study, author did not apply any contrast enhancement and filtering.

V. CONCLUSION

The present results indicates that the sensitivity for the proximal calculus was high, but there are different sensitivities among the observer.

More study should be done to determine that digitized image can be clinically applicable to detecting the proximal calculus.

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-국문초록-

구내방사선사진과 컴퓨터영상의 치아 인접면 치석 진단능의 비교

전남대학교 구강악안면방사선학 교실

강 병 철

전남대학교 치과대학 학생을 대상으로 평행촬영법으로 촬영한 168 장의 구내방사선사진을 디지탈 영상으로 변환하여, 필름상의 치석 유무 판독 결과와 모니터상의 판독 결과를 비교하였다. 3명의 구강악안면방사선학 전공 치과의사가 판독을 하되 필름상의 판독 결과를 판정의 기준으로 하였다. 디지탈 영상은 상업용 필름-비디오 변환장치, 486DX PC, 그리고 PcVision 과 frame grabber을 이용하여 얻었다. 모니터상의 개개 구내방사선사진상은 700×480 pixel로 나타내었다. 디지탈 영상의 치석진단의 sensitivity는 0.79 -0.90(평균 0.86) 이었고, specificity는 0.03-0.43(평균 0.17) 이었다.

LEGEND FOR FIGURES

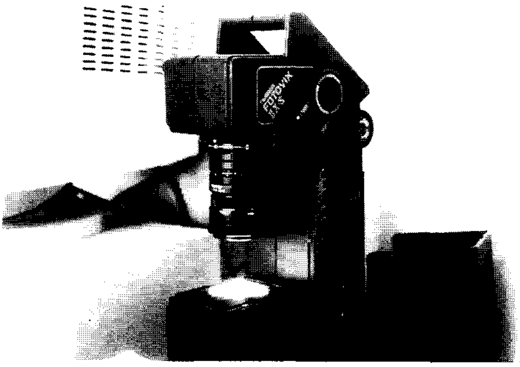

Fig. 1. Film-video processor (FOTOVIX- IIX - S).

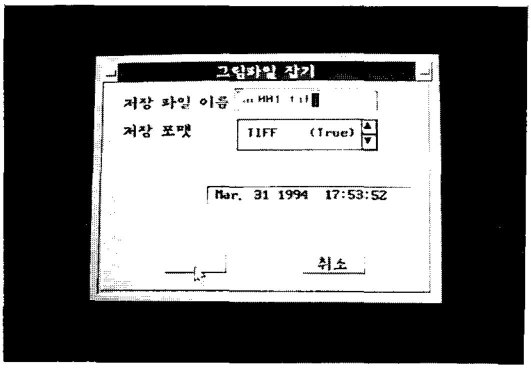

Fig. 2. Film image being captured and stored.

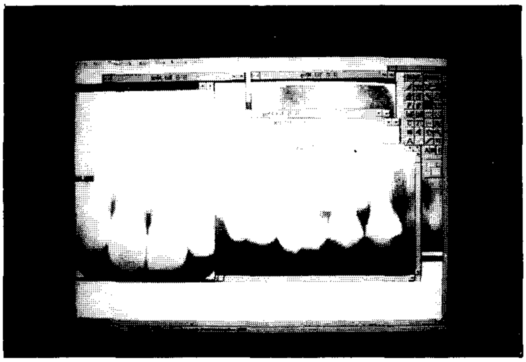

Fig. 3. Displaced digital images on Moni tor. You can notice calculus on proximal tooth surfaces.