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Post-treatment occlusal changes in Class II division 2 subjects treated with the Herbst appliance

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SUMMARY The aim of this retrospective study was to analyse and compare the post-treatment occlusal changes of Class II division 2 treatment with the Herbst appliance in early adolescent, late adolescent, and adult subjects.

The subjects were 37 Class II division 2 patients (19 females and 18 males) treated at the Orthodontic Department, University of Giessen, Germany. All were in the late mixed or permanent dentition and exhibited a Class II molar relationship ≥0.5 cusp width (CW) bilaterally or ≥1.0 CW unilaterally, an overbite (OB) >3.0 mm, and two upper central incisors retroclined. The subjects were divided into three skeletal maturity groups based on evaluation of hand wrist radiographs: early adolescent ($n = 10$, stages MP3-E to MP3-FG at start of treatment, age range: 11.3–13.2 years), late adolescent ($n = 14$, stages MP3-G to MP3-I at start of treatment, age range: 14.1–16.4 years), and adult ($n = 13$, stages R-I to R-J at the start of treatment, age range: 16.3–25.6 years). Study casts from before treatment (T1), after Herbst-Tip-Edge-Multibracket appliance treatment (T2), and after an average retention time of 27 months (T3) were analysed. Statistical analysis was undertaken using *t*-tests for paired and unpaired samples.

For the whole sample, the molar relationship at T3 was stable in 82.4 per cent, the canine relationship in 82.9 per cent, and OB in 75.7 per cent of the cases. In the different skeletal maturity groups, the stability of the molars, canines, and overbite was as follows: early adolescents: 95.0, 100.0, and 70.0 per cent, respectively; late adolescents: 92.9, 74.1, and 85.7 per cent, respectively; and adults 61.5, 80.8, 69.2 per cent, respectively.

Occlusal correction of Class II division 2 malocclusions with Herbst treatment was relatively stable 2 years post-treatment. The outcome of treatment of adolescents was more stable than that of adults.

Introduction

Many studies in the literature have analysed the stability of Class II treatment and deep bite correction (Blake and Bibby, 1998; Bondemark *et al.*, 2007). Class II division 2 malocclusions combine both the following characteristics, a Class II molar relationship and a deep bite (Angle, 1907). Although Class II division 2 malocclusions are reported to be difficult to treat and to have a high risk of relapse (Canut and Arias, 1999), there is research on stability (Fuhrmann and Berg, 1990; Binda *et al.*, 1994; Birkeland *et al.*, 1997; Al Yami *et al.*, 1999; Canut and Arias, 1999; Kim and Little, 1999; Lapatki *et al.*, 2004, 2006; Marku, 2006; Schütz-Fransson *et al.*, 2006).

Although Millett *et al.* (2006) stated that there was no rationale to provide any evidence-based guidance for the treatment of Class II division 2 malocclusions, the Herbst appliance has been shown to be a most effective treatment option (Obijou and Pancherz, 1997; Eberhard and Hirschfelder, 1998; Schweitzer and Pancherz, 2001), correcting both the Class II molar relationship and the deep bite simultaneously. However, in contrast to Class II division 1 treatment (Pancherz, 1994) no data exist on the occlusal stability of Class II division 2 malocclusions treated with the Herbst appliance.

Some studies attribute overbite (OB) stability after treatment to a reduction of the interincisal angle (Riedel, 1960; Ludwig, 1966; Berg, 1983; Kim and Little, 1999) or a relapse of the interincisal angle (Nicol, 1963; Schudy, 1968; Simons and Joondeph, 1973; Lagerström, 1980; Houston, 1989). One of the side effects of Herbst treatment is proclination of the lower incisors (Pancherz and Hansen, 1988; Hansen *et al.*, 1997; Ruf *et al.*, 1998; Weschler and Pancherz, 2005) which contributes to a decrease in the interincisal angle during treatment. This proclination has been suggested to contribute to OB stability after Class II division 2 Herbst treatment (Schweitzer and Pancherz, 2001). On the other hand, Simons and Joondeph (1973) quantified the amount of incisor proclination to correlate with OB relapse.

Class II division 2 malocclusion subjects frequently have a high lip line, which is said to be the cause of the steep upper incisor inclination as well as of the high relapse frequency (Ridley, 1960; Nicol, 1963; Posen, 1972; Mills, 1973; Fletcher, 1975; Luffingham, 1982; Karlsen, 1994; Lapatki *et al.*, 2002, 2004, 2006, 2007). Herbst appliance treatment reduces the lower lip overlap on the upper incisors by 29 per cent (Schweitzer and Pancherz, 2001), thus possibly creating favourable conditions for OB stability.

The amount and direction of mandibular growth after therapy influences the stability of OB correction and molar relationship after orthodontic treatment of Class II division 2 malocclusions (Riedel, 1960; Simons and Joondeph, 1973; Kim and Little, 1999).

The aim of this retrospective study was to analyse and compare the post-treatment occlusal changes of Class II division 2 treatment with the Herbst appliance with respect to the pubertal growth period in which treatment was performed.

Subjects and methods

Of all Class II division 2 patients treated with a Herbst appliance at the Orthodontic Department, University of Giessen, Germany, 37 subjects (19 females and 18 males) fulfilled the retrospective selection criteria of a Class II molar relationship ≥0.5 cusp width (CW) bilaterally or ≥1.0 CW unilaterally, an OB >3.0 mm, retroclined upper central incisors, and complete available records (study casts, lateral head films, and orthodontic notes).

The subjects had to be either in the late mixed or permanent dentition and treated non-extraction with a Herbst-Tip-Edge-Multibracket (Herbst-MB) appliance.

The average duration of treatment was 7.5 months for the first phase (Herbst appliance) and 11 months for the second phase (Tip-Edge-Multibracket appliance). The average retention time was 27 months [standard deviation (SD) 13.3 months]. Retention after active treatment was performed using a removable appliance (Activator 10, upper Hawley 17) in combination with a fixed lower canine to canine retainer in 27 of the 37 subjects. Nine subjects were retained with removable appliances only (Activator 5, upper and lower Hawley 1, positioner 3) and one had exclusively fixed upper and lower canine to canine retainers. At the time of the present investigation, the lower fixed retainers were still *in situ* in 25 patients and the removable appliances were still being worn by 33 patients.

Assessment of the treatment growth period was carried out using hand wrist radiographs which were evaluated using the method of Hägg and Taranger (1980). According to their skeletal maturity at start of treatment, the subjects were divided into three growth period groups (Table 1):

1. Early adolescent: stages MP3-E to MP3-FG (seven females, age range: 12.1–14.4 years; three males, age range: 11.3–13.2 years).
2. Late adolescent: stages MP3-G to MP3-I (six females, age range: 12.2–15.0 years; eight males, age range: 14.1–16.4 years).
3. Adult: stages R-I to R-J (six females, age range: 16.8–36.5 years; seven males, age range: 16.3–25.6 years).

Study casts from before treatment (T1), after Herbst-MB (T2), and after retention (T3) were analysed.

The following variables were used for the assessment of T2-T1 and (T3-T2) changes: MR, ML Sagittal Molar Relationship (Right, Left); CR, CL Sagittal Canine Relationship (Right, Left); and OB (mean right/left).

For the assessment of occlusal stability, the occlusion at T3 was compared with that at T2. The molar and canine relationships were considered stable if a normal or overcompensated Class I relationship existed at T3 or if the occlusion had not changed after T2. A change ≤0.25 CW was considered as insignificant relapse whereas a change >0.25 CW was considered as true relapse.

Concerning OB, unchanged values, an increase ≤1.5 mm or final values up to 3 mm, were considered stable. A final value >3 mm was defined as insignificant relapse if there was an increase between 1.5 and 2.5 mm and as true relapse in the case of an increase >2.5 mm.

All evaluations were performed by both authors and the data were included after mutual agreement. During the evaluation, the examiners were blinded as to skeletal maturity.

Linear measurements were made to the nearest 0.5 mm using a calliper. Ratings of the occlusion were performed to the nearest 0.25 CW. To minimize the method error, all assessments were performed twice, with a time interval of at least 2 weeks. The mean value of the two assessments was used in the final evaluation.

Table 1 General characteristics of the 37 Class II division 2 subjects included in the study divided into three skeletal maturity groups. The data for average pre-treatment age, sagittal jaw base relationship (ANB angle), vertical jaw base relationship (ML/NSL angle), and length of the observation periods T2-T1 (Herbst-Multibracket treatment) and T3-T2 (retention) are given. The statistical significance (*t*- and *P*-value) of the group differences (except for pre-treatment age) is shown.

	Early adolescent (*n* = 10) MP3-E to MP3-FG		Late adolescent (*n* = 14) MP3-G to MP3-I		Adult (*n* = 13) R-I to R-J		Group differences					
							Early adolescent to late adolescent		Early adolescent to adult		Late adolescent to adult	
	Mean	SD	Mean	SD	Mean	SD	*t*	*P*	*t*	*P*	*t*	*P*
Age (years)	12.8	0.96	14.8	1.03	20.0	5.47						
ANB (degrees)	5.2	1.51	4.6	1.80	4.9	2.17	0.72	ns	0.28	ns	0.36	ns
ML/NSL (degrees)	30.9	4.87	29.0	3.86	27.4	5.28	1.06	ns	1.62	ns	0.89	ns
T2-T1 (months)	17.7	3.38	20.1	4.62	18.6	4.15	1.16	ns	0.77	ns	0.47	ns
T3-T2 (months)	22.6	8.25	32.9	16.51	24.2	10.94	1.84	ns	0.39	ns	1.61	ns

The arithmetic mean (mean) and SD were calculated for each variable. As the data showed a normal distribution (Kolmogorov–Smirnov test), the changes of the variables during the different examination periods were evaluated using the *t*-test for paired samples. To compare group differences, the *t*-test for unpaired samples was applied. The following levels of significance were utilized: $P < 0.001$ (***), $P < 0.01$ (**), and $P < 0.05$ (*). A *P*-value > 0.05 was considered as not statistically significant.

Results

The results of the analysis of the study casts are given in Table 2, while the treatment (T2-T1) and post-treatment changes (T3-T2) are shown in Table 3.

The pre-treatment records (Tables 1 and 2) of the three groups revealed a significant difference ($P < 0.01$) with a larger Class II molar relationship on the right side between the early (0.98 CW) and the late (0.70 CW) adolescent groups.

No gender differences were found for any of the variables. Thus, the subjects were pooled for further evaluation.

Changes during T2-T1

For the whole sample, a correction of the Class II molar relationship to a Class I relationship was achieved on both sides. The average correction comprised 0.82 CW ($P < 0.001$) on the right side and 0.85 CW ($P < 0.001$) on the left side. The correction of the Class II molar relationship was largest in the early adolescent group (MR 1.0 CW; ML 0.96 CW). However, a significant group difference could only be found for MR which was significantly larger ($P < 0.05$) than in the late adolescent and adult groups.

Regarding the canine relationship, the whole sample exhibited an average Class II relationship of 0.16 CW on both sides at T2. The average correction during treatment was 0.47 CW ($P < 0.001$) for CL and CR. A significant difference could only be found for the variable CL, which was significantly larger (0.15 CW; $P < 0.05$) in the late adolescent group than in the early adolescent group.

At T2, the average OB for the whole sample was 1.5 mm. The average improvement from T1 to T2 amounted to 4.3 mm ($P < 0.001$). OB correction differed slightly, but insignificantly, between the skeletal maturity groups.

Changes during T3-T2

For all groups (Table 3), insignificant changes occurred for most of the variables during the post-treatment period. However, statistically significant changes ($P < 0.05$ to $P < 0.001$) were seen for ML (whole sample = 0.05 CW and adult group = 0.09 CW) and OB (whole sample = 0.95 mm; late adolescent group = 0.94 mm; and adult group = 1.11 mm). A statistically significant group difference was found for CR, exhibiting significantly larger values (0.11 CW; $P < 0.05$) in the adult than in the early adolescent group.

Molar occlusion (Figures 1 and 2), in the whole sample, was stable in 82.4 per cent, an insignificant relapse occurred in 16.2 per cent, and a true relapse in 1.4 per cent. In the three groups, molar stability was greatest in the early adolescent group (95.0 per cent) and least stable in the adult group (61.5 per cent).

Canine occlusion, in the whole sample, was stable in 82.9 per cent (Figure 3). An insignificant relapse occurred in 17.1 per cent while a true relapse was not seen in any of the

Table 2 Sagittal molar and canine relationship (in cusp widths) and overbite (in mm) in 37 Class II division 2 subjects divided into three groups. The arithmetic mean (mean) and standard deviation (SD) of the study casts data from the start of treatment (T1), after Herbst-Tip-Edge-Multibracket appliance treatment (T2), and after retention of approximately 27 months (T3).

		Whole sample ($n = 37$)		Early adolescent ($n = 10$) MP3-E to MP3-FG		Late adolescent ($n = 14$) MP3-G to MP3-I		Adult ($n = 13$) R-I to R-J	
Relationship		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Sagittal molar right	T1	0.81	0.24	0.98	0.23	0.70	0.25	0.81	0.19
	T2	−0.01	0.19	−0.03	0.17	−0.04	0.23	0.03	0.16
	T3	0.00	0.18	0.00	0.12	−0.08	0.19	0.10	0.18
Sagittal canine right	T1	0.63	0.16	0.64	0.12	0.62	0.17	0.63	0.19
	T2	0.16	0.11	0.16	0.11	0.17	0.11	0.15	0.13
	T3	0.15	0.13	0.08	0.11	0.15	0.12	0.18	0.14
Sagittal molar left	T1	0.84	0.31	0.95	0.36	0.71	0.32	0.90	0.20
	T2	0.00	0.19	−0.01	0.17	−0.06	0.21	0.07	0.16
	T3	0.05	0.18	−0.01	0.09	0.00	0.18	0.15	0.19
Sagittal canine left	T1	0.63	0.16	0.56	0.15	0.63	0.18	0.68	0.14
	T2	0.16	0.11	0.18	0.11	0.11	0.12	0.20	0.10
	T3	0.15	0.12	0.11	0.13	0.14	0.12	0.18	0.12
Overbite	T1	5.83	1.60	5.01	1.53	5.99	1.83	6.30	1.23
	T2	1.52	0.75	1.44	0.87	1.27	0.65	1.87	0.68
	T3	2.47	1.18	2.20	1.43	2.21	1.09	2.97	0.97

Plus indicates a distal molar/canine relationship, Minus indicates a mesial molar/canine relationship.

Table 3 Treatment (T2-T1) and post-treatment changes (T3-T2) of sagittal molar and canine relationship (in cusp widths) and overbite (in mm) in 37 Class II division 2 subjects divided into three groups. The arithmetic mean (mean) and standard deviation (SD) of the study casts data from the treatment (T2-T1) and post-treatment (T3-T2) periods are given. The statistical significance (t- and P-value) of the changes and the group differences is shown.

Relationship		Whole sample (n = 37)				Early adolescent (n = 10) MP3-E to MP3-FG				Late adolescent (n = 14) MP3-G to MP3-I				Adult (n = 13) R-I to R-J				Group differences					
																		Early adolescent-late adolescent		Early adolescent-adult		Late adolescent-adult	
		Mean	SD	t	P	Mean	SD	t	P	Mean	SD	t	P	Mean	SD	t	P	t	P	t	P	t	P
Sagittal molar right	T2-T1	−0.82	0.27	18.66	***	−1.00	−0.19	16.97	***	−0.73	0.28	9.90	***	−0.78	0.26	10.76	***	2.64	*	2.27	*	0.45	ns
	T3-T2	0.01	0.16	0.51	ns	0.03	0.17	0.45	ns	−0.04	0.16	1.05	ns	0.07	0.14	1.72	ns	1.01	ns	0.64	ns	1.92	ns
Sagittal canine right	T2-T1	−0.47	0.15	17.94	***	−0.48	0.10	13.13	***	−0.44	0.17	9.17	***	−0.48	0.16	10.83	***	0.62	ns	0.06	ns	0.59	ns
	T3-T2	−0.01	0.12	0.70	ns	−0.08	0.09	2.38	*	−0.02	0.13	0.52	ns	0.03	0.12	0.90	ns	1.09	ns	2.20	*	0.98	ns
Sagittal molar left	T2-T1	−0.85	0.32	16.11	***	−0.96	0.27	11.26	***	−0.78	0.36	7.98	***	−0.84	0.30	9.94	***	1.36	ns	1.03	ns	0.46	ns
	T3-T2	0.05	0.13	2.53	*	0.00	0.13	0.00	ns	0.06	0.13	1.84	ns	0.09	0.13	2.42	*	1.17	ns	1.58	ns	0.49	ns
Sagittal canine left	T2-T1	−0.47	0.16	18.21	***	−0.38	0.17	6.80	***	−0.53	0.17	11.52	***	−0.48	0.10	17.32	***	2.10	*	1.87	ns	0.84	ns
	T3-T2	−0.01	0.12	0.50	ns	−0.07	0.11	1.89	ns	0.04	0.13	1.00	ns	−0.02	0.11	0.62	ns	1.96	ns	1.04	ns	1.15	ns
Overbite	T2-T1	−4.31	1.87	14.01	***	−3.58	2.19	5.17	***	−4.72	2.01	8.77	***	−4.43	1.36	11.73	***	1.33	ns	1.16	ns	0.44	ns
	T3-T2	0.95	1.29	4.47	***	0.76	1.80	1.34	ns	0.94	1.22	2.87	*	1.11	0.95	4.18	**	0.28	ns	0.59	ns	0.4	ns

ns: $P > 0.05$, *** $P < 0.001$, ** $P < 0.01$, * $P < 0.05$. Plus indicates a distal molar/canine relationship, Minus indicates a mesial molar/canine relationship.

cases. In the skeletal maturity groups, canine stability was greatest in the early adolescent group (100.0 per cent) and least stable in the late adolescent group (74.1 per cent).

OB, in the whole sample (Figures 4 and 5), remained stable in 75.7 per cent of the subjects, an insignificant relapse occurred in 16.2 per cent, and a true relapse in 8.1 per cent. In the skeletal maturity groups, OB stability was highest in the late adolescent group (85.7 per cent) and least stable in the adult group (69.2 per cent).

Discussion

The only significant group difference was a larger Class II molar relationship on the right side in the early adolescent group compared with the late adolescent group. Besides this, the subjects in the three groups were comparable in terms of malocclusion severity, such as OB (mean = 5.8 mm) and Class II molar relationship (mean = 0.8 CW).

In interpreting the results, it must, however, be taken into account that the size of the three maturity groups was relatively small, but unfortunately there were no more subjects available.

During the Herbst-MB treatment period (T2-T1), all Class II division 2 subjects were treated successfully to normal sagittal and vertical dental arch relationships. However, a slight distal canine relationship (0.16 CW) remained, which is a feature of

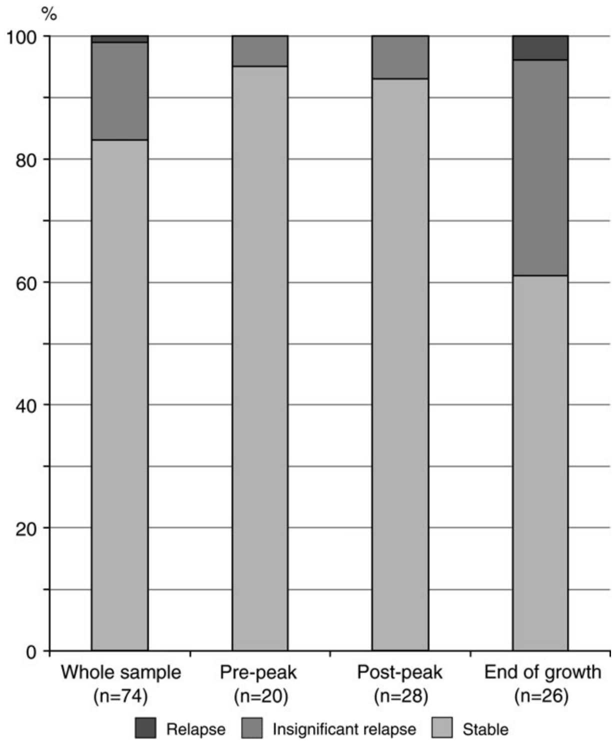

Figure 1 Prevalence (%) of molar stability (left and right side pooled) during the post-treatment period (T3-T2) in 37 Class II division 2 subjects. The degree of stability is shown for the whole sample and the three skeletal maturity groups.

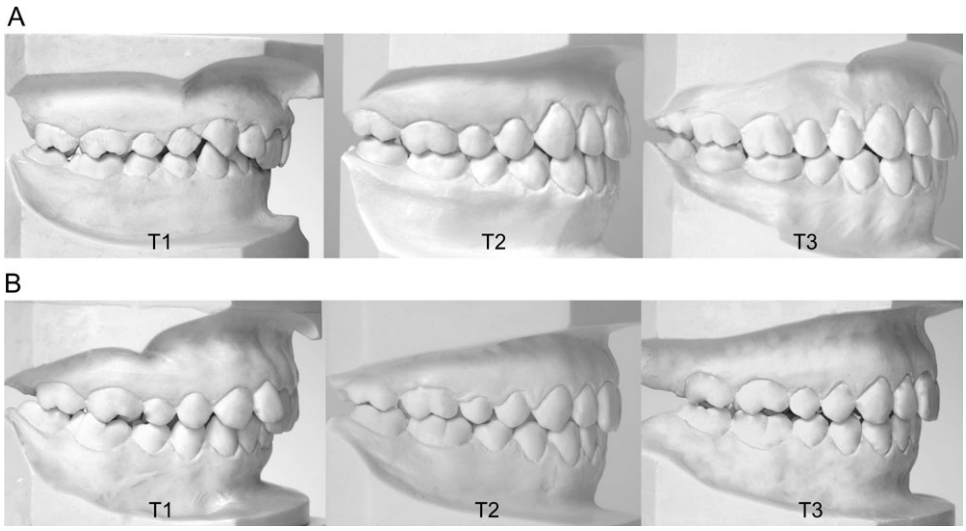

Figure 2 Sagittal occlusion: (A) stable and (B) true relapse (molar)/insignificant relapse (canine).

normal occlusion (Andrews, 1989). The larger amount of molar correction during treatment, seen in the early adolescent group, can be attributed to the more severe Class II molar relationship pre-treatment.

Thus, the immediate success of Herbst-MB treatment seems to be independent of the skeletal maturity stage in which treatment is performed. This assumption is supported by Konik *et al.* (1997), who found treatment with the Herbst appliance to be equally effective in Class II division 1 patients before and after the pubertal peak of growth. Unfortunately, no adequate data for Class II division 2 malocclusions are available in the literature.

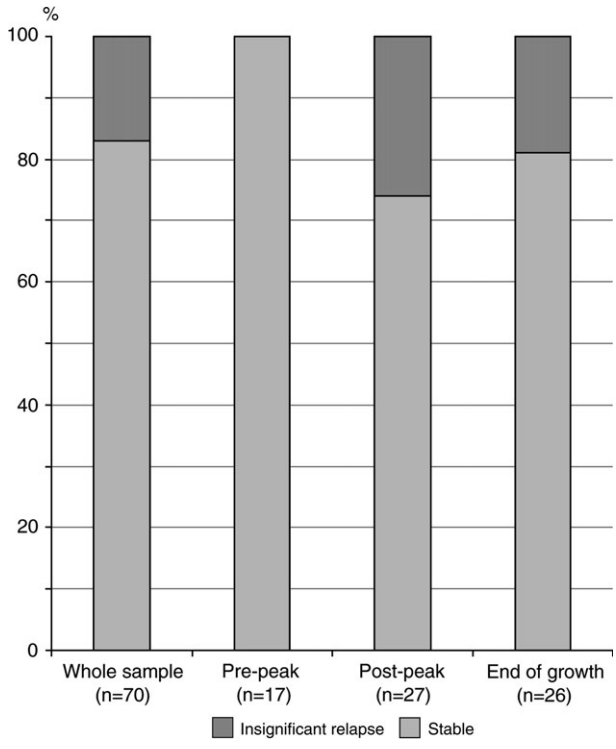

Figure 3 Prevalence (%) of canine stability (left and right side pooled) during the post-treatment period (T3-T2) in 37 Class II division 2 subjects. The degree of stability is shown for the whole sample and the three skeletal maturity groups.

When judging the results in terms of stability, it must be borne in mind that retention was performed using lower fixed retainers in 28 of the 37 subjects and that these retainers were still in place in 68 per cent of the subjects at the time of the present investigation. This could have influenced the stability of OB by preventing a retroclination of the lower incisors, a phenomenon observed by Riedel (1960), Ludwig (1966), Kim and Little (1999), and Schütz-Fransson *et al.* (2006). However, even if the lower fixed retainers might have had an influence on the stability of the sagittal canine occlusion, it seems unlikely that they influenced the sagittal molar relationship. Due to the limited number of subjects in the three subgroups and the variety of fixed/removable retention devices used, it was not possible to separately assess the influence of the retention device on sagittal occlusal stability.

During T3-T2, the occlusion settled to a stable Class I interdigitation and in most cases the OB recovered to normal values. This finding is in concordance with previous studies of Class II division 1 subjects (Pancherz and Hansen, 1986; Pancherz, 1991). However, in some cases, relapse could be seen during the post-treatment period resulting in certain differences between the skeletal maturity groups.

The molar relationship was least stable in the adult group where 35 per cent of the molars exhibited an insignificant relapse and almost 4 per cent a true relapse. In contrast, in the early adolescent and late adolescent groups, insignificant relapse was only seen for 5 and 7 per cent of the teeth, respectively, while a true relapse did not occur. However, a statistically significant difference existed for the right canine relationship between early adolescents and adults.

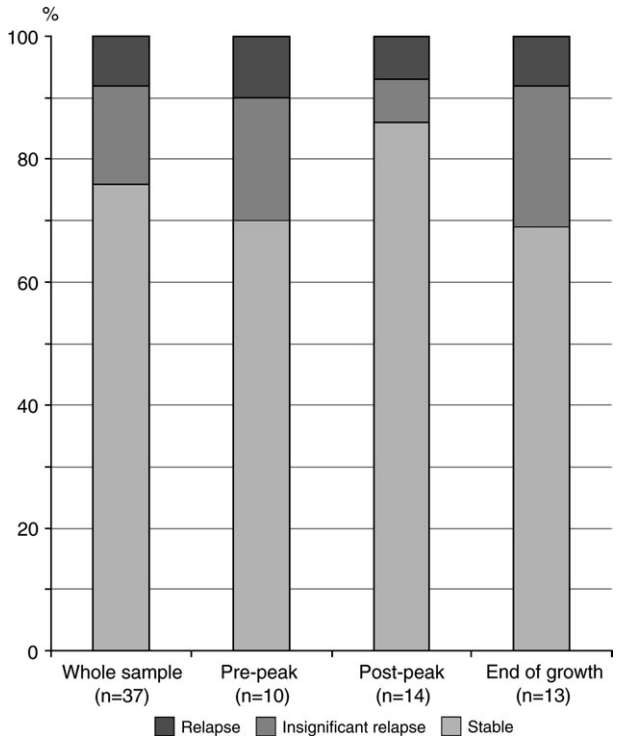

Figure 4 Prevalence (%) of overbite stability during the post-treatment period (T3-T2) in 37 Class II division 2 subjects. The degree of stability is shown for the whole sample and the three skeletal maturity groups.

The stability of the canine relationship was also greatest in the early adolescent group, in which no insignificant relapse or true relapse occurred. In the late adolescent group, an insignificant relapse was seen for 26 per cent and in the adult group for 19 per cent of the canines. A true relapse did not occur. Thus, the overall stability of Class II division 2 treatment with the Herbst appliance was good, but stability was greatest in the early adolescent group. This might be due to the fact that the Herbst appliance produces more dental effects contributing to Class II correction in late adolescent and adult patients than in early adolescent patients (Konik *et al.*, 1997; Ruf and Pancherz, 1999; Pancherz and Ruf, 2000).

Dental changes have been found to relapse especially in Class II division 2 Herbst patients treated late (Marku, 2006). Pancherz (1994) found long-term stability of the sagittal molar relationship in Class II division 1 subjects treated with the Herbst appliance to be greater in late adolescent subjects (0 per cent relapse) than in early adolescent subjects (29 per cent relapse). This seems to be contradictory in comparison with the present results which could be due to the fact that the early adolescent subjects in the study of Pancherz (1994) were in the early mixed dentition and passed through a period of unstable occlusion as the development of the dentition proceeded after Herbst treatment. The latter might have promoted relapse. However, Hansen *et al.* (1991) could not find a conclusive effect of

Figure 5 Overbite: (A) stable (T1 = 7.0 mm, T2 = 1.3 mm, and T3 = 2.1 mm). (B) Insignificant relapse (T1 = 5.4 mm, T2 = 0.8 mm, and T3 = 3.3 mm). (C) True relapse (T1 = 10.8 mm, T2 = 1.1 mm, and T3 = 4.1 mm).

the growth period on the long-term results in adolescent Class II division 1 Herbst patients.

Only three articles could be found in the literature which explicitly describe the stability of the sagittal molar and canine relationship in Class II division 2 subjects. Fuhrmann and Berg (1990) analysed 17 Class II division 2 subjects, on average 2.7 years after fixed appliance treatment, and found the molar and canine relationship to be stable. Thirty Class II division 2 subjects were evaluated by Canut and Arias (1999) who reported the molar relationship to be stable an average of 7 years after non-extraction fixed appliance treatment. Similar results were found by Kim and Little (1999), examining study models of 62 Class II division 2 subjects after a mean post-treatment period of 15.2 years.

The incidence of true relapse for OB was similar in all three groups (7–10 per cent) in the present study. However, most insignificant relapse occurred in the adult group (23 per cent) and in the early adolescent group (20 per cent), while the late adolescent group showed the smallest insignificant relapse rate of only 7 per cent.

The good OB stability in all three groups might be due to the improvement in the upper incisor to lower lip relationship occurring during Herbst-MB treatment (Schweitzer and Pancherz, 2001) and the proclination of the lower incisors resulting in favourable interincisor occlusal support.

For the early adolescent group in comparison with the late adolescent group, a large amount of remaining growth and a post-treatment return to the original growth pattern (Pancherz and Fackel, 1990) could explain the larger percentage of OB rebound (insignificant relapse). This hypothesis is supported by Al-Buraiki *et al.* (2005). On the other hand, the subjects in the adult group with no remaining growth potential showed almost the same insignificant relapse rate as the early adolescent group. This could be due to the fact that Herbst treatment produces more dental effects in adult patients than in adolescents (Konik *et al.*, 1997; Ruf and Pancherz, 1999; Pancherz and Ruf, 2000) and that these dental changes tend to relapse more than skeletal effects (Marku, 2006).

Only a few research projects have analysed OB stability explicitly in Class II division 2 cases. Binda *et al.* (1994) found a significant OB relapse (mean 1.2 mm; $P < 0.01$) 5 years post-retention. Canut and Arias (1999) observed that the OB increased by 0.96 mm (mean) during an average post-treatment period of 7 years. Kim and Little (1999) reported OB to relapse by 1.4 mm during a mean post-treatment period of 15.2 years. Lapatki *et al.* (2004) described an average relapse of 20 per cent of the achieved OB correction 2 years post-treatment. All these results are comparable with the present findings.

Conclusion

Orthodontic therapy of Class II division 2 malocclusions using the Herbst appliance showed acceptable occlusal stability and only small differences between the groups. However, relapse tendencies were seen more frequently in adults than in adolescents.

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