Capability of Senior Dental Students in Detecting the Presence and Diagnosing the Depth of Proximal Caries on a Bitewing Radiograph

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Abstract

Objective: Accurate and early detection of a carious lesion can prevent its further extension. Therefore, capability to accurately diagnose carious lesions is a must-have qualification for dental graduates. The purpose of this study was to evaluate the ability of senior dental students of a dental university in detecting the presence and diagnosing the depth of proximal caries on a bitewing radiograph.

Methods: The present study was a diagnostic assessment and a total of 100 bitewing radiographs of optimal quality were randomly selected from patients’ files. Radiographs were separately observed by 30 senior dental students and 5 university professors from Shahid Beheshti School of Dentistry (in order to determine the gold standard) under similar conditions. The observers were asked to detect presence of carious lesions and diagnose its depth according to the set criteria and mark in the questionnaire. If 3 university professors unanimously agreed on presence or absence of caries, this opinion would be chosen as the gold standard of the study. In order to obtain reliability, radiographs were once again observed and evaluated one month later by the same 5 university professors and 11 students. Data were analyzed using SPSS software and Kappa values were analyzed and compared with t-test.

Results: The mean Kappa value for 2 times observation was 0.777±0.065 among professors and 0.664±0.131 among students. According to Fleiss, this rate was excellent for 3 professors and 3 students. Diagnostic sensitivity, specificity, positive predictive value and negative predictive value of students in caries detection were 78.22%, 82.14%, 79.68% and 80.81%, respectively.

Conclusion: Diagnostic capability of students in differentiating carious lesions from healthy tissue was optimal and their reliability was not significantly different from the gold standard. Students were mostly able to detect the presence of carious lesions but there was an under-estimation about the depth of caries.

Key words: Caries, Diagnosis, Bitewing radiography.

Introduction:

Dental caries is among the most common chronic diseases worldwide. After occlusal pits and fissures, enamel of the proximal surface is the second most susceptible area to caries (1). During the recent decades, several assessment criteria have been introduced for detection of caries. Since the proximal caries are not detectable via visual inspection and clinical examination with an explorer, posterior bitewing radiographs are the main diagnostic tool for detection of these lesions. Studies have demonstrated that there are lots of controversies...
and disagreements among dentists regarding the interpretation of bitewing radiographs (2, 3).

Accurate and early detection of caries can prevent them from further extension; thus, capability to accurately detect carious lesions is a must-have qualification for dental graduates. Detection of proximal carious lesions using radiography depends on the clinical experience of the observer (4).

Evaluations performed in this respect indicate that approximately 50% of dentists’ disagreements in caries detection is related to the diagnosis of the depth of carious lesions (5). In a study conducted in 1997 on final year dental students in Mexico City, it was revealed that misdiagnosis of carious lesions is almost a common occurrence (6). Studies performed in other countries in 2010 and 2011 yielded similar results regarding the impact of clinical experience and educational programs on the accuracy of caries detection (7, 8).

The purpose of this study was to evaluate the capability of senior dental students of a dental university in detecting the presence and diagnosing the depth of proximal caries on bitewing radiographs. The present study results can help to find the weakness of senior dental students in caries detection and educational programs should better address this issue to tackle the shortcomings.

**Methods:**

In this diagnostic assessment, 30 senior dental students of a dental university were randomly selected and their ability to detect proximal carious lesions on bitewing radiographs was evaluated in this study. A total of 100 bitewing radiographs of an optimal quality taken with Planmeca dental x-ray unit (Finland), and processed with Velopex x-ray film processor (made in UK) were randomly selected from the patients’ files. A total of 1,270 proximal surfaces were evaluated. The mentioned 100 radiographs were separately observed and evaluated by 30 senior students without using magnification on a negatoscope in a semi-dark room. If according to the students’ judgment a surface was free of caries, they were asked to leave the respective part blank in the questionnaire. If a carious lesion was detected on a surface, the students were asked to determine the depth of lesion based on the following classification:

A. Caries penetrating less than halfway through the enamel thickness
B. Caries involving more than one-half of the enamel thickness and at the level of DEJ
C. Caries limited to the outer one third of dentin
D. Caries in between the outer one third and one-half of dentin
E. Caries involving more than half the dentin thickness

In order to evaluate the reliability of the study (evaluation of differences in diagnoses of students), 11 students were randomly selected out of the mentioned 30 and observed the same radiographs after one month to detect carious lesions.

In this study, 5 university professors were also chosen to detect carious lesions on the same radiographs. On the first attempt (observation), 3 professors agreed on presence or absence of carious lesions on all radiographs. Therefore, this opinion was selected as the gold standard for this study. In order to obtain the difference in judgment of professors (reliability), radiographs were observed for the second time by the same professors. Eventually, the obtained results in terms of diagnosis of carious lesions were compared between the 2 groups of senior students and professors.

Data were analyzed using SPSS software. The
Kappa statistic was used to evaluate the inter-observer agreement. Kappa values between the 2 groups were evaluated by t-test. Diagnostic values were calculated as sensitivity, specificity, positive predictive value and negative predictive value.

Results:

A total of 1,270 proximal surfaces were evaluated by the professors. Averagely, in 920 understudy cases (72.4% of all cases) the first and second opinions were exactly the same. Kappa value was between 0.678 and 0.841 among professors for detection of caries regardless of their depth which was an acceptable rate. According to Fleiss, this rate was excellent for 3 and moderate to good for another 2 professors. For students, the kappa value was within 0.507 and 0.872. According to Fleiss, this rate was excellent in 3 and moderate to good in the remaining students. Averagely, each student expressed an exactly similar opinion for 920 out of 1,270 surfaces which was equal to 72.5% of all cases. The mean kappa value for 2 times observation was 0.777±0.065 among professors and 0.664±0.131 among students. The difference between the 2 groups was not statistically significant (P=0.091).

Diagnostic values were strictly calculated for diagnosing the presence or absence of carious lesions. In general, 30 students evaluated 100 radiographs including 1,270 surfaces. Therefore, a total of 38,100 evaluations were performed. As shown in Table 1, diagnostic sensitivity, specificity, positive predictive value and negative predictive value were 78.22%, 82.14%, 79.68% and 80.81%, respectively. Diagnostic accuracy was calculated as 80.29%.

<table>
<thead>
<tr>
<th>Student’s opinion</th>
<th>Professor’s opinion</th>
<th>Caries</th>
<th>Intact</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caries</td>
<td>14080</td>
<td>3590</td>
<td>17670</td>
<td></td>
</tr>
<tr>
<td>Intact</td>
<td>3920</td>
<td>16510</td>
<td>20430</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>18000</td>
<td>20100</td>
<td>38100</td>
<td></td>
</tr>
</tbody>
</table>

In case of absence of carious lesions, the diagnostic accuracy was 82.2%. This rate was 42.8% for grade A caries, 44% for grade B caries, 33% for grade C caries, 15.8% for grade D caries and 40.6% for grade E caries. Therefore, students were mostly capable of detecting presence or absence of carious lesions but there was a tendency towards underestimation when determining the depth of caries (Figure 1).

In general, students were more successful in correctly diagnosing the depth of enamel caries than those invading the dentin. With regard to diagnosing the depth of carious lesions, the greatest weakness of students was in stage D caries while the most accurate diagnoses were made for stage B caries. The highest frequency of a decayed tooth wrongfully diagnosed as intact was observed for stage A caries followed by stage C and the lowest frequency of such misdiagnosis was observed among stage E caries (Table 2).
Figure 1- Evaluation of the diagnostic accuracy based on the depth of carious lesions

![Line chart showing evaluation of diagnostic accuracy based on depth of carious lesions.]

Table 2- Comparison of the students’ opinion with diagnostic gold standard set for detection of the depth of caries.

<table>
<thead>
<tr>
<th>Diagnostic gold standard for students</th>
<th>Intact N=6700</th>
<th>A N=1200</th>
<th>B N=1900</th>
<th>C N=1900</th>
<th>D N=400</th>
<th>E N=600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact</td>
<td>16520 (82.2%)</td>
<td>1430 (39.7%)</td>
<td>950 (16.7%)</td>
<td>1290 (22.6%)</td>
<td>180 (15%)</td>
<td>90 (5%)</td>
</tr>
<tr>
<td>A</td>
<td>2060 (10.2%)</td>
<td>1540 (42.8%)</td>
<td>1720 (30.2%)</td>
<td>880 (15.4%)</td>
<td>80 (6.7%)</td>
<td>40 (2.2%)</td>
</tr>
<tr>
<td>B</td>
<td>840 (4.2%)</td>
<td>560 (15.6%)</td>
<td>2510 (44%)</td>
<td>1550 (27.2%)</td>
<td>80 (6.7%)</td>
<td>110 (6.1%)</td>
</tr>
<tr>
<td>C</td>
<td>440 (2.2%)</td>
<td>50 (1.4%)</td>
<td>500 (8.8%)</td>
<td>1880 (33%)</td>
<td>640 (53.3%)</td>
<td>300 (16.7%)</td>
</tr>
<tr>
<td>D</td>
<td>120 (0.6%)</td>
<td>20 (0.6%)</td>
<td>20 (0.3%)</td>
<td>100 (1.8%)</td>
<td>190 (15.8%)</td>
<td>530 (29.4%)</td>
</tr>
<tr>
<td>E</td>
<td>120 (0.6%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>30 (2.5%)</td>
<td>730 (40.6%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>20100 (100%)</td>
<td>3600 (100%)</td>
<td>5700 (100%)</td>
<td>5700 (100%)</td>
<td>1200 (100%)</td>
<td>1800 (100%)</td>
</tr>
</tbody>
</table>

Discussion:

Caries detection although simple, is of utmost importance. Determining the depth of caries helps in choosing an appropriate treatment plan. There are lots of disagreements among dentists in restorative decisions for proximal caries. Significant differences also exist between the observers regarding the interpretation of radiographs (9).

In this study, diagnostic sensitivity and specificity of senior dental students were 78% and 82%, respectively. In a study by Mileman et al (2002), diagnostic sensitivity of 4th year dental students and Dutch general dental practitioners was 67.2% and 54%, respectively (10). The difference in results of the mentioned study and those of ours may be due to different curricula, professional skills of students, and duration of study in dental university (6 years in Iran versus 4 years in the Netherlands). On the other hand, in the mentioned study, students had higher rate of both true positive and false positive diagnoses compared to general dentists. In other words, they tended to interpret suspicious radiolucencies as a carious lesion. We have to keep in mind that clinical experience may improve the performance of general dentists. Yasar et al, in their study in 2011 reported that final year students had a higher kappa value and inter-observer agreement in radiographic caries diagnosis compared to 4th year dental students. In addition, they noticed that radiologists were more capable of detecting caries on a radiograph compared to endodontists and specialists in restorative dentistry (7).
In a study by Diniz et al, in 2010 it was demonstrated that the reproducibility of radiographic examination and the accuracy of detecting occlusal caries were influenced by the examiner's clinical experience, training, and dental education. Also, a significant difference was detected in caries detection sensitivity between the final year dental students and dentists with 5-7 years of clinical experience (8). On the contrary, Wrbas et al, in their study in 2000 demonstrated that participation of final year dental students in 6 consecutive educational courses for improving their diagnostic skills did not significantly improve their radiographic diagnosis of caries (11). Wenzel and colleagues in 2002 compared the diagnostic accuracy of a caries detection program with human observers and concluded that the program in comparison to human observers had a lower accuracy in detecting proximal caries (12). The mentioned study revealed the importance of human observers and emphasized the necessity of adequate and correct education of students regarding accurate diagnosis of proximal caries on bitewing radiographs.

In many studies, histological or macroscopic validations are considered as the gold standard (8,13,14); whereas, we did not use such standard in the present study. It is noteworthy that macroscopic validation is not perfectly reliable and there are lots of false positive or false negative results. Histological examinations are more suitable if several sections are made. In some studies reporting application of this method, limited number of sections or sometimes only one section have been evaluated. Additionally, this method cannot be used for in-vivo studies. MauPome in his study in 1997 in Mexico City used the opinion of 2 expert radiologists as the gold standard (6). However, there is a possibility that both clinicians make a mistake. This issue was simply verified by observing the kappa value in the present study and diagnostic differences. Of 5 professors evaluated in the present study, 2 had kappa values smaller than 0.8 which means their diagnoses were definitely wrong for some cases.

Assessment of validity and reliability indicates that in order to achieve adequate validity, having reliability is an undeniable value. Therefore, apart from the diagnostic power (as a reliability index), in the present study reliability of diagnosis was also determined for both the students and professors. The study results demonstrated that in the majority of cases, the 2 opinions regarding the presence or absence of carious lesions (regardless of the depth of lesion) were adequately similar and the difference between the professors and the students in this respect was not statistically significant. In both groups, in more than 70% of cases, the 2 diagnoses perfectly matched. These findings demonstrate a relatively optimal reliability for both groups. Kappa value less than 0.6 was obtained for only 2 out of 11 students which is indicative of the fact that some students need more practice to yield a higher diagnostic reliability.

More detailed assessments reveal that students usually underestimate the depth of carious lesions. Apart from an actual lack of diagnostic skills, the reason for this problem may be the conservative view of students and avoiding complex cases.

Students’ diagnostic accuracy for diagnosing the teeth determined by professors as intact was more than 80% which decreased to 43% for stage A, and 44% for stage B caries. This reduction was more significant for stage C and was the highest for stage D caries. Deep stage E caries were diagnosed more accurately than the other 2 dentin caries. These findings reveal that regardless of the deepest caries, students diagnose superficial caries better than deep caries and detect enamel caries more accurately than dentin caries.
Conclusion:

Diagnostic power of senior dental students for detection of caries in this study was relatively good (78% sensitivity, 82% specificity, 80% diagnostic accuracy). Reliability of students in determining presence or depth of carious lesions was not significantly different from that of university professors and according to Fleiss was optimal in the majority of cases.

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References: