Does Orthodontic Treatment with Self-Ligating or Conventional Brackets Have Different Effects on Periodontal Health?

Kendinden Bağlanabilen ya da Konvansiyonel Braketlerle Ortodontik Tedavinin Periodontal Sağlık Üzerindeki Etkileri Farklı mıdır?

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ABSTRACT Objective: Maintaining adequate oral hygiene is a challenge for orthodontic patients. The aim of the present study was to compare the effect of self-ligating and conventional brackets on plaque accumulation and clinical periodontal parameters. **Material and Methods:** The study involved 30 patients randomly allocated to two groups: 15 individuals were treated with conventional brackets while 15 subjects were treated with self-ligating brackets in both arches. Clinical periodontal parameters involving probing depth, plaque index and bleeding on probing were recorded at baseline (3rd month of the orthodontic treatment) and at final (5th month of the orthodontic treatment). Additionally, percentage of plaque coverage on maxillary and mandibular incisors was determined objectively using a digital plaque imaging method at baseline and final recording visits. The normality of data was analysed by the Shapiro–Wilk test and statistical analysis was performed using parametric techniques. The fisher exact test was used to analyse the statistical difference in age and gender between the two groups. Comparisons of the clinical periodontal parameters between two study groups and in the same group from baseline to final recordings, were performed using the repeated measures ANOVA test using SPSS. **Results:** Plaque index and percentage of plaque coverage were decreased in both groups in final when compared to baseline (p<0.05). No statistical difference was detected between two bracket types in all periodontal parameters (p>0.05). **Conclusion:** No significant change was found with regard to the periodontal response to orthodontic treatment for the variables assessed between subjects receiving passive self-ligating and conventional brackets.

Key Words: Orthodontic brackets; dental plaque; periodontal index

ÖZET Amaç: Ortodontik tedavi gören hastalarda yeterli oral hijyenin sağlanması güçtür. Bu çalışmanın amacı kendinden bağlanabilen braketlerin ve konvansiyonel braketlerin plak birikimi ve klinik periodontal parametreler üzerine etkilerinin değerlendirilmesidir. **Gereç ve Yöntemler:** Çalışma 2 gruba randomize olarak ayrılan 30 hastadan oluştu: 15 birey alt ve üst arklarda konvansiyonel braketlerle tedavi edilirken, 15 hastanın tedavisi kendinden bağlanabilen braketlerle yürütüldü. Klinik ölçümler, sondalama derinliği, plak indeksi ve sondalamada kanamayı içeren başlangıç (ortodontik tedavinin 3. ayı) ve bitiş (ortodontik tedavinin 5. ayı) periodontal parametrelerden oluştu. Bu ölçümlere ek olarak, başlangıç ve bitiş ölçüm randevularında, maksiller ve mandibuler keserlerdeki dijital plak görüntüleme metodu ile saptandı. Verilerin normal dağılımı Shapiro-Wilk testi ile analiz edildi ve istatistiksel analizler parametrik testlerle yürütüldü. İki çalışma grubu arasında yaş ve cinsiyetteki istatistiksel farkın analizi ise fisher exact testi kullanılarak yapıldı. Gruplar arası ve başlangıç ve bitiş grup içi klinik periodontal parametrelerin ve plak birikiminin karşılaştırılması tekrarlı ölçümler için ANOVA testi kullanılarak yapıldı. **Bulgular:** Başlangıç ölçümlerine kıyasla, bitiş değerlendirmesinde plak indeksi ve plak yüzdesi her iki grupta da önemli derecede daha düşüktü (p<0.05). Değerlendirilen tüm periodontal parametrelerde, iki braket grubu arasında istatistiksel olarak önemli bir farka rastlanmadı (p>0.05). **Sonuç:** Kendinden bağlanabilen ve konvansiyonel braketlerle ortodontik tedaviye verilen periodontal cevapta gruplar arasında bir fark bulunmadı.

Anahtar Kelimeler: Ortodontik braketler; diş plağı; periodontal indeks

Dental plaque is the primary etiological factor in the development, progression and recurrence of periodontal diseases.[1] Numerous clinical studies have demonstrated that patients undergoing orthodontic treatment are more susceptible to periodontal disease and white spots.[2-4] During orthodontic treatment, plaque control is the major consensus to prevent the occurrence of gingival inflammation and cavities.

Orthodontic appliances create retention areas for plaques and have a negative effect on natural cleansing via making the mechanical cleaning of the teeth and gingiva by the tongue and lips more difficult and by increasing the viscosity of the saliva.[5,6] Maintaining oral hygiene becomes more complex due to the difficulty provided by the appliances for the patient.[7] The use of orthodontic appliances was also shown to modify the oral microbiota.[8,9] Periodontal inflammation, hyperemia, hyperplasia, and demineralization of the teeth have been found as a result of failure to ensure adequate oral hygiene during orthodontic treatment.[10,11]

Determining the bracket system that causes a minimal contribution to the plaque accumulation has gained importance recently. Comparing metallic and elastic ligatures, elastic ligatures were shown to accumulate 38% more microorganisms in the form of plaque when compared to metallic ligatures.[12] It was also shown that the number of the teeth exhibited bleeding on probing was substantially higher with the use of elastic ligatures when compared to ligature wires.[13]

Self-ligating brackets (SLBs) have been a major focus of attention in orthodontics in recent years and were expected to have better values for periodontal status because of the lack of ligature materials and having fewer retentive sites compared to other bracket ligation methods.[14] Pellegrini et al. reported that SLBs might promote reduced retention of bacteria than appliances with elastomeric ligation.[14] On the other hand, Pandis et al. comparing the effects of bracket type on the periodontal condition of the mandibular anterior teeth of orthodontic patients in a prospective study, con-

cluded that SLBs do not have an advantage over conventional brackets (CBs).[15]

There is controversy in the literature regarding whether SLBs cause accumulation of more or less bacterial plaque than CBs. Comparisons of the two systems have produced varying results, possibly because of different study designs and bracket designs within each system. Therefore, this prospective study compares gingival responses induced by SLBs and CBs in terms of bacterial plaque accumulation and periodontal parameters.

MATERIAL AND METHODS

A total of 30 patients were included in this study. Patients were recruited from the Department of Orthodontics, School of Dentistry, Ege University in a period between May 2014 and November 2015. The purpose and procedures were explained to all subjects prior to participation, and all participants/parents gave written informed consent in accordance with Helsinki declaration. The study protocol was approved by Ethics Committee of Ege University School of Medicine. Medical and dental histories were taken from all subjects. None of the patients had a history of orthodontic treatment, systemic disease that could impair immune response, and none had received antibiotics or other medicines that could affect their periodontal status or periodontal treatment within the past 3 months. All patients underwent radiographic examination on entering into the study. They had varying degrees of gingival inflammation, but no CAL > 2 mm, no sites with alveolar bone loss present in radiography (i.e., distance between the cemento-enamel junction and bone crest at > 95% of the proximal tooth sites <3 mm). Individuals with the following criteria were included in the study: (a) 2-4 mm of overjet and overbite (b) Angle Class I discrepancy (c) maxillary and mandibular anterior crowding ≤5 mm (e) completion of permanent dentition except third molars. Patients were excluded if (a) anterior teeth had restorations (b) they had any systemic diseases or required periodic medication (c) history of use of drugs that induce gingivitis (d) missing or impacted teeth (e) they were using tobacco products (f) they had open-bite.

After initial examination, the patients were referred to the Department of Periodontology, School of Dentistry, Ege University where they were received periodontal treatment including professional cleaning and oral hygiene instructions before the initiation of orthodontic treatment. All patients were advised to brush their teeth twice daily and received standard oral hygiene kid containing toothpaste (Ipana pro-expert toothpaste), toothbrush (Oral-B orthodontic toothbrush) and interdental toothbrush (Oral-B interdental toothbrush). All the subjects were right-handed. Additional use of any other oral-care products including oral mouth-rinse was prohibited.

Patients were randomly allocated to two groups using RandList 1.2 (DatInf GmbH, Tubingen, Germany). The random number generator is based on the algorithm of Park and Miller with Bays-Durham correction at a 1:1 ratio. The patients in the test group were designated to be treated with preangulated and pretorqued edgewise brackets having self-ligation (SL group; Empower, American Orthodontics, Sheboygan, WI) while preangulated and pretorqued edgewise brackets with conventional elastomeric ligation (CL group; Master Series, American Orthodontics, Sheboygan, WI) were applied to patients in the control group. Allocation concealment was achieved by sealed envelopes. Sequentially numbered thirty-two envelopes were prepared containing the number that indicated the treatment group to which the patient would be allocated. Bonding was carried out by 2 orthodontist (I.A. and A.A.). Transbond Plus Color Change (3M, Monrovia, CA, USA) adhesive was used to be able to accomplish a better determination of any excess resin. The archwire sequence until the baseline measurements for the two groups was 0.014-in nickel-titanium and 0.016-in nickel-titanium archwires so that crowding and rotations were eliminated. The follow-up visits with new archwire engagements were arranged every 6 weeks.

After unravelling of the crowding and correction of rotations with the aforementioned archwire sequence corresponding to 3 months subsequent to bonding, 0.016x0.022-in nickel-titanium archwires were placed in upper and lower jaws. At this point, patients were recalled to the periodontology department for baseline recordings of the periodontal clinical parameters. All patients were provided with new standardized oral hygiene kid also at this visit. Final recordings of the periodontal clinical parameters were performed 2 months after the initial recordings. Before both recordings the archwires were removed.

PERIODONTAL PARAMETERS

The whole mouth clinical periodontal parameters were assessed at six sites around each tooth (mesio-buccal, mid-buccal, disto-buccal, mesio-lingual, mid-lingual and disto-lingual locations) and performed by a calibrated examiner (S.B.). The intraexaminer reliability was high as revealed by an intraclass correlation coefficient of 0.90 for probing depth (PD) measurements. The whole mouth clinical periodontal parameters included; PD, which was performed using manual Williams probe, bleeding on probing (BOP) and plaque index (PI) were recorded at baseline and final.

Additionally, percentage of plaque coverage (PC) on maxillary and mandibular incisors was also determined objectively using a digital plaque imaging method at baseline and final recording visits. Patients disclosed their plaque with fluorescein solution by rinsing for 10 seconds with 25 mL of phosphate buffer, then rinsing for 1 minute with 5.0 mL of 1240 ppm fluorescein in phosphate buffer, and then rinsing 3 times for 10 seconds with 25 mL of phosphate buffer that contains the sodium salts of fluorescein as colouring. The room was darkened to prevent reflection and better delineation of the fluorescence variation. Cheek retractors were placed and images were captured with the incisal teeth in tet-a-tet position. Two light-emitting diode units (Light Emitting Diode-Elipar Freelight, 3M ESPE, Germany) were used as the light source from a distance of 10 cm. For each patient maxillary and mandibular central incisors were centred and captured with the camera from a distance of 30 cm with the patients Frankfurt horizontal plane parallel to the floor (Figure 1 and 2). Photoshop CS 6 software (Adobe, CA, USA) soft-
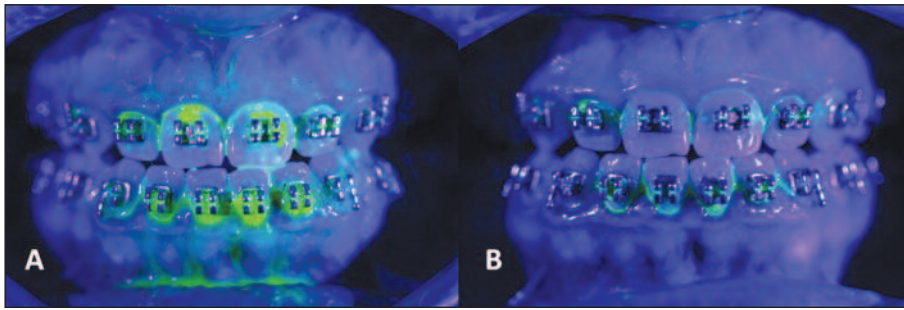
FIGURE 1: Disclosure of plaque with fluorescein solution in conventional ligation group at baseline **(A)** and final assessments **(B)**.
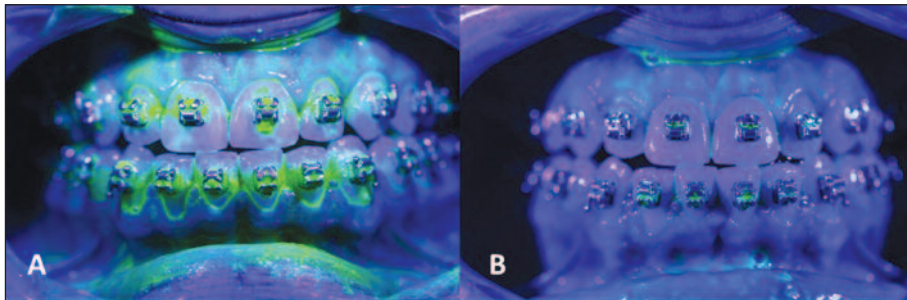

FIGURE 2: Disclosure of plaque with fluorescein solution in self-ligation group at baseline **(A)** and final assessments **(B)**.

ware was used in the determination of the percentages of PC. For the selection of plaque glowing yellow-green due to fluorescein "color range" and "magnetic lasso" tools were used. These measurements were done by a single researcher (I.A.). The intraexaminer reliability was high with an intraclass correlation coefficient of 0.91 for the preceding method.

STATISTICAL ANALYSIS

The power calculation analysis revealed that the required sample size was minimum 15 subjects for each study group. Sample size of the present study was calculated to detect a 0.5 difference in PI and PBI scores at the 0.05 probability level with a power of 80%. The normality of data was analysed by The Shapiro–Wilk test and statistical analysis was performed using parametric techniques. The patient was used as the unit of the observation. The fisher exact test was used to analyse the statistical difference in age and gender between the two study groups. Comparisons of the clinical periodontal parameters between two study groups and in the same group from baseline to final recordings, were performed using the repeated measures ANOVA test using SPSS.

RESULTS

Table 1 shows the distribution of demographic variables into the two groups. There was no statistical difference between the two study groups with regard to gender (P>0.05) and age (P>0.05).

The clinical periodontal parameters are presented in Table 2. There was no statistical difference in PD between the baseline and final measurements in both groups (P>0.05). Also no statistical difference was detected in PD between the two study groups (P>0.05). In both SL and CL study groups, baseline PI was significantly higher when compared to final PI (P<0.05). There is no statistical difference detected in PI between two groups neither at baseline nor at final (P>0.05). BOP val-

TABLE 1: Demographic variables of the study groups.		
	Self-Ligating Bracket Group	Conventional Bracket Group
Gender	9 Female/6 Male	8 Female/7 Male
Age (year)		
(mean ± SD)	14.93±1.62	15.07±1.10
(range)	(12-17)	(12-17)

TABLE 2: Clinical periodontal parameters of the study groups.

	Self-Ligating Bracket Group		Conventional Bracket Group	
	Baseline	Final	Baseline	Final
PD	2.20±0,17	2.23±0.18	2.22±0.23	2.21±0.22
PI	2.94±0.41	2.02±0.42*	3.00±0.74	2.11±0.5*
BOP	34.74±14.59	28.73±12.45	30.95±13.96	25.99±13.37
PC (maxilla)	33.66±12.64	17±4.41*	33.67±11.42	17±3.34*
PC (mandibula)	28.35±13.74	16.14±3.22*	28.61±14.72	16.67±3.48*

*: Significantly different from the baseline in the same group (P<0.05).
PD: Probing depth; PI: Plaque index; BOP: Bleeding on probing; PC: Plaque coverage.

ues were did not show a statistical difference between baseline and final recordings in both study groups (P>0.05). Also no significant difference was detected between two study groups at baseline and final (P>0.05).

PC on maxillary incisors was decreased in final recordings when compared to baseline recordings in both groups (P<0.05). No statistical difference was detected in the percentage of PC on maxillary incisors between the two study groups at baseline and final recordings (P>0.05). PC on mandibular incisors was also decreased in final recordings when compared to baseline recordings in both groups (P<0.05). No statistical difference was detected in the percentage of PC on mandibular incisors between the two study groups at baseline and final recordings (P>0.05).

DISCUSSION

This randomized, prospective, parallel design study compared SLBs with CBs in order to determine which system caused more plaque accumulation and tissue response. Final PI and PC on both maxillary and mandibular incisors were decreased when compared to baseline values regardless of the bracket type. SLBs showed no additional advantage over CBs in the periodontal parameters analysed in this study.

In orthodontic patients, generally maintaining oral hygiene becomes more complex for the difficulty provided by the appliances.[7] Patients with orthodontic bands and brackets may show greater accumulation of dental plaque, requiring enhanced

programs of personal oral hygiene and regular professional prophylaxis. Mateu et al. reported that initially patients visited the clinic with indices compatible with gingival periodontal disease, but after receiving instruction on how to perform proper oral hygiene and undergoing plaque control before beginning their orthodontic treatment, they achieved indices compatible with periodontal health, as is needed in order to bond the brackets.[16] In order to promote and maintain satisfactory oral health, orthodontic patients should undergo a stringent program of oral hygiene and dental plaque control before and during orthodontic treatment.[16] In the light of the current literature, patients received periodontal treatment including professional cleaning and oral hygiene instructions before the initiation of the orthodontic treatment in the present study. Three months after the initiation of orthodontic treatment, oral hygiene instructions were given again and baseline periodontal parameters were recorded. The recordings of the baseline periodontal parameters was performed 3 months after bonding of the teeth in order to overcome the effects of bonding on the periodontal parameters recorded in the present study. Additionally, the cut-off point of three months was selected so that the crowding and rotations were corrected to be able to eliminate the confounding factor of crowding which could impede on the sufficiency of oral hygiene procedures carried out by the subjects.[17] Final PI and PC were decreased when compared to baseline PI and PC in both study groups of the present study. This reduction in plaque accumulation is possibly related to the stringent oral hygiene program applied before and during the orthodontic treatment. On the other hand, it is widely accepted that in severe crowding cases the hygiene supplement may not be enough;[18] thus patients with moderate crowding were selected so that the effect of crowding were eliminated.

The periodontal indices have been used for individual patient needs, in assessing the hygiene compliance in specific dental arch sites and also in research with the objective of characterizing the periodontal status of a population and the effec-

tiveness of treatment protocols. Their use in research may be viewed a violation because index scores, which are basically ordinal data, are treated as interval or scale, and a mean and a standard deviation from multiple measurements are extrapolated. Apart from the inappropriateness of this notion, the results obtained have no physical meaning: for example, a PI index of 2 does not mean that the area of tooth covered by plaque is 200% of that with an index of 1.[15] To overcome this problem beside the PI values the percentage of PC was also detected by digital plaque image analysis in the present study.

SLBs were suggested to introduce the possibility of performing better hygiene, as they do not require wire ligatures, recognized as the focus of plaque formation.[14,19] Elastic ligatures were reported to accumulate 38% more micro-organisms in the form of plaque when compared to metallic ligatures, thereby contraindicating the use of elastic ligatures in individuals with bad hygiene habits.[12] Bleeding on probing was also found to be higher with the use of elastic ligatures when compared to ligature wires.[13] Additionally, method of ligation becomes an important clinical issue when sliding mechanics are to be used in terms of space closure rates and posterior anchorage loss due to the friction generated.[20,21] Conventional elastomeric ligatures bring about higher levels of friction compared to steel ligatures.[22-25] However since our groups included a treatment protocol comprising crowding with non-extraction treatment and no sliding mechanics were to be used, despite the aforementioned disadvantages of elastomeric ligatures, elastic ligatures were chosen in the present study because of the fact that they are the common method for archwire ligation.[14]

Pejda et al. compared the periodontal clinical parameters and composition of subgingival plaque among patients with different types of brackets.[26] Even though a significant prevalence of A. actinomycetemcomitans was detected with CBs, no statistical difference in percentage of tooth surfaces with plaque among SLBs and CBs was noted with no causal relationships among AA and periodontal

parameters. From the mechanotherapeutic aspect, this finding was linked with surface roughness of stainless steel ligatures. In their study comparing microbial flora periodontal conditions, Uzuner et al. came up with a significant difference pertaining to only the PD values.[18] They associated this disparity to bracket design of SLB used in their study group which was larger in size and closer to the gingival margin. In the current study, the brackets were chosen from the same company with nearly identical bracket dimension, eliminating the confounding factors as much as possible. Hence when the big picture is considered, the non-significant differences detected in the present study are in accordance with the findings of Pejda et al. and Uzuner et al.[18,26]

On the other hand, in a study by Nalçacı et al. SL group had lower PI, gingival index and bleeding on probing values when compared to CB group.[19] It was stated that bracket type had an effect on periodontal status and also on halitosis. This could be due to the difference of bracket dimension used in that study, namely, Damon Q having a mesiodistal width of 3 mm whereas Mini-Taurus brackets possessed a width of 3.8 mm. Additionally, while Damon Q brackets have no inherent hooks, Mini-Taurus brackets have built-in hooks depending on the clinician's choice, which readily contributes to plaque accumulation. However no information was present pertaining to this issue in the aforementioned article. Hence these factors could have confounded the results in favour of SLB. Pellegrini et al. reported that plaque accumulation was higher in CBs ligated with elastomeric ligature than on SLBs.[14] In that study also, SLB were slightly larger compared to the CB. To the contrary no difference was found in PI, PC and BOP values between SLBs and CBs in the present study. All these conflicting results can be attributed to the differences in the study models, material and methods, bracket system, bracket size, oral hygiene habits of the study population and oral hygiene protocol of the study.

SLB brackets discard ligature usage which is considered to lessen plaque accommodation. However their opening and closing mechanism possibly

acting as plaque retentions sites may eliminate their preceding advantage. On the other hand, microbial dental plaque is a multifactorial phenomenon, and bracket type is only one aspect of the issue. It should be born in mind that, patient cooperation, motivation for oral hygiene, and dietary habits of the patients change in the course of the orthodontic treatment which are among the contributory factors.[27] Thus, the results of the current study suggest that all these pros and cons among different bracket designs and ligation methods can be settled with proper oral hygiene instructions provided regularly.

CONCLUSION

Within the limitations of this study, it can be concluded that SLBs have no advantage over CBs in plaque accumulation and periodontal tissue response when investigated in terms of periodontal health (probing depth, plaque index, bleeding on probing) and plaque accumulation (digital plaque image analysis). Hence, periodontal concerns should not be a factor in deciding which bracket system to use. Oral hygiene procedures provided regularly seems to have the utmost importance in improving oral health.

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