

A comparison of periapical radiographs and their digital images for the detection of dental caries

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I. INTRODUCTION

The conventional intraoral radiographic examination has its greatest value in the detection of proximal carious lesions that are not easily detectable by careful and thorough clinical examination.^{9,10}

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.¹⁷ Digital imaging technique can be applied to automatic analysis of radiographic images^{1,2,16} and image processing for the evaluation of dental implants,^{3,4} computer aided image interpretation to the diagnosis of periapical bone lesions, caries, and alveolar bone changes.^{1,2,7,13,14,15}

Dove and McDavid had already studied whether computer image processing could improve the diagnostic accuracy for the proximal caries.⁵ Wenzel, et al¹⁸ also reported that the RVG performed more accurate caries diagnosis.

Generally speaking, the image processing can enhance the brightness, contrast, and detail of image.⁵ These facts can be merits of digital images over film images. 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 dental caries detection.

II. MATERIAL AND METHOD

168 intraoral periapical radiographs of which have C1(first stage) and C2(second stage) caries in their proximal surface were chosen from radiographs of the dental patients of the Chonnam National University (kwangJu, korea).

The X-ray unit was GX-770(GENDEX Corp, Illinois, USA). The unit was set 70 kVp and 7 mA. And the used films were Kodak Ektaspeed (E group).

All Radiographs were judged by four oral radiologist to determine the radiographic status of dental caries. They were asked to score the caries on the crown for the first and second stage. Two criteria were applied to C1 and C2 caries : present or not present.

If three or four observers agreed on the diagnosis of a particular caries on the radiographic(film) images, then diagnosis was considered true. If, however, only two, or less agreed then a consensus was reached in a plenary session(13). The total caries lesions were 243(on the radiograph). Among them second stage caries was 213 and first stage caries was 30. The findings of the radiographs served as the validation criteria.

Digitized images of periapical radiographs were obtained using a commercial film video processor FOTOVIX II-S(TAMRON, Japan)(Fig. 1). And the computer system was 486 DX PC(SAMSUNG, korea) with Dooin PCVision and frame grabber(Fig.2). The 17" display CRT(SyncMaster 5G : Samsung) had a resolution of 1280×1024 pixels.

The digitized images were processed into grey scale by the soft ware PHOTOSYLTTERS 1.1(Aldus, USA). The CRT displayed the individual intraoral radiograph on one frame(Fig.3,4,5).

Diagnosis on the CRT was performed according to the same procedures as on the radiographic images.

The digitized iamges were compared with conventional intraoral radiographs for the detection of proximal surface caries. The diagnostic accuracy of the digitized image was expressed by sensitivity.⁸

III. RESULTS

Observers viewed 712 tooth surfaces from the 168 radiographs and recorded the proximal caries findings on film images and digitized images.

There are 243 caries lesions (C1 = 30, C2 = 213)

Table I. Outcomes for the assessing proximal caries on the monitor

	TP	FP
Overall	213	4
C2	213	0
C1	26	4

Table II. True-positive and false-positive rate

	TP	FP
Overall	0.98	0.01
C2	1.00	0.00
C1	0.87	0.01

The overall digitized image sensitivity of the caries was 0.98. The digitized image sensitivity of the second stage caries was 1.00 and that of the first stage caries was 0.87.

IV. DISCUSSION

The purpose of this research was to determine the diagnostic accuracy of the digital images of the intraoral radiographs. The results indicated that the digital images provided the same diagnostic accuracy only in the detection of proximal second stage caries as in the conventional film-based images. This may suggest that the digital images can be used for the diagnosis of the definitely large proximal caries(C2).

A factor which may have biased this study was familiarity of the image presentation.⁴ The observers were accustomed to presentation of the information in a standard, generally reproducing manner. This means that the normal visual cueing of surrounding normal anatomy that the observers use in caries diagnosis is unfamiliar and may interfere with the detection task.⁶ More training of the observers may be necessary to determine the caries detection on monitor, because they were accustomed to film-based reading skills.^{4,11}

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 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 caries detection even when enhanced by common image processing operation.⁶ Hildebot, et al¹² introduced four general purpose image processing programs for Apple Macintosh II computer. We can easily process the digital images using these soft wares. These soft wares also present the digital images as 8 bit grey levels.

Dubrex, et al⁶ studies with high resolution(4k x 4k pixels and 12 bit acquisition) digital analysis for the measurement of bone density. But the resolution of digital image was still inferior to that of the conventional film. And resolution increases, memory requirements and computational times also increase.

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.¹³ This improves image contrast. People can more readily detect intensity changes in darker images than in lighter images. Edge enhancement also improves visual detection.¹³

Summary

In summary, it has been demonstrated by this study that the detection rate of definite large proximal surface caries(C2) on the digital images was good and the detection rate of the first stage caries(C1) was somewhat inferior to the film based images.

It has been demonstrated by this study and others that the detection of proximal surface caries by present clinical methodologies is still poor. Every effort should be made to develop new means

to improve digitizing process.

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인접면 치아우식증의 진단의 치근단 X선사진과 디지털영상의 비교

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강 병 철

전남대학교 치과진료처에 내원한 환자의 구내방사선사진중 1단계 (C1: 30개 병소) 또는 2단계 (C2: 213.8 병소) 의 인접면 치아우식을 가진 방사선사진 168장을 연구대상으로 하였다. 이들 방사선사진은 코닥사의 Ektaspeed(E group) 필름을 사용하여 평행촬영법으로 촬영하였다. 168장의 방사선사진에 대하여 1단계 및 2단계 치아우식증을 4명의 구강악안면방사선학을 전공한 치과의사들이 같이 판독하여 그 결과를 기록하였다. 또한 168장의 방사선사진을 필름-비디오 변환장치를 이용하여 디지털 영상으로 전환하였다. 이때 486 DX PC에 PCVision과 frame grabber를 이용하였다. 각각의 구내방사선사진영상은 17"크기의 1280×768 픽셀의 해상도를 갖는 모니터상에서 256 단계 흑화도를 갖는 700 × 480 픽셀로 제시되었다. 모니터상에서의 치아우식 판독 결과를 구내방사선사진 판독 결과와 비교하였다. 그 결과 sensitivity는 0.98 이었다. 1단계 치아우식은 0.87, 2단계 치아우식은 1.00 의 sensitivity를 나타내었다.

LEGEND FOR FIGURES

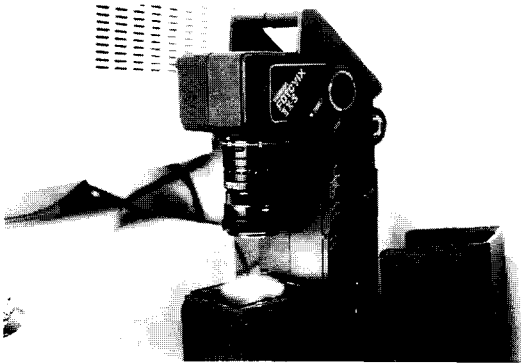


Fig. 1. The film-video processor FOTOVIX IIX- S, which captures film image as an analogue signal.

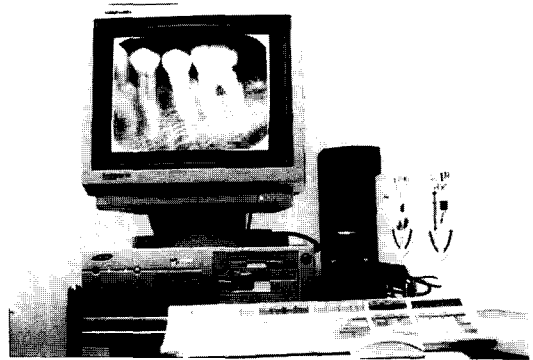


Fig. 2. The captured film image by film video- processor. The image is in color.

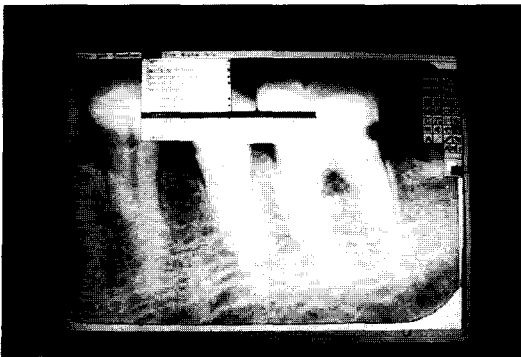


Fig. 3. The digital image in color waiting for grey scale conversion.



Fig. 4. The image converted into grey scale (256 grey levels). There is a C2 caries on the distal proximal surface of the lower first molar.

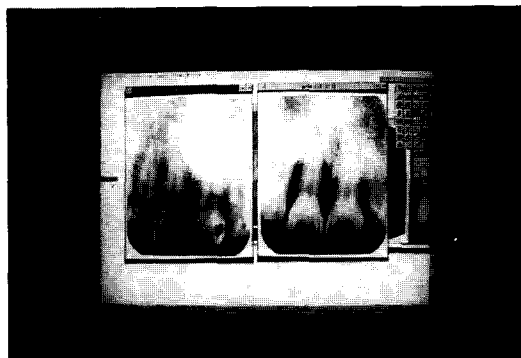


Fig. 5. There are C1 caries on the proximal tooth surfaces.