Diagnosing the severity of buccal caries lesions in governmental and private orthodontic patients at debonding, using the ICDAS-II and the DIAGNOdent Pen

Naif A. Almosa*; Ted Lundgrenb; Abdullah M. Aldreesc; Dowen Birkhede; Heidrun Kjellberg

ABSTRACT
Objectives: To clinically evaluate the prevalence of buccal caries and white spot lesions (WSLs) at debonding in governmental and private orthodontic patients, using the International Caries Detection and Assessment System (ICDAS-II) and the DIAGNOdent Pen, and to study the correlation between the two methods.

Materials and Methods: A cross-sectional study was carried out on the nonextracted premolars and anterior teeth of 89 orthodontic patients. They were recruited into two groups based on the treatment center they attended: governmental group (G; n = 45) and private group (P; n = 44). Immediately after debonding, the examination of buccal caries and WSLs on premolars and anterior teeth was carried out using the ICDAS-II and the DIAGNOdent Pen. Cross-tabulation was applied to study the correlation between the ICDAS-II index and the DIAGNOdent Pen by calculating the Spearman correlation coefficient.

Results: The G group showed a significantly higher (P < .0001) prevalence of WSLs and/or buccal caries compared to that of the P group based on evaluation by the two methods. Based on ICDAS-II, 43% of the patients in the P group and 9% in the G group were free from any WSLs. In the G group, 22% of the patients had ≥16 lesions, whereas there were none for the P group. The Spearman correlation coefficient between the two methods was .71.

Conclusions: The prevalence of caries and/or WSLs at debonding was significantly higher in the G group compared to the P group. The clinical index (ICDAS-II) showed a good correlation with the DIAGNOdent Pen. (Angle Orthod. 0000;00:000–000.)

KEY WORDS: White spot lesions; ICDAS; International Caries Detection and Assessment System; Laser fluorescence; Fixed orthodontic appliance

INTRODUCTION
Research has shown that fixed orthodontic appliances promote plaque accumulation because of the difficulties patients face in cleaning their teeth. Food retention facilitates white spot lesion (WSL) formation; thus, enamel demineralization on the buccal surfaces has been a common adverse effect of orthodontic treatment.1,2 Recent studies have reported a high incidence of new WSL development during orthodontic treatment, affecting 60% to 70% of patients.3,4 Orthodontic patients develop significantly more WSLs than nonorthodontic patients, which leads to esthetic
problems that may develop into caries lesions after orthodontic treatment. The DP was used with a mean age of 22.5 years, and a private (P) group (n = 44), with a mean age of 21.2 years. Informed consent was obtained before the start of examination. The College of Dentistry Research Centre Ethical Sub-Committee at King Saud University, Riyadh, Saudi Arabia (Reg. No. NF 2225) approved the study. The prevalence of buccal caries lesions on the G and P groups was determined on the tooth level (qualitative) and on the individual level (quantitative) to evaluate differences between the two groups.

Error of Method

The primary author (Dr Almosa) attended workshops by the manufacturer for training in the correct use of the DP. Two independent examiners examined 20 patients using the two methods to evaluate the interexaminer reliability, and these patients showed at least one WSL. For calibration purposes, the primary author (Dr Almosa) demonstrated and taught the correct use of the DP to the other examiner, and the two examiners then examined the first two patients together before examining the patients independently. To evaluate the intraexaminer reliability, these 20 patients were examined twice by the main author, with a minimum of 2 weeks interval in between.

Clinical Examination

Immediately after debonding and removal of the remaining resin, the teeth were cleaned using a rubber cup, pumice paste, and dental floss, and they were rinsed and dried with compressed air in order to remove plaque and extrinsic stains. Thereafter, all premolars and anterior teeth were examined for buccal caries lesions using the two caries detection methods: the ICDAS-II (Table 1) and the DP. The DP was used
According to the instructions provided in the manual from the manufacturer, teeth were rinsed and dried before registration, the DP was calibrated with ceramic standard before each session, the flat tip was swept across the buccal surfaces, and the peak value was considered. Table 2 shows the ranges of values for the DP and their corresponding diagnoses. These values are provided from the manufacturer and are based on the fact that a zero value needs to first be measured on a healthy coronal location. In order to study the prevalence of buccal caries lesions and the correlation between the ICDAS-II and the DP, the ICDAS-II index was merged from seven scores to four scores (Table 1) according to the histological study performed to validate ICDAS-II as follows:

- Score 0 were considered to be healthy, sound tooth and indicated as score 0.
- Scores 1 and 2 were considered to be enamel caries and indicated as score 1.
- Scores 3 and 4 were considered to be deep, enamel caries and indicated as score 2.
- Scores 5 and 6 were considered to be dentin caries and indicated as score 3.

Table 2. DIAGNODent Pen Values and Corresponding Diagnosis

<table>
<thead>
<tr>
<th>DIAGNODent Pen Values</th>
<th>Diagnosis</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–13</td>
<td>Healthy tooth</td>
<td>0</td>
</tr>
<tr>
<td>14–20</td>
<td>Enamel caries</td>
<td>1</td>
</tr>
<tr>
<td>21–29</td>
<td>Deep enamel caries</td>
<td>2</td>
</tr>
<tr>
<td>≥30</td>
<td>Dentin caries</td>
<td>3</td>
</tr>
</tbody>
</table>

Statistical Analysis

All data were analyzed using the Statistical Package for the Social Sciences (IBM SPSS Statistics; version 20; IBM, Chicago, Ill). Descriptive statistics were used to study the mean age, frequency of gender, and different scores of the two methods on the tooth level, and the frequency of buccal caries lesions on an individual level. The independent-sample t-test was applied to the two main groups, G and P, to determine the statistically significant differences of buccal caries lesions on the individual level. Fisher exact test was used to compare the different categories of the buccal caries lesions count on individual levels. For all tests, the significance level was \( P < .05 \).

The cross-tabulation was applied to evaluate inter- and intraexaminer reliability as well as to study the correlation between the ICDAS-II index and the DP by calculating the weighted kappa and the Spearman correlation coefficient.

RESULTS

The G group comprised 19 males and 26 females, and the P group comprised 14 males and 30 females. There were no statistically significant differences between the two groups in the aspect of age and gender \( (P > .05) \). The inter- and intraexaminer reliability of the ICDAS-II and the DP for examining buccal caries lesions were evaluated, and kappa values ranged between .87 and .93 (Figure 1). Both methods reveal similar outcomes that show very good reproducibility.
On Tooth Level

In total, the buccal surfaces of 1653 teeth, 822 teeth in the G group and 831 teeth in the P group, were examined for the presence of buccal caries lesions using two methods: the ICDAS-II and the DP. One hundred twenty-seven teeth were congenitally missing or extracted for orthodontic reasons. Figure 2 illustrates the prevalence, pooled together using the two methods, of buccal caries lesions in the G and P groups. The ICDAS-II and DP indicated that 67.3% and 78.8% of the buccal surfaces, respectively, were healthy. In addition, the ICDAS-II detected scores 1 and 2 (enamel caries and deep enamel caries) almost three times more often than the DP. Moreover, the DP indicated that approximately 10% of the total number of teeth in both groups had dentin caries.

Figures 3 and 4 show the prevalence of buccal caries lesions in the G vs P groups according to the ICDAS-II and DP, respectively. The results reveal higher percentage figures for the DP in comparison with the ICDAS-II for the healthy teeth (score 0) and dentine caries (score 3). Moreover, the percentages of enamel caries, deep enamel caries, and dentin caries (scores 1, 2, and 3, respectively) were higher in the G group compared to the P group irrespective of the method used.

On an Individual Level

No statistically significant difference was found between males and females in the aspect of buccal caries lesions (P > .05) using either the ICDAS-II or the DP. Statistically significant differences were noted between the G and P groups for buccal caries lesions (P < .0001; Figure 5). These differences applied for the total number of lesions as well as after categorizing the lesions into five different counts. In the G group, 8.9% of the patients were free from any lesion, whereas 22.2% had more than 16 lesions. On the other hand, 43.2% of the patients in the P group were free from any lesion; no patients had more than 16 lesions. We also found that the G group had a prevalence for developing six to 20 lesions, whereas the P group had a prevalence for developing up to five lesions.

Correlation Between the Two Methods

To study the correlation between the ICDAS-II and the DP, cross-tabulation was applied (Table 3), from
which the Spearman correlation coefficient was calculated to be .71. Given ICDAS-II with scores of 0 and 3, the chances of getting the same scores using DP were 97% and 86%, respectively. However, diagnosing teeth with scores of 1 and 2 using the ICDAS-II gives a chance of 14% and 22%, respectively, using the DP.

DISCUSSION

This study revealed that the prevalence of buccal caries lesions was significantly higher in the G group compared to that in the P group. This finding was in agreement with a previous report in Australia,24 which showed that patients who visit private dental clinics receive better dental care compared to those who attend public clinics. Also, the current study supports the results of the earlier caries risk analysis of patients in KSA,8 which revealed that the G group patients had a greater risk than those in the P group. Differences in socio-economic status and the related differences in oral hygiene practices between the two patient groups may play a role in the variations in the buccal caries lesions prevalence.25 Since orthodontists in governmental hospitals in KSA are required to see a large number of patients every day, they may not be able to spend sufficient time reviewing preventive dental measures with their patients, and this may have contributed to the increased prevalence in buccal caries lesions during orthodontic treatment. Motivation toward treatment is expected to be greater in patients attending private clinics, because of the accompanied expenses, than it is in those attending free-of-charge governmental institutes, which may also explain the differences in the buccal caries lesions numbers.

In this study, the teeth were rinsed and dried with compressed air in order to remove any paste remnants after being polished with pumice paste, which could cause false-positive readings by the DP.26 The clinical advantages of using the DP are that it is more objective and the measurements can be displayed to the patient and may, therefore, have a pedagogical value; however, it is more time consuming clinically, and the device is expensive. On the other hand, ICDAS-II has no cost and is less time consuming clinically, but it’s more subjective.

Recent studies3,4 showed an increased tendency toward development of WSLs following orthodontic treatment. This could be a reflection of the use of advanced methods for the early detection and quantification of carious lesions, or it could be an indication of the ineffectiveness of the prevention programs, especially in the patients treated at the governmental hospitals in KSA. No association between the buccal caries lesions prevalence and gender was revealed in this study. Similar conclusions were reported in previous studies.5,6 However, a tendency for male patients to develop more WSLs than female patients has been noted in a few studies.1,4 Ethnic and cultural differences between the studied groups of patients may explain these differences.

The data presented in this study indicate the ICDAS-II and the DP have good inter- and intraexaminer reliability. These findings were in agreement with previous studies.17,23 The slightly higher reproducibility of the DP could be due to its greater objectivity compared to that of the ICDAS-II. However, according to Landis and Koch,27 intraexaminer agreement of 61% to 80% denotes significant agreement, whereas exceeding 80% is almost perfect intraexaminer agreement.

The current investigation revealed that the clinical criteria (ICDAS-II) correlated well with the DP. This correlation was measured based on the chance for the DP to be in agreement with the ICDAS-II in the diagnosis of different scores of buccal caries lesions, but not vice versa. For example, 12 out of 14 teeth diagnosed with ICDAS-II score 3 (dentin caries) had the same score using DP, whereas 159 teeth diagnosed with DP score 3 resulted in only 12 teeth having the same score using the ICDAS-II. This could be because the DP tends to give more positive diagnosis with lower specificity, as concluded by

Table 3. Cross-Tabulation Between the ICDAS-IIa and the DIAGNOdent Pen

<table>
<thead>
<tr>
<th>Score</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICDAS-II</td>
<td>1079</td>
<td>21</td>
<td>9</td>
<td>4</td>
<td>1113</td>
</tr>
<tr>
<td>1</td>
<td>191</td>
<td>40</td>
<td>29</td>
<td>23</td>
<td>283</td>
</tr>
<tr>
<td>2</td>
<td>32</td>
<td>38</td>
<td>53</td>
<td>120</td>
<td>243</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>1302</td>
<td>100</td>
<td>92</td>
<td>159</td>
<td>1653</td>
</tr>
</tbody>
</table>

*ICDAS-II indicates International Caries Detection and Assessment System.
In general, the clinical index (ICDAS-II) shows a Caries Res regarding Proceedings of. 2012;82:

The reported high prevalence of buccal caries lesions in our study at governmental institutions in KSA indicates the need for establishing a comprehensive approach toward prevention based on the available evidence. The Cochrane review\(^{29}\) regarding fluoride for the prevention of white spots on teeth during fixed orthodontic appliance treatment concluded there is some evidence that daily fluoride mouth rinse could reduce the occurrence and severity of WSLs.

**CONCLUSIONS**

- The prevalence of buccal caries lesions at debonding was significantly higher in the G group compared to that of the P group.
- In general, the clinical index (ICDAS-II) shows a good correlation with the laser fluorescence device (DP).

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