# Effects of thermoplastic retainers on occlusal contacts

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SUMMARY The aim of this prospective study was to evaluate the number of contacts in centric occlusion during retention with thermoplastic retainers (Essix retainers) and in the long term. After four premolar extractions and active orthodontic treatment of 15 Class I (10 females, 5 males; mean age 17.20  $\pm$  1.7 years), thermoplastic retainers were used. Occlusal contacts were determined from occlusal registrations taken in centric occlusion at the beginning (T0), end (9 months of retention; T1), and after 2.5 years (T2). The occlusal contacts determined in these patients were compared with the values of 15 'normal' Class I subjects (9 females, 6 males; mean age 17.10  $\pm$  1.60 years) who had not undergone orthodontic treatment. Wilcoxon and a Mann–Whitney *U*-tests were used to evaluate intraand intergroup differences.

No significant change was observed in the number of posterior contacts during T1, whereas a significant increase was found at T2 (P < 0.01) for the second premolars (P < 0.01) and second molars (P < 0.05). Both 'ideal' and 'non-ideal' contacts increased significantly but only at T2 (P < 0.05). The number of ideally located contacts on the posterior teeth at all three periods were lower than normal values (P < 0.01); while non-ideal contacts at T1 (P < 0.05) and T2 (P < 0.01) were found more often when compared with the values of normal subjects. Only the increased number of premolar contacts at T2 was more than normal values (P < 0.01). There was no expected increase in occlusal contacts at T2; however, posterior occlusal contacts were increased at T3.

## Introduction

Tooth alignment, aesthetics, and function achieved by active orthodontic treatment are kept stable by retention appliances following active treatment. The goal of retention is to achieve occlusal stability. One of the most important factors in occlusal stability is the existence of occlusal contacts (centric stops) that take place on functional cusps. Both increases in the number of occlusal contacts and 'ideally located' contacts are important for occlusal stability. Whereas maximizing tooth contacts in centric occlusion minimizes the stresses distributed on the teeth, ideally located centric contacts cause vertically directed forces parallel to the long axes of the teeth (Dawson, 1989). It has been suggested that good occlusal contacts and intercuspation may be the keys to a stable orthodontic result (Nanda and Nanda, 1992; Storey, 1993).

The length of the retention period is important to prevent relapse and to provide stability of treatment. The ideal retention device should allow settling while ensuring a safety margin and reducing the tendency toward relapse.

Clear thermoplastic appliances have been recommended for use as transitional retainers, finishing appliances (McNamara *et al.*, 1985), and even permanent retention (Sheridan *et al.*, 1993). They are easy to fabricate, inexpensive, aesthetic, and comfortable and thus have a high level of patient acceptance (Sheridan *et al.*, 1992). The major disadvantages are their tendency to open the bite and their low durability (Sheridan *et al.*, 1993).

There are various studies in the literature reporting changes in the occlusion and especially increases in the number of occlusal contacts after orthodontic treatment with the use of conventional retention devices, tooth positioners, or fixed retainers (Durbin and Sadowsky 1986; Haydar *et al.*, 1992; Dinçer *et al.*, 2003; Başçiftçi *et al.*, 2007). In recent years, the use of thermoplastic retainers has increased yet there are no studies evaluating occlusal contact changes with thermoplastic retention appliances. The aim of this study was to determine the changes in occlusal contacts in centric occlusion during retention with full covarage thermoplastic appliances (Essix retainers) and in the long term.

## Subjects and method

Fifteen Class I patients (5 males, 10 females; mean age  $17.20 \pm 1.7$  years) treated with first premolar extractions and straightwire mechanics at the Department of Orthodontics, Gazi University, and 15 individuals (6 males, 9 females; mean age  $17.10 \pm 1.60$  years) with a 'normal' occlusion who had not undergone treatment were included in the study.

Final selection of the sample was based upon the following criteria:

- 1. Patients who had full fixed banded and/or bonded orthodontic appliance treatment (at least 18 months) with or without auxiliary appliances treated to an optimum occlusion with the treatment objectives satisfied.
- 2. Patient availability for long-term follow-up recording.

The normal values of the untreated Class I sample were compared with the number of occlusal contacts in the treated group at the end of active orthodontic treatment (T0), at the end of the 9 month retention period (T1), and in the long term (T2), that is after 2.5 years. The normal values were obtained from dental students with Class I occlusions, all teeth present except third molars, no history of orthodontic or prosthodontic treatment, and no symptoms of temporomandibular joint disorders.

The treated patients received upper and lower full coverage Essix retainers as retention appliances with instructions to wear them full-time except during meals for 6 months and then at night only for the next 3 months. The retainers were formed from the action of heat from 0.75 mm (0.030 inches) copolyester Essix sheets (Dentsply Raintree Essix, New Orleans, Louisiana, USA) which is thermoformed to a thickness of 0.015 inches. The retainers were equilibrated and placed on the same day the fixed appliances were removed. The retainers extended to the second molars.

Occlusal records were taken using a method similar to that described by Razdolsky et al. (1989) The records included alginate impressions for study models to evaluate the occlusal contacts. Bite registration records were taken with a soft silicon-based impression material. (Zetaplus, Zhermack, Badia Polesine, Italy) The occlusal records were determined from treated patients at T0, T1, and T2. Occlusal records of the untreated normal sample were obtained once in centric occlusion when identified as appropriate for the study. The subjects were seated upright in a dental chair and the registration material was applied over the occlusal surfaces of the mandibular teeth. The patient was instructed to bite firmly in maximum intercuspation (centric occlusion). A second bite registration was made within 15 minutes to test reproducibility. If a subjective difference in the pattern of the contacts was observed, a further registration was obtained.

The interocclusal registration was viewed by holding it to the light box; perforations in the interocclusal registrations that let through light and very thin transparent sections without perforations were recorded as contacts.

The posterior contacts on the premolars and the molars were determined on the lower study models. The location of ideal posterior contacts were evaluated according to the method of Ramfjord and Ash (1971; Figure 1). Contacts on the cusp-marginal ridges and within 1 mm of that area were identified as 'ideally located contacts', while those in other areas were identified as 'non-ideal contacts'. First premolar contact areas were not taken into consideration in the untreated normal sample as these teeth had been extracted in the study group. All registrations were undertaken evaluated, and measured by the same orthodontist (BIA).

A Wilcoxon test was used to statistically evaluate the differences between T0, T1, and T2. Differences between the treated group and untreated normal sample were determined by the Mann–Whitney *U*-test.

The records of 10 patients at T0 were randomly selected to determine the method error. For each of the 10 patients, two similar occlusal registrations that were obtained at the clinical examination were used. There were no statistically significant differences (P > 0.05) in the mean number of contacts recorded using the two sets of registrations as determined by Wilcoxon test (Table 1).

## Results

Table 2 shows the descriptive statistics and the significance of the differences between T0, T1, and T2 for the treated and untreated groups. Neither the posterior contacts nor the ideally located or non-ideal contacts showed a significant difference at T1.

No significant change was observed in the number of posterior tooth contacts at T1 whereas a significant increase was found at T2. An increase in posterior contacts was funded on the second premolar and second molar teeth. The



Figure 1 Location of 'ideally located contacts' modified from Ramfjord and Ash (1971).

**Table 1** Descriptive statistics of two registrations of the studygroup at the beginning of retention and the main differencesbetween the two registrations.

	Registration	$X \pm$ standard deviation	Р
Posterior	1	$21.70 \pm 1.06$	0.66
	2	$21.60 \pm 0.52$	
Ideally located	1	$10.80 \pm 1.14$	0.34
	2	$10.70 \pm 1.16$	
Non-ideal	1	$11.10 \pm 0.74$	0.16
	2	$10.90 \pm 0.88$	
Premolar	1	$4.90 \pm 0.74$	0.16
	2	$4.70 \pm 0.68$	
First molar	1	$8.40\pm0.70$	0.16
	2	$8.60 \pm 0.76$	
Second molar	1	$8.30\pm0.68$	1.00
	2	$8.30\pm0.68$	

 Table 2
 Descriptive statistics and significant differences before (T0), after retention (T1), and 2.5 years after treatment (T2) and main differences between the normal (N) untreated sample and the study group.

			Centric occlusion								
	Group		X	Standard deviation	Р			Р			
					T0-T1	T1-T2	Т0-Т2	T0–N	T1–N	T2–N	
Posterior	Study	TO	21.80	1.92	NS	**	*				
	2	T1	22.13	1.78							
		T2	27.67	1.86							
	Normal		23.00	1.53				NS	NS	NS	
Ideal location	Study	Т0	10.67	0.40	NS	*	*				
	-	T1	10.47	0.62							
		T2	12.00	0.92							
	Normal		15.73	1.01				**	**	**	
Not ideal location	Study	Т0	11.13	1.76	NS	*	*				
		T1	11.67	1.63							
		T2	15.67	1.51							
	Normal		7.27	1.18				NS	*	**	
Premolar	Study	Т0	4.93	0.47	NS	**	**				
		T1	5.13	0.65							
		T2	7.40	0.58							
	Normal		5.07	0.46				NS	NS	**	
First molar	Study	Т0	8.60	0.91	NS	NS	NS				
		T1	8.67	0.83							
		T2	10.27	0.83							
	Normal		8.47	0.69				NS	NS	NS	
Second molar	Study	Т0	8.20	0.91	NS	*	*				
	-	T1	8.33	0.91							
		T2	10.00	1.00							
	Normal		9.40	0.85				NS	NS	NS	

\**P* < 0.05, \*\**P* < 0.01; NS, not-significant.

increase in ideally located and non-ideal contacts was found to be significant at T2 when compared with T0 and T1.

While the number of ideally located contacts on the posterior teeth at all three time points was lower when compared with normal values, non-ideal contacts at T1 and T2 were found more often when compared with normal values. Only the increased number of premolar contacts at T2 was more than the normal values.

Table 3 shows the changes in distribution and characteristics of posterior contacts in centric occlusion during T0–T1, T1–T2, and T0–T2. Ideally located contacts on the premolars increased significantly at T2 compared with T1, whereas non-ideal contacts on the premolars increased significantly at T2 compared with T0 and T1.

## Discussion

Evaluation of occlusal contacts, which may be the most important predictor of occlusal stability, would help to explain any future relapse. Various studies have evaluated occlusal contact changes with conventional retainers; yet there is no research concerning occlusal contacts when Essix retainers are used. Therefore, in this study, the aim was to analyze occlusal contact changes in centric occlusion during the retention period in which full coverage thermoplastic appliances were used and also following long-term retention.

Clear thermoplastic appliances are aesthetic and comfortable and thus patient cooperation is better than with other retainers (Sheridan *et al.*, 1992). Therefore, these retainers are commonly used. An Essix retainer is thinner and stronger than other designs, but since it covers only the six anterior teeth, it still has a slight tendency to open the bite (Sheridan *et al.*, 1993). Wang (1997) advised that in extraction cases, thermoplastic retainers should be extended to the mesiobuccal grooves of the first molars. A full coverage, clear plastic type that can be worn full time is also preferable (Sheridan *et al.*, 1992). Consequently, in this study, full coverage Essix retainers ending at the second molars were used where extractions had been carried out.

There are different opinions concerning the retention schedule of these retainers. Sheridan *et al.* (1993) prescribed full-time wear of mandibular retainers and half-time wear of maxillary retainers for the first 4 weeks and both retainers only at night thereafter. Wang (1997) preferred the maxillary retainer to be worn all day and the mandibular retainer only at night for 2 months and then both retainers for 2 years or, if possible, indefinitely. In a recent study, Gill *et al.* (2007)

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Table 3	Distribution of contacts of	on posterior teet	h in centric	c occlusion	in the study	group at the	beginning (T0)	, end of retention	(T1),
and in the	e long term (T2).								

	Centric occlusion							
		Х	Standard deviation	Р				
				T0-T1	T1–T2	Т0-Т2		
Premolar ideal location	Т0	2.53	0.24	NS	*	NS		
	T1	2.20	0.22					
	T2	2.93	0.35					
Premolar not ideal location	Т0	2.40	0.47	NS	**	**		
	T1	2.93	0.58					
	T2	4.47	0.54					
First molar ideal location	Т0	4.00	0.24	NS	NS	NS		
	T1	4.27	0.30					
	T2	4.60	0.31					
First molar not ideal location	Т0	4.60	0.79	NS	NS	NS		
	T1	4.40	0.76					
	T2	5.67	0.71					
Second molar ideal location	Т0	4.13	0.32	NS	NS	NS		
	T1	4.00	0.27					
	T2	4.40	0.41					
Second molar not ideal location	Т0	4.13	0.81	NS	NS	NS		
	T1	4.33	0.86					
	T2	5.60	0.86					

\*P < 0.05, \*\*P < 0.01; NS, non-significant.

compared part- and full-time Essix-type retainer wear with respect to dental alignment and occlusal changes. The retainers were either worn full time for 6 months or only at night. They concluded that night-time-only Essix retainer wear may be an acceptable retention regimen following the use of fixed appliances. In the present study, the patients were instructed to wear the retainers full time for 6 months and then at night for 3 months.

When upper and lower plastic appliances are worn simultaneously, because of the double thickness of plastic between the terminal molars (Sheridan *et al.*, 2001), the appliances in the present study were equilibrated to avoid any semblance of an efficient centric occlusion.

The total average number of posterior contacts was 22.13 at T1 and increased to 27.67 at T2. Posterior contacts did not increase significantly during T0–T1. This could be due to construction of the Essix retainers which covered the occlusal surfaces of the teeth. The significant increase at T2 was a consequence of the removal of the Essix retainers. This result shows the continued mobility of teeth even after 9 months of retention.

Retainers should be designed to eliminate occlusal interferences and to allow for continuing vertical settling (Alexander, 1993) Long-term studies have shown that a variety of occlusal changes occur after the active phase of orthodontic treatment. These changes may take place shortly after the removal of the active appliances, during the period of post-treatment 'settling', or over a period of years (Shapiro, 1974; Little *et al.*, 1981; Sadowsky and Sakols, 1982; Uhde *et al.*, 1983). It was also reported by Razdolsky *et al.* (1989) that relative vertical movements can continue up to 21 months after orthodontic therapy. If thermoplastic retainers are used, canine-to-canine Essix retainers, as introduced by Sheridan *et al.* (1993) or any other modification, can be designed to allow vertical settling.

McNamara and Henry (1971) reported a mean increase of posterior contacts from 17.4 to 19.7 at the end of a 1 year retention period, whereas Gazit and Lieberman (1985) found a mean increase of 11.2 to 17.4. In the study of Haydar et al. (1992), there was a slight increase in the number of contacts in the Hawley group to 22.40 and in the positioner group to 27.00 at the end of 3 months' retention. Dincer et al. (2003) found a significant increase in posterior contacts from 11.45 to 19 with Hawley retainers after 9 months of retention. Sauget et al. (1997) also found a statistically significant increase in the number of total contacts after 3 months of retention with Hawley retainers. After a 3 month retention phase with conventional retainers, Durbin and Sadowsky (1986) found a 16 per cent increase in the number of posterior contacts. Razdolsky et al. (1989) counted a mean number of 36.6 contacts at the end of treatment and 58.2 contacts after 21 months. Başçiftçi et al. (2007) also found a slight increase with modified wrap-around Hawley retainers and Jensen plates with mandibular fixed retainers after a retention period of one year.

There were no differences in the number of posterior contacts in centric occlusion at any time point when compared with normal values. When distribution of contacts on posterior teeth were evaluated, the contacts on the second premolar and second molars increased significantly. Contrary to the present findings, Sultana *et al.* (2002) found no changes in the premolar regions and stated that no change in the premolar region after active treatment should be expected; they found a larger increase in the molar region, especially at the second molar after 1 year of retention.

In the present study, the number of ideally located contacts was less than normal values at T0, T1, and T2; however, the number of non-ideal contacts was greater than normal values at T1 and T2. Both the number of ideal and non-ideal contacts increased only at T2. Non-ideal contacts increased more than ideally located contacts. This may be the result of settling not being established by retainer guidance. Evaluation of the distribution of posterior contacts showed that the number of ideal and non-ideal contacts increased only for the second premolar teeth at T2. Dincer *et al.* (2003) found that the number of ideal contacts significantly increased at the first and second molars at the end of retention.

An increased number of ideal contacts is important because the construction of ideal posterior occlusal guidance results in distributing the occlusal forces on the maximum number of inclined planes during interdigitation and provides maximum periodontal support (Alhgren and Posselt, 1968). An increase in the number of non-ideal contacts also suggests that settling should be carried out during the last phase of active treatment rather than in the retention period (Razdolsky *et al.*, 1989).

## Conclusion

The expected increase of occlusal contacts was not observed at the end of the retention period with Essix thermoplastic retainers as these cover the occlusal surfaces of teeth. Both ideal and non-ideal posterior contacts increased in the long term while the number of non-ideal contacts was more than the ideal contacts.

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