Original Article

Occlusal Contact Changes with Removable and Bonded Retainers in a 1-Year Retention Period

Zafer Sari[a]; Tancan Uysal[b]; Faruk Ayhan Başçiftçi[a]; Ozgur Inan[c]

ABSTRACT

Objective: To test the hypothesis that there is no difference in the number of occlusal contacts in centric occlusion in patients treated with bonded and removable retention procedures and a control group during a 1-year retention period.

Materials and Methods: Twenty-five patients received a removable Hawley retainer, and 25 patients received maxillary and mandibular bonded retainers. The retainer patients were compared with 20 control subjects with normal occlusions. Silicone-based impression bites were used to record occlusal contacts. Paired-sample *t*-test, analysis of variance (ANOVA), and Tukey tests were used to evaluate intragroup and intergroup differences.

Results: An increased number of occlusal contacts were recorded in total-arch and posterior combined (actual/near) teeth during the retention period as compared with the control group. In the Hawley group, actual and total contacts on the first and second molar and actual contacts on the premolar and canine showed statistically significant increases. In the bonded retainer group, near and total contacts on the first and second molars and premolars showed statistically significant increases. Slight occlusal changes were seen in the control sample during the observation period, presumably from growth and development. ANOVA comparisons of total contacts of anterior and posterior teeth indicated statistically significant differences in the three groups on posterior segments.

Conclusions: The hypothesis is rejected. Both retention procedures allowed relative vertical movement of the posterior teeth, but the number of contacts on the posterior segment was increased more in the bonded retainer group than in the Hawley and control groups at the end of retention. (*Angle Orthod.* 2009;79:867–872.)

KEY WORDS: Occlusal contacts; Retention; Bonded retainers; Hawley

INTRODUCTION

One of the important challenges in orthodontics is to maintain the occlusal stability achieved at the end of active treatment.[1] Retainers are customarily used after the completion of the active phase of orthodontic treatment to maintain the arch dimensions and alignment of the teeth while allowing for posttreatment settling.

Relative movements in the vertical direction of the posterior teeth after orthodontic repositioning are termed settling.[2] One study looked at settling of the occlusion, during the retention stage which could be considered a ''beneficial'' type of relapse.[3] These are changes in the occlusion that increase the number of interarch occlusal contacts. The best retention device would be one that allows settling, but prevents relapse.[2]

In a study by Gottlieb et al[4] in 1996, 81% of surveyed orthodontists reported that they use bonded lingual retainers; 37% used them routinely and 44% used them occasionally. The bonded orthodontic retainer gives the clinician the means of providing the patient with an efficient, esthetic retainer that can be maintained long-term.[5] Fixed mandibular lingual retainers have been recommended for patients with a deep

[a] Associate Professor, Department of Orthodontics, Selcuk University, Konya, Turkey.

[b] Associate Professor and Department Chair, Department of Orthodontics, Faculty of Dentistry, Erciyes University, Kayseri Turkey.

[c] Professor, Department of Prosthodontics, Selcuk University, Konya, Turkey.

Corresponding author: Dr Tancan Uysal, Department of Orthodontics, Erciyes University, Kayseri 38039, Turkey (e-mail: tancanuysal@yahoo.com)

Accepted: November 2008. Submitted: October 2008.

overbite or severe pretreatment mandibular incisor crowding or rotation; they are also recommended for patients after advancement of the mandibular incisors during active treatment, after nonextraction treatment for crowding, and for patients with a planned alteration in the mandibular intercanine width.[6]

Maximizing tooth contacts in centric occlusion minimizes the stresses on the teeth and periodontal tissues since ideally located centric contacts cause vertically directed forces parallel to the long axes of the teeth.[7] For that reason, occlusal therapy can be an important adjunct in the treatment of periodontal disease.[8,9] Thus, more ideal occlusal contacts are important factors for the maintenance of healthy periodontal status.

Lingual or palatal fixed retainers are generally bonded to anterior teeth and generally cover no occlusal surfaces of the posterior teeth. Because of these differences in retainer design, characteristic changes in tooth position with the use of fixed retainers can be expected in the retention phase.

Few studies have evaluated changes in tooth contacts after orthodontic treatment with various retention devices. Most compared conventional removable retainers with a tooth positioner or clear overlay retainers.[2,3,8–12] Sauget et al[3] compared Hawley and clear overlay orthodontic retainers and reported different retentive capacities in the two retainers. They indicated that there is a need for future investigations to include comparisons of changes in occlusal contacts with other types of removable as well as fixed retainers as well as long-term follow ups on changes occurring over an extended retention period. In a recent study, Başçiftçi et al[2] documented the efficiency of lower fixed retainers combined with upper retention plates and compared them with Hawley retainers. Unfortunately, the effectiveness of bonded maxillary and mandibular retainers after the active-phase of orthodontic treatment was not adequately documented. Therefore, the aim of this follow-up retrospective study was to evaluate the number of contacts in centric occlusion during a 1-year retention period with the bonded and removable retention procedures and to compare them with a control sample.

MATERIALS AND METHODS

At the completion of full orthodontic treatment, 50 patients from the postgraduate orthodontic clinics at the Selcuk and Erciyes University Faculty of Dentistry and 20 individuals who had normal occlusions and did not receive orthodontic treatment were included in the study.

The patient selection and rejection criteria were[12]:

—All patients were treated with fixed banded and/or bonded edgewise appliances with or without auxiliary appliances;
—Patients must have been treated to the optimum occlusion with the treatment objectives satisfied, usually involving overcorrection. Patients in which treatment was discontinued before completion because of poor patient compliance were not included;
—Patients requiring prosthetic treatment of missing teeth were not included;
—Availability of patient for follow-up recordings after at least 12 months was important.

A control group was formed from graduate students of the Dentistry Faculty who had normal occlusion with all teeth present except third molars, no history of orthodontic and prosthodontic treatment, and no symptoms related to temporomandibular joint disorder. Criteria for enrollment in this study were informed consent and willingness to participate before occlusal records were taken. The mean age was 16 years (±3 years, 3 months).

Twenty-five patients (9 male and 16 female) received maxillary and mandibular Hawley retainers, and 25 (6 male and 19 female) received maxillary and mandibular bonded lingual retainers. All patients had been in orthodontic treatment for at least 14 months.

In the maxillary and mandibular Hawley retainer group (group 1), 13 had Class I; nine had Class II, division 1; and three had Class III malocclusion before treatment. This sample contained eight patients who had four first premolar extractions, 16 patients who were treated without extractions, and one patient who had congenitally missing maxillary lateral incisors. The mean age was 15 years, 1 month (±2 years, 3 months).

In the maxillary and mandibular bonded retainer group (group 2), 14 had Class I; eight had Class II, division 1; and three had Class III malocclusion pretreatment. The mean age was 17 years, 2 months (±3 years, 8 months). This sample comprised five patients who had four first premolars, two patients who had two upper first premolars, one patient who had one central incisor extraction, one patient who had congenitally missing maxillary lateral incisors, and 16 patients who were treated without extraction protocols. In the nonextraction patients, all bonded retainers were constructed from canine to canine teeth. Bonded retainers were placed premolar to premolar in the extraction patients. When placing maxillary bonded retainers, care was taken to ensure the retainer was free from occlusal trauma to reduce the likelihood of failure.

Patients receiving removable retainers were all instructed to wear their appliances full time, except during meals for 6 months; and only nights for the next 6 months.

Occlusal records were gathered from all patients and the control sample at two points in time. In group 1, the first set of records was gathered within 2 hours after removal of orthodontic appliances (T1); the second set was obtained during the retention period approximately 14 months (±1.5 months) later (T2). In group 2, the first set of records was taken similar to group 1, and the second set was obtained during the retention period approximately 15 months (±2.5 months) later (T2). In the control group, the second set of occlusal records was obtained approximately 12 months (±1.5 months) later (T2).

Occlusal records were taken with a method similar to that described by Razdolsky et al.[8] The records included alginate impressions for producing study models to evaluate the occlusal contacts. After the removal of fixed appliances, occlusal records were taken with Zetaplus (Zhermack, Badia Polesine, Italy), a soft silicone-based impression material. With the patients seated in an upright position at the dental chair, impression material was injected onto the occlusal surfaces of all mandibular teeth, and the patients were then asked to bite the material firmly with their back teeth for approximately 1 minute. Fifteen minutes later the procedure was carried out again to compare with the first registration for reproducibility. Two registrations of patients appeared similar, so third registrations were taken.

The interocclusal registration was viewed by holding it to the light box, perforations in the interocclusal registrations that let the light go through were identified as actual contacts, and very thin transparent sections without perforations were recorded as near contacts. After these contacts were scored, they were transferred to the maxillary model. The midpoint of the near-contact areas were transferred to the study model with a marker.

The variables recorded from the maxillary and mandibular study models at each of the two time points included the total number of contacts (actual and near contacts combined); the number of actual contacts on second molars, first molars, premolars, canines, and incisors; and the number of near contacts on the second molars, first molars, premolars, canines, and incisors. Unchanged contacts were not used in the statistical evaluation. Because the first premolars had been extracted in some of the patients in the study groups, first premolar contacts were not considered in the nonextraction patients and control group.

All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS, version 15.0, SPSS Inc, Chicago, Ill) software package. The distributions of occlusal contact areas and model measurements were first analyzed for skewness and kurtosis. Because the data were normally distributed, the mean and standard deviation were used for descriptions. Paired *t*-tests were used to assess differences between the mean at T1 and T2. To compare the changes observed in subgroups, a one-way analysis of variance (ANOVA) and Tukey honestly significant difference (HSD) tests were performed. The level of significance for measurements was set at $P < .05$.

For 10 randomly selected patients, the 2 similar occlusal registrations obtained at the clinical examination were analyzed to determine methodologic error. A paired *t*-test analysis was also used and showed no statistically significant differences in the mean number of contacts recorded using the two sets of occlusal registrations.

Table 1. Changes in Mean Numbers of Combined (Actual and Near) Contacts of Three Groups (n = 70) on the Anterior, Posterior, and Total Segments[a]

Groups	Combined Contacts	T1	T2	Difference	Paired Samples *t*-Test
Hawley retainer	Posterior	10.90	14.05	3.15	*
	Anterior	1.55	2.35	0.80	NS
	Total	12.45	16.40	3.95	*
Bonded retainer	Posterior	17.20	29.60	12.40	***
	Anterior	6.35	7.40	1.05	NS
	Total	23.55	37.27	13.72	***
Control group	Posterior	31.65	33.10	1.45	NS
	Anterior	6.75	6.77	0.02	NS
	Total	38.40	39.87	1.47	NS

[a] T1 indicates after treatment; T2, after retention; NS, not significant.

* $P < .05$; *** $P < .001$.

RESULTS

Table 1 shows the changes in the mean numbers of combined (actual and near) contacts of three groups on the anterior, posterior, and total segments.

In group 1, the mean number of combined contacts increased from 12.45 to 16.40, and this was found statistically significant ($P < .05$). The number of teeth in contact increased by an average of 3.15 in the posterior ($P < .05$) and 0.80 in the anterior ($P > .05$) segments.

In group 2, the mean number of teeth in combined contacts increased by an average of 13.72 ($P < .001$). The mean number of posterior ($P < .001$) and anterior ($P > .05$) contacts increased from 17.20 to 29.60 and 6.35 to 7.40, respectively.

The increased occurrence of combined contacts on the anterior, posterior, and total segments of the control sample was not statistically significant.

Table 2 shows the mean, difference, and statistical comparison of all investigated teeth during the 1-year retention period. In group 1, actual ($P < .01$) and total ($P < .001$) contacts on the second molar, actual and

Table 2. Preretention and Postretention Mean Values and Standard Deviations of Occlusal Contacts for Each Tooth in Each Group and Results of Statistical Comparisons (n = 70)[a]

	Hawley Retainer (n = 25)						Bonded Retainer (n = 25)						Control Group (n = 20)					
Occlusal	T1		T2		Difference	Paired Samples *t*-Test	T1		T2		Difference	Paired Samples *t*-Test	T1		T2		Difference	Paired Samples *t*-Test
Contacts	Mean	SD	Mean	SD	(T2 − T1)	*P* Value	Mean	SD	Mean	SD	(T2 − T1)	*P* Value	Mean	SD	Mean	SD	(T2 − T1)	*P* Value
Second molar																		
Actual	2.05	1.43	3.05	1.09	1.00	**	2.20	2.23	2.60	2.66	0.40	NS	5.40	1.42	5.10	1.25	−0.30	NS
Near	1.20	1.23	1.65	0.81	0.45	NS	3.50	2.39	7.15	3.93	3.65	***	5.00	1.80	6.10	2.01	1.10	NS
Total	3.25	1.48	4.70	1.21	1.45	***	5.70	4.06	9.75	5.18	4.05	***	10.40	2.20	11.20	1.67	0.80	NS
First molar																		
Actual	2.15	1.30	2.95	1.35	0.80	***	1.90	1.94	2.80	2.09	0.90	NS	6.30	3.10	6.00	0.54	−0.30	NS
Near	1.70	1.08	2.05	1.09	0.35	NS	4.60	2.52	9.15	3.81	4.55	***	5.80	1.34	6.20	0.96	0.40	NS
Total	3.85	2.05	5.00	1.89	1.15	***	6.50	3.05	11.95	3.95	5.45	***	12.10	1.54	12.20	1.78	0.10	NS
Premolar																		
Actual	1.70	1.34	2.55	1.50	0.85	**	1.10	0.78	0.95	1.05	−0.15	NS	4.75	2.10	5.20	2.08	0.45	NS
Near	2.10	1.07	1.80	1.05	−0.30	NS	3.90	2.24	6.95	2.39	3.05	***	4.40	1.76	4.50	2.10	0.10	NS
Total	3.80	1.60	4.35	2.20	0.55	NS	5.00	2.47	7.90	2.55	2.90	**	9.15	1.62	9.70	1.76	0.55	NS
Canine																		
Actual	0.15	1.00	0.50	1.03	0.35	**	1.10	1.02	0.60	0.82	−0.50	NS	1.50	1.22	1.00	1.99	−0.50	NS
Near	1.05	0.75	1.00	0.64	−0.05	NS	2.25	1.11	3.10	1.07	0.85	NS	2.05	0.56	1.90	1.05	−0.15	NS
Total	1.20	0.95	1.50	1.10	0.30	NS	3.35	1.13	3.70	0.97	0.35	NS	3.55	2.10	2.90	1.49	−0.65	NS
Incisor																		
Actual	0.21	0.43	0.50	0.65	0.29	NS	0.40	0.59	0.70	1.26	0.30	NS	1.00	0.88	1.30	2.00	0.30	NS
Near	0.35	0.58	0.75	0.96	0.40	NS	2.60	1.27	3.00	1.16	0.40	NS	2.20	0.43	2.57	2.12	0.37	NS
Total	0.35	0.58	0.85	1.10	0.50	NS	3.00	1.55	3.70	1.07	0.70	NS	3.20	1.65	3.87	0.43	0.67	NS

[a] T1 indicates after treatment; T2, after retention; SD, standard deviation; NS, not significant.
* $P < .01$; *** $P < .001$.

total contacts on the first molar ($P < .001$), and actual contacts on the premolar and canine ($P < .01$) showed statistically significant increases.

In group 2, near contacts on the first and second molars and premolars ($P < .001$) and total contacts on the first and second molars ($P < .001$) and premolars ($P < .01$) showed statistically significant increases (Table 2). No statistically significant changes were observed on actual contacts of all investigated teeth.

No statistically significant differences were found in all teeth of the control sample during the 1-year observation period (Table 2).

Statistical comparisons of two retention groups and one control group in total contacts of anterior and posterior teeth are shown in Table 3. The results of ANOVA indicated statistically significant differences in three groups on the second molar ($P < .001$), first molar ($P < .001$), and premolar teeth ($P < .01$). The Tukey-HSD test showed that the posterior occlusal contact difference was significantly increased in the bonded retainer group compared with the Hawley and control groups. Posterior contact changes in group 1 and the control group during the observation period were not statistically significant. No statistically significant contact changes were determined at canine and incisor segments in all tested groups.

DISCUSSION

The effectiveness of bonded retainers used at both maxillary and mandibular arches during the retention phase of orthodontic treatment has not been reported in the literature. Therefore, the present study was carried out to evaluate the number of contacts occurring in centric occlusion during the retention period in different retention procedures and compared with the control sample.

This follow-up study demonstrates the dynamic changes in occlusal contacts that occur following the active phase of orthodontic treatment. It was thought that these continuous changes are most likely due to the lifelong processes of continual eruption and adaptation. Dynamic alterations are based on the premise that an increased number of occlusal contacts in maximum intercuspation represent an improved interdigitation of the teeth. Evaluation of the number and location of the occlusal contacts that may be the most important predictors of occlusal stability would help to explain any relapse that might occur in the future.[11]

Table 3. Preretention and Postretention Mean Difference and Standard Deviation of Occlusal Contacts for Each Tooth in Each Group and Results of ANOVA and Multiple Group Comparisons (n = 70)[a]

Teeth	Group	Mean Difference	SD	Min	Max	Sig	Bonded Retainer	Control Group
Second molar	Hawley retainer	1.45	1.05	0.00	5.00	*** F = 20.523	***	NS
	Bonded retainer	4.05	3.35	−2.00	11.00			***
	Control group	0.80	1.42	0.00	2.30			
First molar	Hawley retainer	1.15	1.09	0.00	4.00	*** F = 56.166	***	NS
	Bonded retainer	5.45	2.76	1.00	10.00			***
	Control group	0.10	3.10	0.00	3.50			
Premolar	Hawley retainer	0.55	2.16	−5.00	4.00	** F = 8.539	**	NS
	Bonded retainer	2.90	3.46	−4.00	9.00			**
	Control group	0.55	2.10	0.00	3.00			
Canine	Hawley retainer	0.30	0.57	−1.00	1.00	NS		
	Bonded retainer	0.35	1.42	−3.00	2.00			
	Control group	0.65	1.22	0.00	2.00			
Incisor	Hawley retainer	0.50	0.83	0.00	2.00	NS		
	Bonded retainer	0.70	1.45	−2.00	4.00			
	Control group	0.67	0.88	0.00	2.00			

[a] SD indicates standard deviation; Min, minimum; Max, maximum; Sig, significance; NS, not significant.
* $P < .01$; *** $P < .001$.

A more informative and detailed examination and evaluation of interarch occlusal contacts has not been a routine orthodontic practice. Gazit and Lieberman[9] recorded actual and near contacts using the photo-occlusion technique. The most commonly used procedures for evaluation of occlusal contacts utilize colored articulating papers, silicone records, or indicator waxes. It is difficult to make direct comparisons of the occlusal contact values with those reported by other investigators, because the number of contacts recorded can vary according to the methods used. Diagnosis of the interarch occlusal relationship intraorally or on a study model does not properly reveal the number and the location of occlusal contacts. The bite technique for recording occlusal contacts was highly reproducible, and the method has been validated in several previous studies.[8,10,11]

An attempt was made to randomly select the type of retainer to be used in each patient. The comparison groups were matched for size, age, Angle classification, and numbers of patients with teeth extracted.

The total mean numbers of contacts at the end of the active orthodontic treatment were 12.45 for the Hawley and 23.55 for the bonded retainer group, and both of these groups were much less than that of the control group (38.40). After a 1-year retention period, statistically significant increases were observed in both patient groups. This significant increase of total contacts was entirely due to the development of more contacts in the posterior segments (premolars and molars). The increase of posterior contacts found here supports the previous work by Razdolsky et al[8] who reported that the relative vertical movements may continue up to 21 months.

At the end of the active orthodontic treatment, the number of contacts in the anterior segment of the bonded retainer group (6.35) was similar in the control group (6.75), and higher than in the Hawley group (1.55). This could have been caused by incomplete Class II correction resulting in excessive overjet in the Hawley retainer group or factors related to anterior retainer interference in the bonded retainer group. Anterior occlusal contact findings in our study are similar to those of Durbin and Sadowsky,[12] and the development of contacts in the incisors was not statistically significant during the retention period. In the anterior region, the changes from the canine region were also not significant. Different from the present findings, Razdolsky et al[8] determined a significant increase for near contacts on incisors.

Sauget et al[3] reported a statistically significant increase in the number of total contacts after 3 months of retention with the Hawley retainers. Haydar et al[10] found a statistically significant increase for the actual contacts only on the second premolar teeth after a 3-month retention period. In the current study, actual and total contacts on the first and second molars, and actual contacts on the premolar and canine teeth showed statistically significant increases. These increases were greater than those reported by Haydar et al,[10] presumably because our follow-up period was longer.

Başçiftçi et al[2] investigated occlusal contact changes during the retention period with a maxillary removable appliance combined with a mandibular bonded retainer and reported that actual contacts on all teeth except the incisors, and total contacts on both molars showed statistically significant increases. Dincer et al[11] investigated contacts with a Hawley retainer and found that the number of actual contacts was greater than

the number of near contacts at the end of retention. Interestingly, we observed major changes only in near contacts. Changes in actual contacts of the bonded retainer group at different time points were not statistically significant. Ideal or extensive occlusal contacts in maximum intercuspation as reported by Hellman[13] and Ricketts[14] were not found in any of the control subjects. In an ideal occlusion, Ricketts,[14] Ehrlich and Taicher,[15] and Hellman[13] determined 48, 79, and 138 occlusal contacts, respectively. Haydar et al[10] investigated contacts in the normal occlusion group and observed 40.50 contacts. Our findings in the control sample are similar to the findings of Haydar et al[10] with 38.40 contacts. These great differences could be related to a selected sample or occlusal contact recording methods. Razdolsky et al[8] showed a mean of 58.2 contacts at 21 months posttreatment. In the current study, at the end of the retention period of the bonded retainer group (mean combined contact: 37.27), occlusal contacts should come close to the control sample (mean combined contacts: 39.87).

According to multiple comparison results related to the total contact changes during the follow-up period, significant differences were found for all investigated posterior teeth. Posterior occlusal contact difference was significantly increased in the bonded retainer group compared with the Hawley retainer and control groups. This could be the result of continued vertical mobility of posterior teeth during retention and eruption as that was easily possible with the bonded retainers because no barrier exists on the occlusal surfaces of the posterior teeth.

Finally, throughout the retention period, the increase in the number of contacts in ideal locations may suggest a good relation between the quality of the posterior occlusion and the health, function, and perhaps stability of the dentition.[11] However, the changes in the number of contacts during treatment in not ideal locations also suggests that settling should be done at the finishing-phase of the active treatment and not be postponed to the retention period.[16]

CONCLUSIONS

- The total and the posterior combined contacts of the study groups were increased throughout the 1-year retention period. No significant anterior contact changes were observed.
- The number of contacts on the posterior segment was increased more in the bonded retainer group than in the Hawley group at the end of retention.
- During the observation period, a number of slight occlusal changes were determined in the normal occlusion sample.

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