Caries incidence in lower anterior teeth bonded with fixed orthodontic retainer

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Abstract Purpose of the study: To evaluate the incidence of carious lesions along the lower fixed retainer wire placed after orthodontic treatment both clinically and radiographically. Methodology: Seventy participants contributed in this study. The experimental group consisted of forty participants (20 males and 20 females with a mean age of 23.4 years and 24.4 years, respectively) bonded with lower fixed retainer for a period ranging from one to six years. The retainers were immediately placed after orthodontic treatment from right canine to left canine, while the control group consisted of 30 participants (15 males with a mean age of 24.6 years, and 15 females’ mean age were 26.8 years). All participants’ lower anterior teeth from 3 to 3 were examined separately clinically and radiographically. Examiners filled a questionnaire concerning patient’s oral hygiene, dietary habits, as well as, frequency of fixed retainer detachment in the experimental group. Results: Out of the 240 bonded teeth that had been examined clinically and radiographically, only 17 teeth had shown carious lesions. Results in both experimental and control group showed insignificant caries incidence (P > 0.05). When both genders were compared, males had three times higher caries incidence than females in the experimental group with insignificant difference between both (P > 0.05). Central and lateral incisors in the experimental group had higher caries frequency (37.5%) than canines (25%), 20% of the experimental group experienced retainer detachment. Oral hygiene status evaluation showed significant difference (P < 0.05) between the experimental and control groups, the percentage of good oral hygiene for both was 61.8% and 20.0%, respectively. Moreover, there was slight significant difference among both regarding the frequency of scaling and prophylactic measures.
1. Introduction

One of the great controversies that concern all orthodontists is long-term post treatment retention. Moyers\(^1\) defined retention as “the holding of teeth following orthodontic treatment in the treated position for the period of time necessary for the maintenance of the result” or by Riedel\(^2\) as “the holding of teeth in the ideal aesthetic and functional position”, while Angle\(^3\) stated that “the problem involved in retention is so great as to test the utmost skill of the most competent orthodontist, often being greater than the difficulties encountered in the treatment of the case up to this point”.

Over the past few years, several appliances have been introduced to ensure the stability of orthodontic treatment results. Angle\(^3\) introduced his first, which was based on bonded fixed appliance. He was also confident that occlusal forces against normal occluded teeth would maintain teeth in their proper position but his belief was replaced by his student Tweed, who demonstrated that avoidance of arch expansion will prevent relapse after premolar extraction, then Hawley\(^4\) introduced his removable appliance to maintain treatment results.

Orthodontists sought extra supplementary methods to prevent post treatment changes such as suggested by Reitan\(^5\) that the gingival elastic fibers are the ones that contribute to relapse after correction of rotations. Blake\(^6\) recommended over rotation correction, while Edwards\(^7\) suggested surgical circumferential supracrestal fibrotoamy to prevent rotational relapse. Alternatively, Boese\(^8\) combined surgical supracrestal fibrotoamy and major reproximation of mandibular anterior teeth during and after treatment.

On the other hand, others studies\(^9\)–\(^13\) related long-term stability to interincisal angle correction, maintenance of intercanine width, post treatment growth, and maintenance of arch form, respectively. Sinclair et al.\(^14\) and Bishara et al.\(^15\) concluded that arch length decreases and mandibular incisor crowding increases throughout life even with untreated patients.

In spite of the previously conducted studies, orthodontists concluded that the only effective method to avoid relapse and secondary mandibular incisor crowding after treatment is by placement of fixed permanent bondable retainer for decades or throughout life.

Bondable fixed retainers consist of a length of orthodontic wire bonded to the six mandibular anterior teeth with acid-etch retained composite. Since, it introduced different kinds of wires, as well as, bonding materials were reported in the literature to construct bonded retainers and to evaluate their effects on oral hygiene status.

Several advantages were reported for usage of such retention including stabilization of teeth till growth is completed or even after, holding of either space closure especially in extraction cases of adults, or space opening for a bridge or an implant placement.\(^16\) But the major advantage of those lingually bondable retainers is that they are compliance free, except for oral hygiene maintenance, in which plaque accumulation along the wire over a period of time might cause iatrogenic damage to the teeth and supporting structures.

Earlier studies found that there were no signs of carious lesions or white spots in the lingual aspects of the teeth bonded to the lingual retainer.\(^17\)–\(^20\) and even with poor oral hygiene patients.\(^21\) In contrast, Hirshfield\(^22\) and Axelsson et al.\(^23\) reported incidence of white spots in their samples, also Birdsall et al.\(^24\) concluded that the risk of dental caries continues throughout retention phase.

Since fixed retainer is recommended to be used after orthodontic treatment for a long period to maintain treatment results risk of carious lesions may be expected on the involved bonded teeth surfaces. Therefore, the purpose of this study was to evaluate the incidence of carious lesions along the extended canine- to- canine fixed retainer wire both clinically and radiographically.

2. Methodology

2.1. Direct Clinical Examination

2.1.1. Experimental group

The experimental group was collected from the orthodontic clinic at the College of Dentistry, King Saud University which consisted of forty patients (20 males and 20 females with age ranging from 15 to 30 years old and a mean of 23.4 years, and from 17 to 37 with a mean of 24.4 years old, respectively). They were examined for incidence of cavitations in presence of orthodontic bondable retainer to the six lower anterior teeth at least one year after orthodontic treatment is finished.

2.1.2. Control group

Patients were randomly selected from the routine follow-up appointment clinic at the College of Dentistry, King Saud University on the basis that none of them had received any previous orthodontic treatment. Then they were examined for presence of non-developmental carious lesions. This group consisted of thirty patients (15 males with age ranging from 18 to 32 years old and a mean age of 24.6 years, while the 15 females’ age range was 13 to 38 years with a mean of 26.8 years), such selection was determined to provide a baseline of the expected prevalence of carious lesions excluding any orthodontic treatment procedures.

Carious lesions for both earlier mentioned groups were detected clinically by visual-tactile method.\(^25\)

2.2. Indirect radiographic examination

The entire sample (control and experimental teeth) were well examined radiographically for detection of cavitated lesions...
by anterior periapical radiographs, using parallel technique, high speed films exposed at 60 KvP, 7 mA for 0.25 seconds. Presence of an ill-defined decrease in density of tooth structure will be considered as cavitations.

Comparisons between the control and the experimental groups were taken into consideration by providing a questionnaire that was filled by the two examiners, and consisted of 7 questions related to social and motivation status, oral hygiene habits, dietary habits, frequency of topical fluoride application, and frequency of dental polishing and scaling. Additional question was directed only to the experimental group related to the frequency of fixed retainer detachment. Those parameters were firmly evaluated to rule out any variable difference in the studied sample.

The study was approved by the Ethical Committee of the College of Dentistry Research Centre and all the subjects signed an informed consent form.

Additionally, all the anterior teeth from canine to canine were coded statistically from T1 to T6 as follows: T1 = tooth #33, T2 = tooth #32, T3 = tooth #31, T4 = tooth #41, T5 = tooth #42 and T6 = tooth #43.

Caries lesions were also coded according to the tooth surface affected in the sample group as: 0 = None, 1 = mesial caries, 2 = distal caries, 3 = mesial and distal caries, 4 = incisal and mesial caries, 5 = buccal and distal caries, 6 = buccal caries.

The statistical analysis of the data was done using an SPSS program for windows (version 13.0 SPSS Inc., Chicago, USA), to compare carious distribution between the two groups. A sex dimorphism carious incidence difference was also evaluated and a P value of 0.005 was considered significantly valid.

### 3. Results

The 70 participants were distributed as follows 55% (experimental) and 36.7% (control) finished high school and, 32.5% (experimental) and 36.7% (control) had bachelor degree. Table 1 shows the educational level distributions in the sample.

The measurements of error were carried out by two different investigators. An intra- and inter-examiner reliability was tested. In the inter-examiner reliability, 10 patients were selected randomly and each examiner detected carious lesions independently. The Kruskal–Wallis Test was used for comparison and there was no significant difference between both examiners (P value < 0.05 for each tooth). At the same time, intra-examiner reliability test was assessed by replicating the caries detection on the patient with two weeks intervals, paired t-test (P = 0.81) showed no significant difference.

| Table 1 Distribution of education level in the sample. |
|-----------------|-----------------|-----------------|
|                 | Experimental N (%) | Control N (%) |
| Education level |                  |                |
| <- High School  | 2 (5%)           | 4 (13.3%)      |
| High School     | 22 (55%)         | 11 (36.7%)     |
| Diploma         | 2 (5%)           | 0 (0%)         |
| Bachelor’s degree | 13 (32.5%) | 15 (50%)     |
| Master’s degree | 1 (2.5%)         | 0 (0%)         |
| Total           | 40 (100%)        | 30 (100%)      |

### Table 2

<table>
<thead>
<tr>
<th>Time</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year</td>
<td>13 (32.5%)</td>
</tr>
<tr>
<td>2 years</td>
<td>7 (17.5%)</td>
</tr>
<tr>
<td>3 years</td>
<td>9 (22.5%)</td>
</tr>
<tr>
<td>4 years</td>
<td>1 (2.5%)</td>
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<tr>
<td>5 years</td>
<td>6 (15%)</td>
</tr>
<tr>
<td>6 ≤ years</td>
<td>4 (10%)</td>
</tr>
<tr>
<td>Total</td>
<td>40 (100%)</td>
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</table>

Table 2 represents the retention duration of the fixed retainer, which ranges from one year to more than six years.

#### 3.1. Caries incidence

For the experimental sample, a total of 240 teeth had been examined clinically and radiographically, only 17 teeth had carious lesions with no more than 3 carious lesions were found in any of the patients.

Among the male patients, six carious teeth were detected in the experimental group, while nine carious teeth were found in the control group. In contrast, female patients had just two carious lesions and only in the experimental group. Comparison between the two genders in the experimental group revealed that male patients had three times higher carious prevalence than females but with no significant differences, P value for each tooth > 0.05 (Fig. 1).

In spite of these findings, initial results showed no significant difference between males and females, either in the experimental or control group, therefore both genders in each sample were combined mutually. Further caries detection using Chi-square test for each tooth, and t-test for the sum of the carious teeth for each patient clinically and radiographically showed a P value > 0.05 (Figs. 2–4).

A thorough investigation related to which teeth are more prone to dental caries than others, were as well reviewed from the figures for the entire sample. Results showed that central and lateral incisors were equally affected with 37.5% frequency in the experimental group, while the control had frequency of 33.3% equally for both incisors. Canines showed lesser frequency with 25% in the experimental group and equal to incisors in the control 33.33% (Figs. 5 and 6).

Twenty percent of the experimental group patients (8 patients) had the experience of detachment, 75% (6 patients) experienced one time detachment, whereas 25% (2 patients)
had two times detachments. Only one carious tooth found in one of the male patients.

3.2. Oral hygiene aids and oral hygiene care

Oral hygiene status evaluation showed a significant difference between the two groups, the experimental group (61.8%) had better oral hygiene maintenance than the control (20%) ($P$ value = .037).

Additionally, there was a significant difference between the two groups concerning dental floss usage. From the entire sample, 25.0% (9 patients) of the experimental group were using dental floss, while only 3.3% (one patient) from the control reported usage of dental floss. Out of those patients that had been found using dental floss, 90.9% were from the experimental group ($P$ value = 0.019) and 5% (2 patients) of these patients were using super floss.

Regarding usage of mouthwash, we found that there was significant difference between the two groups ($P$ value = 0.034) and all patients were only from the experimental group.

Even though, frequency of teeth brushing between the two groups generally revealed no statistical significant difference ($P$ value = 0.078), the lingual surface brushing of the lower anterior teeth showed higher percentage in the experimental group (90.0%) than the control (53.3%). This finding showed statistical significant difference ($P$ value = 0.001).

Furthermore, no statistical significant difference was also found between both samples in relation to the frequency of topical fluoride application ($P$ value = 0.104).

Moreover, 32.5% and 53.3% of the experimental and control groups, respectively, did not receive any prophylactic scaling and polishing measures. Twenty percent of the experimental group had scaling and prophylactic polishing twice yearly, while no one of the control group had for the same frequency. Among patients who do scaling and polishing once per year, 60% were from the experimental group. Therefore, there is slight statistical significant difference between both groups regarding the frequency of scaling and prophylactic polishing ($P$ value = 0.046).

4. Discussion

This study was conducted to evaluate the incidence of carious lesions along the lower fixed retainer wire placed after orthodontic treatment both clinically and radiographically. In the present study the patients with bondable lingual retainer were
influence of the orthodontist.

It was observed in this study that the experimental group had fewer teeth cavitations than control group, which suggests that inadequate oral hygiene is directly related to the undesirable tooth cavitations. This result is in agreement with the results of Axellson et al.23 where they reported that only 2 cases of enamel demineralization was found after 2 years of placing labial bonded retainers in the buccal segments. In contrast, Hirshfield22 reported incidence of white spots in his experimental group more than control group, in addition, Artun17 reported no apparent damage to the enamel after long-term usage of lingual fixed retainer in any of his sixty-three persons. Similarly, Gorelick et al.26 found no carious lesions on the lingual surfaces of the mandibular lower incisors and canines in any of his examined patients, while in the non bondable patients there were more carious lesions detected. Furthermore, Artun et al.19 observations confirmed that regardless of occasional accumulation of plaque and calculus along such retainers, carious formation was not a problem. As this could be potentially influenced by other factors like; enamel structure, compositions and flow of saliva, frequency of brushing and flossing, as well as, prophylactic measures which were highly encouraged by the orthodontists. These data supported our findings.

Additionally, Booth et al.21 followed up patients with bondable lingual retainers for 20 years or longer and he found no effect of bonded retainer on hard or soft tissue, even in those with poor oral hygiene. The same finding was reported by other investigators but with a shorter time duration such as Dhal et al.26 and Artun17 they were both reported no signs of dental caries or white lesions. On the other hand, Birdsall and Robinson24 published a case report of one of the patients who had worn lower Essix retainer and he developed significantly demineralization due to large consumption of carcinogenic drinks.

On the light of the previous results of the complete absence or the few caries incidence lesions reported by Gorelick et al.22 Artun17, Artun et al.18,19, Axellson et al.23 and Booth et al.21, the main factors could be; better daily home care, more regular recalls for prophylaxis for patients with retainers, as well as, patients attitude and motivation possibly acquired under the influence of the orthodontist.

Despite the frequent accumulation of calculus that had been noted over the lingual surfaces of the bondable retainer in our experimental group, only few carious lesions were detected which was in agreement with the other studies except for Hirschfield22 who reported contradicting results. Our finding was striking and elucidated by that it might be due to better oral hygiene, dental floss usage, or routine prophylaxis from the experimental group than the control. Moreover, to the free salivary flow this might be the major factor in avoiding decalcification of such teeth.

In addition, presence of tooth cavitations with bondable fixed retainer furthermore reviewed from the figures. This further investigation revealed that mandibular central and lateral incisors had equal incidence (37.5%), while canines showed lesser frequency (25%), but when related to the control group, the same was found for all the anterior teeth (33.3%).

Though, Nowadays, lingual bonded fixed retainers are the most commonly used method for long-term esthetic retention. Attention is still required to assess involvement of iatrogenic damage to hard and soft tissues during semi permanent and permanent retention. Orthodontists and other dentists bear the responsibility to insure that patients are educated regarding risks of caries and tooth demineralization that may be associated with bonded fixed retainers. Further long-term studies, as well as, larger sample are required before final evaluation can be made.

5. Conclusion

1. Despite, accumulation of plaque and calculus along the lingually fixed bondable retainer in our sample no apparent damage to the teeth was noticed.

2. Oral hygiene evaluation within our study showed that the experimental group had better oral hygiene maintenance than control indicating that good oral hygiene can be maintained regardless of the presence of bondable retainer.

3. The mandibular central and lateral incisors in the experimental group had equal caries frequency compared to each other, but with higher frequency when compared to canines.

4. In the control group caries frequency was the same for all the anterior teeth.

Conflict of interest

The authors have no conflict of interest to declare.

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