Diagnosis of initial carious lesion by clinical and conventional radiographic methods in comparison to direct digital radiography.

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ABSTRACT

Background: Digital radiographic system is still not widely used in routine dental practice. Their superiority in the early detection of carious lesion compared to clinical examination and conventional radiography is still questioned. For this reason this study was designed.

Materials and Methods: Children aged 7-9 years attending the dental clinic were examined for initial caries clinically using d1-4, D1-4 index. Two radiographic images were taken for posterior teeth, in addition to a direct digital radiograph following parallel technique.

Results: For both dentitions, the direct digital radiographs were more precise in the detection of decayed surfaces compared to both clinical and conventional radiographic examinations. Statistically significant differences were recorded. Results however varied when studying lesions according to grades of severity as clinical examinations appeared to be sufficient in caries detection.

Conclusion: Clinical examination need to be supplemented by radiography in the diagnosis of early lesion.

Key words: Initial carious lesion, digital radiography.

INTRODUCTION

The primary goals of an effective dental diagnosis and treatment programs are the early detection of caries lesion and the limitation of caries activity prior to tooth destruction(1). Diagnosis of carious lesion is principally based on clinical inspection and probing. This however, needs to be supplemented by radiographic examination, especially for approximal surfaces (2).

Classically dental radiography relies on films, which is based on shades of gray (from white to black) known as continuous tone image (3). This traditional dental X-ray seems to be surpassed by the development of digital technology. The image in this relatively new digital radiography is converted into minute bits of information called picture elements or pixels. Each pixel contains information about light intensity (brightness) and location (x, y coordinates) of the image. These are quantified by the computer to produce a digital radiographic image (3, 4). There are two types of digital radiography systems, a directly obtained digital image (DDR) or an image that are transformed from analog to digital (3). To obtain a digital image with a direct system, a wire based sensor containing a computer chip inside a protective casing is connected to a computer. The sensor is placed in the patient mouth by a holder, where a charge-coupled device captures the light information emitted by the phosphor plate (within a sensor) when activated by the x-ray beam.

The charge coupled device is also referred to as the heart of the digital dental radiography (3, 5). Recorded parameters are directly sent to the computer and presented as an image on the computer screen. The direct digital radiography allows the analysis and manipulation of the displayed image (3).

The direct digital radiography system was introduced only recently in the Department of Paedodontics and Preventive Dentistry / College of Dentistry. Still it is not yet used in the routine dental examination for the detection of initial caries lesion, as there are still questions regarding the superiority of this technique to traditional methods. For this reason this study was designed.

MATERIALS AND METHODS

Through a three weeks period (June, 2005) children attending the clinic, Department of Paedodontics, College of Dentistry, University of Baghdad for the first time were involved in the present investigation. They were all fulfilling the following criteria:

- Healthy children with no history of serious illness or chronic systemic diseases.
- Had full set of upper and lower posterior teeth.
- Had no open cavities or severely destroyed posterior teeth because of caries.

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In the dental clinic and following the approval from parents, children were examined for dental caries in the posterior segment under standardized condition using plane mouth mirrors and sharp dental explorers. Two bite-wing radiographs were taken for posterior teeth. An x-ray machine with closed cone (General) was used and operated at 70 kVp at 8 mA, exposure time was 1.5 seconds. A film size 2 was used (Kodak ultra speed, general electric/ USA). A uni bite film holder was applied for the standardization of the film position and distance with the x-ray machine.

Direct digital radiography; DDR were taken for each child (Dimax / Procline CC2002, Planmeca). Two images were taken for posterior teeth using parallel technique. The distant and direction of the machain head from the sensor was also standardized using the same uni bit holder. The sensor size used was (B1), exposure 70 kV, 8 mA, d, 0.05s.

Diagnosis and recording of dental caries were according to the following criteria:

**Fissure and pits caries**
- Grade 0 Healthy.
- Grade 1 Thin light line, chalky margin of fissure or pits.
- Grade 2 Thin brown to black line.

**Smooth surface caries**
- Grade 0 Healthy.
- Grade 1 Chalky spot less than 2 mm in extent.
- Grade 2 Chalky spot greater than 2 mm.

**Radiographic examination**
- Grade 0 Healthy.
- Grade 1 Radiolucency in the outer most half of the enamel.
- Grade 2 Radiolucency in the inner half of the enamel only.

Data processing and analysis were carried out using SPSS package version 10. Analysis of variance and Student’s t-test were applied for statistical analysis at level of significance 5%.

**RESULTS**

The total number of children involved was 10 (seven boys and three girls). Table 1 illustrates the mean values and standard deviation of decayed surfaces in both dentitions by the three methods of examinations. Statistically significant and highly significant differences were seen in values of total d/D, in primary and permanent teeth respectively. A higher value of decayed surfaces was recorded by the DDR compared to both conventional radiography and clinical examination. The image taken by DDR was more obvious and better in quality compared to conventional x-ray (Figure 1). When decayed surfaces were studied by grades of lesion severity, results varied between d1/D1 and d2/D2. In regards to d2/D2 results coincide completely with that of the total d/D fractions, while different versions of the results were recorded for d1/D1, as seen in Table 1. For the primary teeth the mean value of d1 was the highest recorded by the clinical examination followed by conventional X-ray then DDR with statistically significant differences. For permanent teeth, value of D1 was the highest recorded by the conventional radiography with statistically significant differences compared to those recorded by other methods.

The t-values and probabilities between mean values of decayed surfaces are shown in Table 2 and 3. For primary teeth no significant differences were seen between values of d1. While for d2 highly significant differences were recorded between clinical examination and conventional radiography and DDR. The differences between the last two methods were statistically significant. In permanent teeth, the only significant difference in D2 was seen between that recorded by conventional radiography and DDR, while no significant difference was observed between results recorded by clinical examination and the other methods. As for the total D fraction, highly significant and significant differences were recorded between DDR and clinical examinations and conventional method respectively. On the other hand, no significant difference was seen between clinical examination and conventional radiography.

**DISCUSSION**

Early detection of carious lesion is considered to be one of the most important aspects in clinical dentistry. It is actually not an easy process especially when carious lesion is still limited in the enamel layers of tooth surfaces. Clinical inspection alone may not be sufficient for the early diagnosis of carious lesions. Studies show that it needs to be supplemented by radiographic examination especially for the detection of proximal lesions.

The present study goes with those previous observations, as results showed that radiography whether taken by conventional technique or DDR more precise in the detection of initial caries is compared to clinical examinations. However, no significant differences were recorded between the three methods in the detections of grade 1 lesion severity. This is not difficult to explain, if we know that the criteria of recording d1/D1 involve changes in the color of pits and fissure which...
could be easily detected clinically. In addition, tooth surfaces examined in the present study involved proximal as well as other surfaces which could be detected more precisely clinically.

Although the DDR systems are not yet used for routine examinations, it has been described as a vision for the future \(^{2,5}\). It provides better diagnostic performances as seen by previous studies \(^{11, 12}\). Results of the present comparative study are in agreement with these studies, regarding the superiority of the DDR in the detection of initial caries compared to conventional radiography. Other reported however, a similar diagnostic efficacy of both radiographic techniques \(^{13, 14}\).

### Table 1: The mean values and standard deviation of decayed surfaces in both dentition by the three methods of examination.

<table>
<thead>
<tr>
<th>Methods of examination</th>
<th>No.</th>
<th>(d_1) mean±SD</th>
<th>(d_2) mean±SD</th>
<th>d mean±SD</th>
<th>(D_1) mean±SD</th>
<th>(D_2) mean±SD</th>
<th>D mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical</td>
<td>10</td>
<td>2.8±1.62</td>
<td>---</td>
<td>2.8±1.62</td>
<td>1.2±0.420</td>
<td>---</td>
<td>1.2±0.420</td>
</tr>
<tr>
<td>Conventional</td>
<td>10</td>
<td>2.4±1.58</td>
<td>1.3±0.67</td>
<td>3.7±1.8</td>
<td>1.3±0.483</td>
<td>0.2±0.42</td>
<td>1.5±0.85</td>
</tr>
<tr>
<td>DDR</td>
<td>10</td>
<td>2.0±1.63</td>
<td>3.0±1.49</td>
<td>0.5±1.83</td>
<td>1.2±0.42</td>
<td>1.2±0.91</td>
<td>2.4±0.70</td>
</tr>
<tr>
<td>F-test</td>
<td>2.522</td>
<td>3.404</td>
<td>5.389</td>
<td>4.900</td>
<td>15.00</td>
<td>24.484</td>
<td></td>
</tr>
<tr>
<td>P-value</td>
<td>0.037</td>
<td>0.026</td>
<td>0.018</td>
<td>0.047</td>
<td>0.003</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Df</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2: Comparison between mean values of decayed for primary teeth.

<table>
<thead>
<tr>
<th>Methods of examination</th>
<th>(d_1) t-test</th>
<th>P-value</th>
<th>Sig</th>
<th>(d_2) t-test</th>
<th>P-value</th>
<th>Sig</th>
<th>D t-test</th>
<th>P-value</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical &amp; conventional</td>
<td>0.332</td>
<td>0.656</td>
<td>N.S</td>
<td>14.22</td>
<td>0.000</td>
<td>H.S</td>
<td>4.820</td>
<td>0.029</td>
<td>S</td>
</tr>
<tr>
<td>Clinical &amp; DDR</td>
<td>0.268</td>
<td>0.500</td>
<td>N.S</td>
<td>15.33</td>
<td>0.000</td>
<td>H.S</td>
<td>5.970</td>
<td>0.018</td>
<td>S</td>
</tr>
<tr>
<td>Conventional &amp; DDR</td>
<td>0.194</td>
<td>0.344</td>
<td>N.S</td>
<td>7.620</td>
<td>0.016</td>
<td>S</td>
<td>6.880</td>
<td>0.011</td>
<td>S</td>
</tr>
</tbody>
</table>

S= significant, N.S = not significant, H.S = highly significant

### Table 3: Comparison between mean value of decayed surface for permanent teeth.

<table>
<thead>
<tr>
<th>Methods of examination</th>
<th>(D_1) t-test</th>
<th>P-value</th>
<th>sig</th>
<th>(D_2) t-test</th>
<th>p-value</th>
<th>sig</th>
<th>D t-test</th>
<th>p-value</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical &amp; conventional</td>
<td>1.000</td>
<td>0.343</td>
<td>N.S</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.406</td>
<td>0.193</td>
<td>N.S</td>
</tr>
<tr>
<td>Clinical &amp; DDR</td>
<td>0.000</td>
<td>1.000</td>
<td>N.S</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9.000</td>
<td>0.000</td>
<td>H.S</td>
</tr>
<tr>
<td>Conventional &amp; DDR</td>
<td>0.429</td>
<td>0.678</td>
<td>N.S</td>
<td>3.873</td>
<td>0.004</td>
<td>S</td>
<td>5.014</td>
<td>0.001</td>
<td>S</td>
</tr>
</tbody>
</table>

S= significant, N.S = not significant, H.S = highly significant

**Figure 1:** Direct digital radiography and Conventional X-ray for posterior teeth.
Besides the good quality of the image, the DDR system has other advantages as quick image acquisition, elimination of harmful processing solutions and the dark room environment. Further, image manipulation and archiving may improve patient dental education and over all the decrease of radiation to the patients \((4, 15)\). However, the high cost of the sensor and its design may limit the use of this relatively new technique. The sensor is thick and rigid and the positioning of the cord in the mouth can sometimes create a difficulty to be used in patients with limited mouth opening or gag reflex \((16)\). It was sometime difficult to be used for children as observed by the present study.

An important conclusion of the current study is that in spite of the superiority of the DDR in caries detection, it cannot substitute the clinical examination what so ever, but is an important supplement for the inspection of dental caries.

REFERENCES