Impact of self-ligating orthodontic brackets on dental biofilm and periodontal pathogens in adolescents

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The aim of the present prospective study was to evaluate periodontal health and subgingival microbiological alterations in adolescents treated with fixed self ligating orthodontic brackets in comparison to subject without any orthodontic appliance. A total of 40 adolescents (23 females and 17 males; mean age: 13.2 ± 3.2 years) were included: 30 subjects with self ligating brackets (test group) and 10 patients without orthodontic appliances (control group). Follow-ups were as follows: T1 (1 month), T2 (3 months), T3 (6 months) from the beginning of the orthodontic therapy. Clinical parameters (plaque index, gingival index and clinical attachment level) were measured for every patient and a microbiological analysis was performed. Mann Whitney test was performed to evaluate clinical parameters between test and control group and Friedman test and Fisher test were adopted to evaluate intra group differences at different follow-ups. Student *T*-test was performed to compare clinical attachment level between the two groups. Significance level was set at $p<0.05$. No periodontal pathogens and no clinical attachment loss were found in the whole sample. A slightly higher plaque index and gingival inflammation were recorded in the test group in comparison to the controls.

Orthodontic brackets are often associated with gingival inflammation and higher dental plaque accumulation (1). Conventional brackets need elastomeric ligations or stainless-steel ligature wires while self ligating brackets utilize a permanently installed, moveable component to entrap the orthodontic archwire that may allow a lower dental biofilm accumulation (2). The Russel lock was a self ligating bracket introduced in 1935 and nowadays self ligating brackets are used worldwide because of several advantages: provide a full orthodontic wire engagement, lower time to remove and replace the archwires in comparison to conventional brackets, a rapid tooth movement because of the low friction forces and an easier dental hygiene because of the fewer retentive sites for microbial accumulation; however, there is insufficient high-quality evidence to support the use of self-ligating brackets over conventional appliances (3).

Active self ligating brackets have a metallic slide that create an active labial surface invading the orthodontic slot while passive brackets have an in-built metal face that did not invade the slot (4). The risk of gingival inflammation in orthodontic patients treated with fixed brackets is increased in subjects with high levels of bacterial plaque and poor oral hygiene and the presence of gingival inflammation over time may facilitate the onset of periodontal disease in adult age; therefore, an early diagnosis and timely treatment of gingival inflammation in orthodontic patients would avoid the onset of more severe periodontal issues over time

Key words: orthodontics, microbiology, dental plaque, gingival inflammation

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(5). Furthermore, orthodontist may decide to debond orthodontic brackets earlier in patients that show a poor oral hygiene. Patients that neglect oral hygiene during fixed orthodontic treatment are associated with a higher incidence of white and brown spots, dental caries and gingival inflammation. Orthodontic tooth movements did not cause bone resorption; however, patients with bad oral hygiene and severe gingival inflammation may show some bone defects (6).

Moreover, microbiological changes in subgingival dental biofilm may be found in orthodontic patients and a higher prevalence of: *Porphyromonas gingivalis, A. actinomycetemcomitans, Tannerella forsythia, Treponema denticola, Prevotella intermedia, Prevotella nigrescens, Campylobacter rectus, Peptostreptococcus micron, Fusobacterium nucleatum* are often observed during orthodontic therapy (7).

It was stated that fixed orthodontic treatment may cause a periodontal attachment loss because of the orthodontic forces; however, in orthodontic patients with good dental hygiene no periodontal attachment loss was observed (8).

It was found that metallic ligatures allow a lower dental plaque accumulation in comparison to elastic ligatures that exhibit significant volumetric and structural changes during the treatment (9). As regards self ligating system few studies have analysed dental biofilm accumulation and microbiological changes during the orthodontic treatment: Pandis et al. evaluated conventional brackets in comparison to self ligating system and did not found statistical differences in salivary streptococcus mutans levels in patients with conventional and self-ligating brackets (10). Pellegrini et al. observed a lower association of periodontal species and self ligating brackets in comparison to conventional elastic ligatures (11-20).

The aim of the present study was to evaluate periodontal health and subgingival microbiological alterations in adolescents treated with fixed self-ligating orthodontic brackets.

MATERIALS AND METHODS

In the present prospective study 40 patients (23 females and 17 males; mean age: 13.2 ± 3.2 years) were included. The test group included 30 orthodontic patients (17 females and 13 males) treated with self ligating passive brackets (Damon Q Ormco and buccal tubes on maxillary and mandibular molars) and the control group included 10 patients (6 females and 4 males) with normal occlusion, without any orthodontic appliance and without periodontal diseases or gingival inflammation at T0 (beginning of the study).

Inclusion criteria were as follows: age between 12 and 18 years old, absence of periodontal diseases or periodontal pockets ≥ 4 mm, teeth without dental caries or extensive fillings and patients that exhibited a good compliance during orthodontic therapy and visited the orthodontist regularly.

Exclusion criteria were as follows: drugs or antibiotics that may influence microbiological environment, chronic use of antinflammatory drugs and pre-medication within three months prior to study, systemic diseases that might have caused alterations of the periodontal status, mouthwash use, smoking.

Toothbrushing frequency was at least twice a day (Bass technique was adopted for every patient included in the study) with a duration of 2 minutes with a manual toothbrush. Furthermore, other cleaning tools were included: dental floss and proxy brushes to clean around brackets and wires at least once/day. Moreover, all the patients gave written informed consent to participate in the study. All procedures were conducted according to the principles expressed in the Declaration of Helsinki.

All patients showed similar diet habits and sugar intake at T0. Before orthodontic treatment, all patients underwent a session of oral hygiene aimed at obtaining a plaque index of zero. Pattern of scheduled follow up appointments was as follows: T1 (1 month), T2 (3 months), T3 (6 months). Daily oral hygiene methods and strategies specific to the orthodontic patient were adopted and oral hygiene evaluation was performed during follow-ups and a dental hygiene diary was used by each patient. Plaque index and gingival index were measured for every patient on every surface of two teeth: 11 and 25.

The periodontal status of each subject was examined by the same calibrated operator with a mouth mirror and UNC 15 periodontal probe. Clinical Attachment Level (CAL) was measured: the distance between the cementoenamel junction and the bottom of the pocket or sulcus. The calibrated UNC 15 probe was inserted parallel to the long axis of each tooth at four sites of a

tooth (mesiobuccal, buccal, disto-buccal, and mid-lingual). The deepest pocket was considered among all CAL measurements.

The clinical findings were rounded up to the nearest millimeter and each examination was performed with a 1-week interval in order to evaluate the intra-examiner error (Kappa statistics: 0.78).

Microbiological samples were collected on two teeth (11 and 25) and put in a sterile tube with dimethyl sulfoxide (DMSO) that is an organosulfur compound that dissolves both polar and nonpolar compounds and is miscible in a wide range of organic solvents as well as water.

Bacteria can survive for a short period of time at 4°C; therefore, samples were stored in a refrigerator (-30 degrees celsius) and precaution has been taken to avoid contamination.

Polymerase chain reaction (PCR) technique was applied to detect and identify oral microorganisms: *Aggregatibacter actinomycetemcomitans (Aa 652, Aa JP2), Porphyromonas gingivalis (Pg), Prevotella intermedia (Pi), Tannerella forsythensis (Tf).*

Statistical analysis

The data were processed using the program SPSS 15.0 (Windows). Mann Whitney test was performed to evaluate clinical parameters between test and control group. Morever, Friedman test and Fisher test were adopted to evaluate intra group differences at different follow-ups. Student T test was performed to compare clinical attachment level between the two groups. Significance level was set at: $p<0.05$.

RESULTS

Microbiological analysis showed absence of: *Aa 652 e Aa JP2, Tannerella forsythensis, Prevotella intermedia, Porphyromonas gingivalis* in all the samples. In the test group, plaque index (tooth 11) was significantly higher at T2 ($p<0.05$). From T2 to T3 a significant decrease ($p< 0.05$) was recorded (Fig. 1).

A significant difference was observed between test and control group at T2 ($p <0.05$) (Fig. 2).

In the test group, plaque index (tooth 25) was

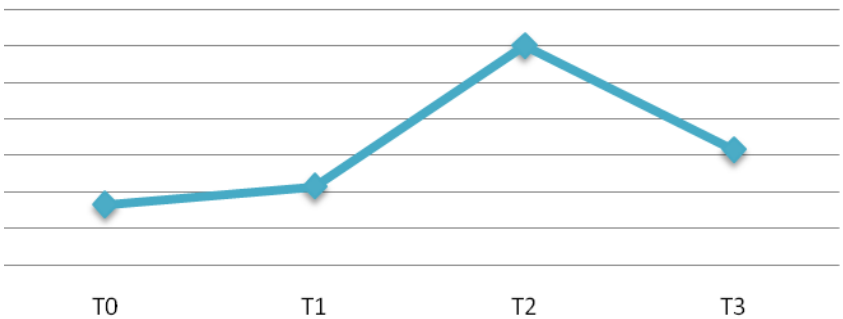

Fig. 1. *PI (tooth 11) in the test group: T0 (0.3), T1 (0.4), T2 (1.2), T3 (0.6). Friedman and Fisher test: p< 0.05.*

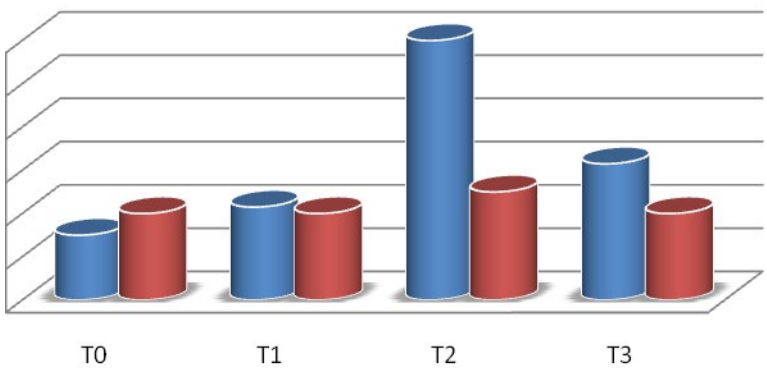

Fig. 2. *Plaque index (tooth 11) inter group comparison (test group: left column and control group: right column). Test group: T0: 0.2; T1: 0.3; T2: 1.2; T3: 0.55. Control group: T0: 0.3; T1: 0.25; T2: 0.4; T3: 0.3. Mann Whitney test and Fisher test: p< 0.05.*

significantly higher at T2 ($p<0.05$). Moreover, a significant decrease ($p< 0.05$) was recorded at T3 (Fig. 3). The test group showed a higher value ($p< 0.05$) in comparison to the control group both at T2 and T3 (Fig. 4).

Gingival index (tooth 25) was significantly higher at T2 ($p< 0.05$) in the test group. No significant difference was observed comparing the two groups ($p> 0.05$) (Fig. 5).

We did not find any periodontal pocket ≥ 4 mm in the test group. Moreover, also in the control group no pathological periodontal pockets were recorded. Therefore, CAL did not show any significant difference ($p> 0.05$).

DISCUSSION

Fixed orthodontic treatment is often associated with dental caries, enamel demineralisation and gingival inflammation (21). Adolescents usually did not have a good oral hygiene and they are recognized as having possible distinctive needs due to a potentially high caries and periodontal disease rate, a tendency for poor nutritional habits (soft drinks and high sugar intake), dental phobia, cigarette smoke and social and psychological aspects (22).

Gingivitis with swollen gums and gingival bleeding is generally associated with fixed orthodontic treatment in a high percentage of patients because brackets, bands and tubes increase dental biofilm accumulation, and it is difficult to maintain oral hygiene at home.

However, after brackets debonding gingival status usually improves because gingivitis is the early, reversible phase of periodontal disease. Diet, daily maintenance and regular professional care are the main factors that prevent gingival inflammation (23-35).

In the present study it was observed a slightly higher gingival inflammation and dental plaque accumulation in patients with orthodontic brackets

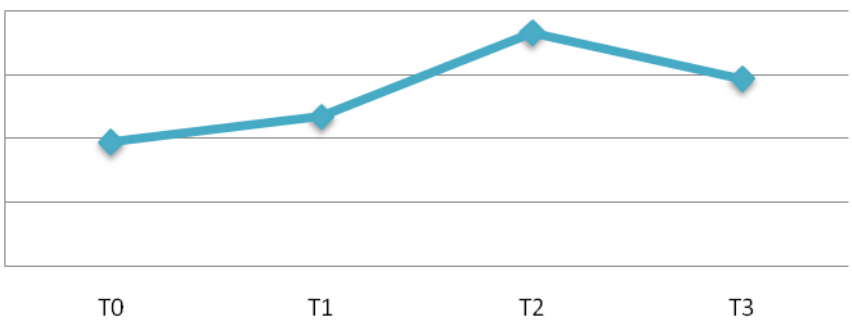

Fig. 3. *Plaque index (tooth 25) in the test group (T0: 1; T1: 1.2; T2: 1.8; T3: 1.5). Friedman and Fisher test: p< 0.05.*

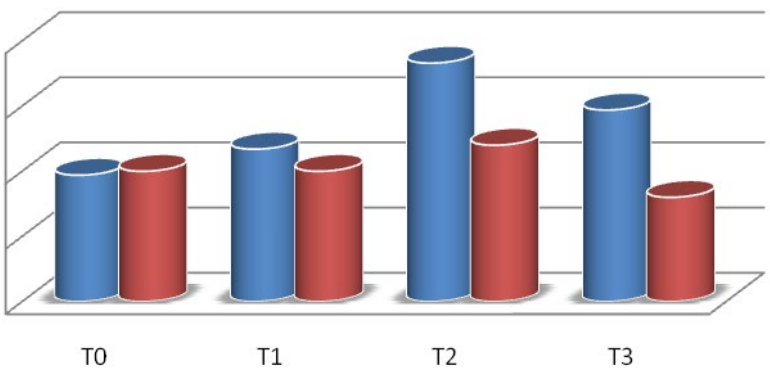

Fig. 4. *Plaque index (tooth 25) in the two groups (test group: left column and control group: right column).Test group: T0: 0.8; T1: 1; T2: 1.7; T3: 1.3. Control group: T0: 0.8; T1: 0.8; T2: 1; T3: 0.7. Mann Whitney and Fisher test, p< 0.05.*

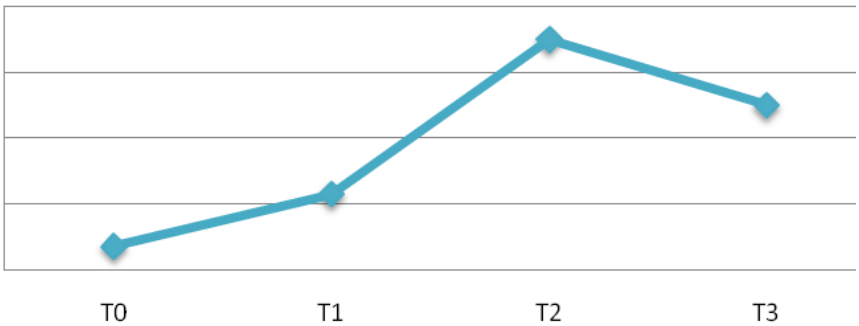

Fig. 5. *Gingival index (tooth 25) in the test group (T0: 0.1; T1: 0.2; T2: 0.7; T3: 0.5). Friedman and Fisher test: p< 0.05*

in comparison to subjects without any orthodontic appliance. However, after 6 months (T3) gingival status was better in the test group in comparison to T2 (3 months), probably because dental hygienist reinforced oral hygiene habits.

The upper central incisor showed a lower gingival inflammation in comparison to maxillary premolar probably because it is easier to brush than the upper second bicuspid.

Furthermore, in this study we did not find any pathological periodontal pocket; in literature it was observed a slight clinical attachment loss in some orthodontic patients. However, it should be stated that in the present study we did not used molar bands that are often associated with gingival inflammation. Moreover, self ligating brackets may have promoted a decrease dental biofilm accumulation. A limit of the present study is the absence of a group of patients treated with conventional elastic or metallic ligatures, therefore we cannot state if the self ligating system promote oral health in clinical practice. Finally, in our study we did not find any periodontal pathogens after the microbiological analysis and we should consider that we only included adolescents in the study, while adults usually exhibit a higher prevalence of periodontal pathogens (36-44).

The absence of periodontal pathogens was associated with the clinical absence of periodontal pockets higher than 4 mm. Therefore, we can conclude that fixed orthodontic treatment in the first 6 months of therapy did not cause attachment loss or bone resorption.

The results of the present study showed that only a slightly higher dental plaque accumulation and gingival inflammation is associated with fixed orthodontic treatment with self ligating brackets in comparison to subjects without any orthodontic appliance (45-55). No periodontal attachment loss was observed in the sample and no microbiological changes were observed during the first 6 months of orthodontic treatment (absence of periodontal pathogens). Upper central incisor exhibited a lower dental biofilm accumulation and gingival inflammation in comparison to maxillary second bicuspid (56-60).

After 3 months we observed a higher dental plaque accumulation and gingival inflammation in compariso to T0; however, after 6 months both plaque index and gingival index decreased.

Further studies will be necessary to compare self ligating brackets with conventional orthodontic brackets with elastic or metallic ligatures (60-66).

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