Efficiency of Caries Detection Using Two Types of Intraoral Films under Different Processing Conditions

Original Article

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Abstract

Introduction: The image quality is as well as film speed influenced by the film processing conditions. Different combinations of films and processing methodsaffect the diagnostic accuracy.Temperature and developer exhaustion result in different image quality. The purpose of this study was to evaluate the influence of film type and processing conditions on caries detection.

Material and Methods: Eighty proximal surfaces in forty extracted unrestored premolars were radiographed under standardized conditions using D and F speed Flow Dental intraoral films. The exposure time was reduced by 50% for F-speed films.Half of the samples in each group were processed manually while the others automatically. No replenishment was used and the temperature was kept constant during the procedure.True caries diagnosis was based on histological assessment of the surfaces after sectioning the teeth. Two observers read the radiographs using a four-point scale to record their diagnosis. Observers' responses were evaluated using repeated measures analysis of estimation Error.

Results: No significant differences were found in the diagnostic efficiency between two films and two processing methods in fresh and exhausted processing solution. F-speed(FV-58),however, showed earlier loss of diagnostic efficiency than D-speed(DV-58). Differences between observers were also not statistically significant.**Conclusion:** The performance of the new F-Speed film(FV-58) was not statistically different from D-Speed for caries detection under different processing condition, and could be recommended for using in dental practice contributing to dose reduction.

Key words:•Dental caries •Diagnosis •Radiography • X-ray

Introduction

One of theclinical dental problems is accurate diagnosis of the caries and its extension. The most common methods of caries detectionareclinical examination andtaking intraoral radiographs by using films.Despite the introduction of digital dental radiography since 1987, low cost and good image quality of conventional filmshas kept them in competition with digital radiography.[1,2]

The main objective of diagnostic radiologyis better image quality with the lowest acceptable patient dose. One of the most effective ways to reduce the patient dose is the use of high speed films. Fast films require less radiation to produce an image while can increase the radiographic noise.The effort of manufactures is to produce faster films without sacrificing the image quality.

One of the factors that affects the image quality is processing condition which might result in dose reduction by avoiding repetition of radiographic examination.[1,3]

Despite the fact that the developer exhaustion resulted in poor image quality,some researches have been doubtful about the way different film show to response to different processing conditions.[4-12]

Svensonet al.evaluated the influence of different developing solutions and developing times on radiographic caries detection using D and E-speed films.

According to the results of this study,rapid processing led to a lower density and contrast than the conventional developer.Under developed films due to rapid processing had an un acceptable image quality.[4]Thunthy and his coworkers evaluated the effectof developer exhaustion on three types of intraoral films.They found that in the exhausted developer, Ekta speed Plus film lostits sensitivity faster than Ultra-speed but slower than Ekta speed.So, Ultra-speed film had the highest stability. Ekta speed Plus lost contrast within two-weeks,where as Ultra-speed and Ekta speed lost it within three weeks.[5]

In comparison to performance of caries detection using D and E-speed film safter processing in the new and old developers, Ludlow et al.found that Ekta speed Plus and Ultra-speed films had no significant difference in detection of small caries. Ekta speed Plus could be used by reducing patient dose achieving high and stable diagnosis quality.[6]Developer aging had different effects on sensitometric properties of Ekta speed Plus and Insight films in Casanova's study.[7] These different effects were verified by changing the characteristic curves in the third week of automatic processing and fourth week of manual processing. Developer aging was faster in automatic processing than manual. In old developer, both films demon strated increase inlatitude and decrease in speed and contrast. Insight was more resistant to decrease in speed and latitude where as E plus was more stable incontrast.[7]

Carvalho et al. study on the properties of the new film (DFL) showed that the speed and contrast of the film washigher and its latitude was lower than Insight film. Also the above parameters were not affected significantly by using exhausted solution. His results showedthat the new film (DFL) has stable properties when using old developer in manual processing and can be used in dentistry to reduce the dose.[8]

Due to variation of films and processing solutions in the market and limited clinical experience, more studies are required to investigate different properties of them as well as using the best types. In this study, the effect of developer exhaustion inmanual and automatic processing wasevaluated on

the efficiency of caries detection using two types Flow Dental films(F and D speeds).

Materials and Methods

In this invitrostudy, eighty proximal surfaces of human premolars extracted because of orthodontic treatments were used. The selected teeth had sound proximal surfaces or small caries.This selection was based on clinical and radiographic examination.The teeth were placed in close contact in acrylic blocks similar to human mouth; i.e two selected premolars, one canine and one molar on either side of the premolars were established. D and F-speed intraoral films(Flow Xpress TM (FV58) and Flow Silver DTM(DV58) of Flow dental Co. USA) were used to take radiographs from the samples.X-ray was generated by a Planmeca unit (Planmeca,Helsinky, Finland). The exposure parameters were set on 70Kvp and 0.40s for D film safter several trial to get the best density.

Theexposure time for F films was 50% lower,m 0.20s, according to the manufacturer's instruction.A device was designed to fix the distance from x ray source to samples with the aid of film holder (RWT,Regular,German)(Figure1).

The glass plate with 0.5cm thickness was used asthe soft tissue equivalent. For each sample, two films(F and D-speed) were exposed. Film processing was done in two ways; manual and automatic. Half of the films were processed by intraoral automatic processor (Peri-Pro, Hope x-ray,USA)with7 minprocessing time and constant temperature. The other half was processed manually with constant time and temperature as ordered.Champion processing solution (X-Ray Co, Tehran, Iran) was used in both methods. In order to simulate clinical conditions, 10periapicalfilms per daywere processed in 1 liter trial solution.Processing was done with an interval of two to three days for 7 weeks. Teeth crowns were sectioned with a diamond disk in mesiodistal direction.

Analysis of variables was performed by radiographic and microscopic observation. Two maxillofacial radiologists with similar experience evaluatedcaries lesions on radiographs according to rating scales: 0= no caries, 1= caries restricted to enamel, 2=caries reaching to DEJ, 3=caries extending into the dentin. This procedure was repeated four weeks later. An oral pathologist examined the tooth sections by stereomicroscope based on the rating scales and the results were recorded as gold standard for the presence of caries (Figure2).

Results

In this invitro study,micro scopical examination of the teeth reported that thirty eight proximalsurfaces (47.5%) were caries free; seven proximal surfaces(8.8%)had caries lesions limited to the enamel; twosurfaces (2.5%)had caries lesions restricted to the DEJ and thirty threesurfaces (41.2%) had caries lesions extending into the dentin. After evaluation ofradiographs by observers, the Mann-Whitney statistical test was used to determine intra & interobserver agreement. There was no significant difference at the 95% confidence interval.

P-value of interobserver agreement is shown in Table1.

Table 1. Interobserver agreement in caries detection on radiographs of D& F films

observer	radiographic proximal surfaces No.	Mean Rank	Test
Observer1	320	321.11	Mann-Whitney Z = 0.111 P = 0.911
Observer2	320	319.89	

Table 2. Effective factors on caries detection during the experimental period

effective factors	Mean square	df	F	P-Value
observer	0.167	3.10	0.036	0.992
Developer aging	65.987	3.10	14.09	0.000*
film type	2.849	3.10	0.61	0.617
processing method	4.924	3.10	1.05	0.376

*significant

To check the rate of estimation error of observers for caries detection according to the solution aging, repeated measure analysis was performed, and calculated in Green ouse method. The results showed that the error ratewas statistically significantwith respect to time.(P=0.0001) (Figure3 and Table 2)

The graph of the errors' changes was plotted based on solution aging dividing in film and processing methods.

It showed the rate of errors in both films with two different processing methods increased over time, but there were not significant differences based on Repeated measure analysis.(P=0.995)(Figure4 and Table 3)

Figure1: Prefabricated tool for imaging of the samples

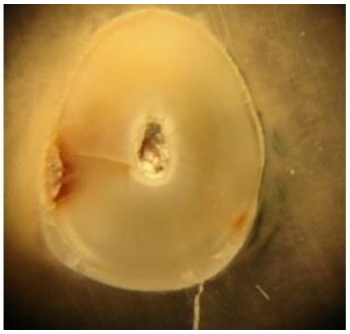

Figure 2: Microscopic view of the sectioned tooth

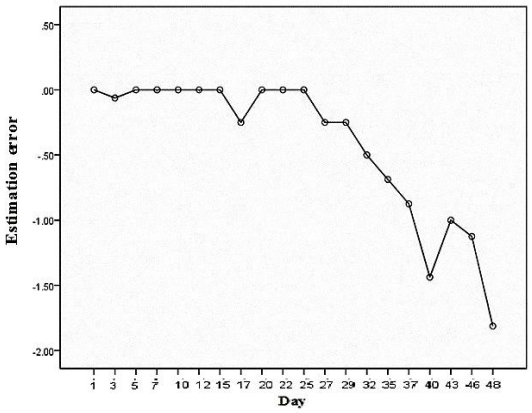

Figure 3: Observer estimation errors per day for caries detection

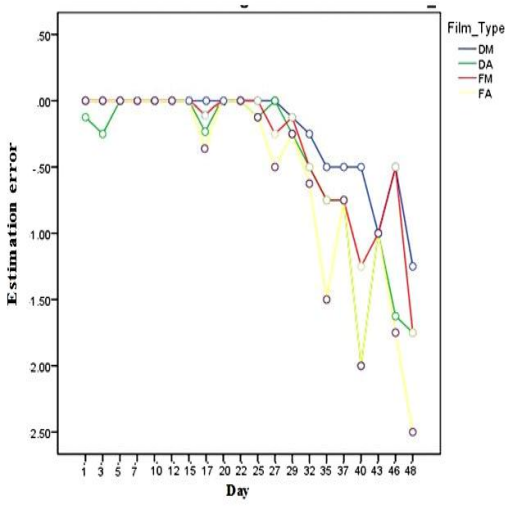

Figure 4: Observer estimation errors per day based on film typeand processing method for caries detection

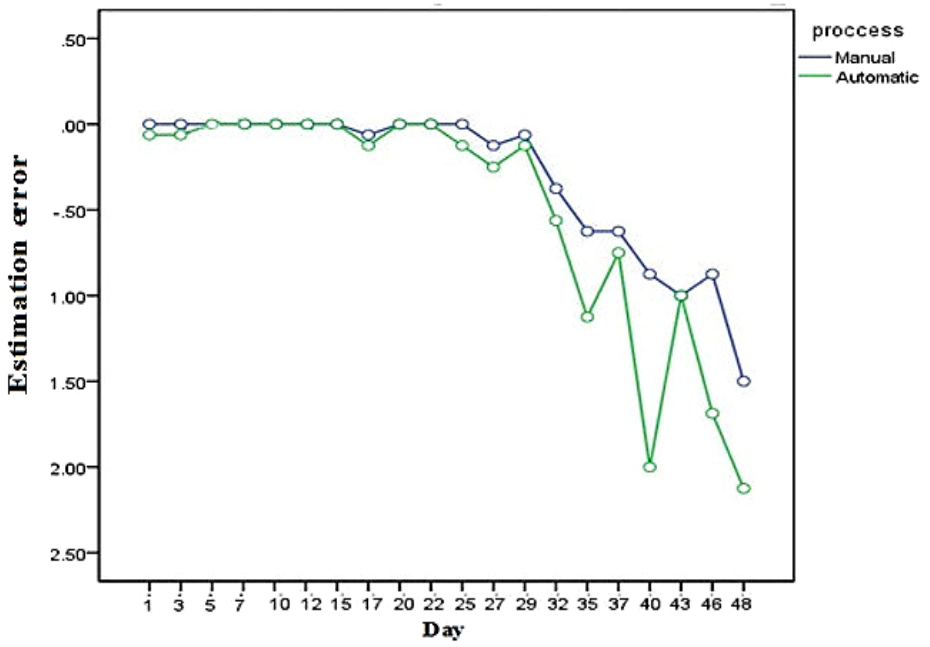

Figure 5. Observer estimation errors per day based on processing method for caries detection

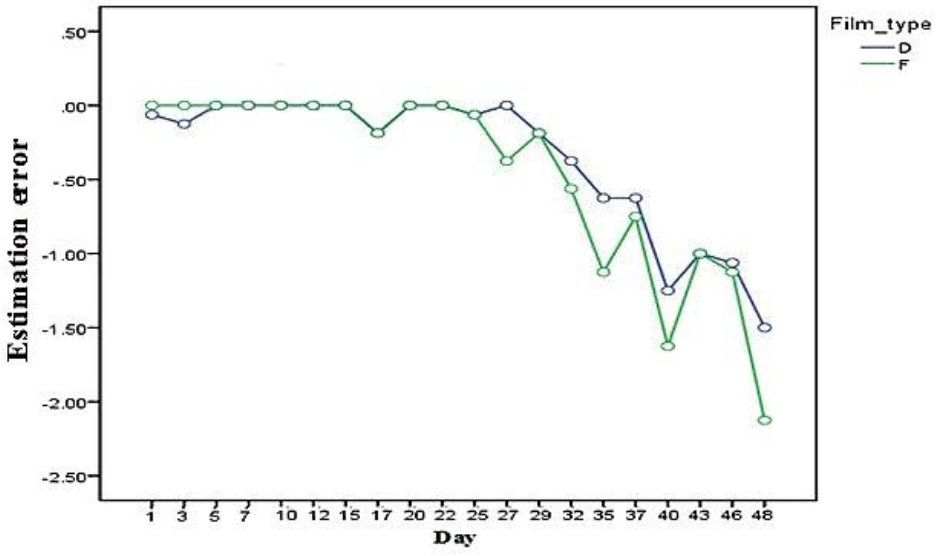

Figure 6. Observer estimation errors per day based on film type for caries detection

The rate of errorswas lower in manual than automatic processing, but there were not significant differences(P=0.367)(Figure 5 and Table 2).Also the rate of errorswas lower in D than F-speed film,but there were not significant differences(P=0.617)(Figure 6 and Table 2).

Table 3. Interaction of effective factors on caries detection during the experimental period

Interaction effect	Mean square	df	F	P-Value
Observer/ film type	0.09	3.10	0.02	0.997
Observer/ processing method	0.13	3.10	0.03	0.995
film type/processing method	1.66	3.10	0.36	0.792
observer /film type/ processing method	0.12	3.10	0.03	0.995

Discussion

This in vitro study compared the diagnostic efficacy of Flowdental intraoral films (DV58&FV58) in caries detection under manual and automatic processing inthe old and new solutions.The results of this study showed that the diagnostic performance of FV58 in response to half exposure time and changing processing conditions is equivalent to DV58.Developer exhaustion had a significant effect on the diagnostic performance of two films,but the purpose of this study was to compare the effects of the developer aging.The results showed no significant differences. Increasing diagnostic errors of observers was earlier in automatic than manual processing and for F was earlier than D film.

Although the differences were not statistically significant, but the ability of observers in diagnosis of dental caries on F film was lower than D film. It seems thatthe life time of developer is shorter in using the automatic methodthusthe processing solution should be changed earlier than manual method.Also higher speed film (F) is more sensitive to changes of the developerconditions.

Carvalho et al.studyshowed the changes in processing conditionare effective on thefilm propertiesincluding speed, contrast and latitude.Besides,different films respond differently to the old solution.[8]Also Farma-nandGeistreported the differentcombination-sof film and processing solution couldlead to increasing or decreasing the sensitivity of the film as it shiftsbetween different speed groups.[9,10]These findings are in agreement with our study.

In Farman et al.study, sensitometric properties of Flow film(F speed) was compared with D and E-speed films by using six different developers. It wasconcluded that this film could reduce the dose without losing diagnostic quality, although the developer type is effective on radiographic properties such as speed.[9]In addition, Ludlow et al.evaluated the characteristics of Insight film(F-speed) and revealed that this film retains contrast in depleted processing solutions and is able to demonstrate at least 20 line pairs per millimeter, such as Ektas-speedplus film.[11]

In our study,in both films and both processing methods,diagnostic error was absent or very low until the end of the fourth week but during the last three weeks, error rate increased almost parallel to each other.Loss of diagnostic performance in the F-speed film with automatic processing occurred earlier than other combina-tions,increase in errors was significantat the end of the fourth week. This happened later in the D-speed film with manual processing,error rate increasedsignificantly in the last week of trial. The other two combinations of film-processing, D film with automatic and F film with manual processing, were in

intermediate zone of curve of estimation error.So,there was significant increase of errors at the end of the fifth week. Since in both processing methods, the increase of diagnostic errors occurred earlierin association with Ffilm,it could beconcludedthat theperformanceof F film reduces faster with developer exhaustion.

In Casanova et al. study, depletion of processing solution had different effects on films which developed manually and automatically. In old solution, Insight film was more resistant to decrease in speed and latitude,whereE plus was more resistant to decreasein contrast.In their study, chemical depletion in automatic processing was faster than manual method.[7]It was similar to our study.

In Syriopoulous et al. study, trial period was six weeks and film processing was done once a week. They considered only the factor of "time"as developer aging.[12]On the other hand, in Ludlow et al. study,developer exhaustion was based on the number of developed films during five days.[6]In the present study, to weaken the solution, daily tenperiapical films were processed in the solution, in order to have the effects of both aging and loss of solution strength through the repeated use during 48 days. This method is similar to the one used in Thunthyet al.[5]

Conclusion

This study indicated thatin both processing methods, the performance of FV58 (F-speed)in relationship withcaries detection was slightly less than DV58 (D speed).In old solution, F-speed film lost its performance earlier than D film. There were not significant differences and diagnostic performance of both films was comparable. Since the patient exposure reducesto 50% by using FV58, therefore, it is recommended for detection of proximal caries.

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