Original Article

Class II subdivision treatment with the Herbst appliance

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ABSTRACT

Objective: To assess the effectiveness of Class II subdivision Herbst nonextraction treatment and its short-term stability retrospectively.

Materials and Methods: Twenty-two Class II subdivision (SUB: right-left molar difference ≥0.75 cusp width) and 22 symmetric Class II patients (SYM: ≥0.75 cusp width bilaterally) were matched according to gender and pretreatment handwrist radiographic stage. The mean treatment duration of the Herbst and subsequent multibracket phase was 8 months and 14 months, respectively. The mean retention period amounted to 36 months. Dental casts from before treatment (T1), after Herbst treatment (T2), after Multibracket treatment (T3), and after retention (T4) were evaluated.

Results: A bilateral Class I or super Class I molar relationship was seen in 72.7% (SUB) and 77.3% (SYM) at T3. The corresponding values at T4 were 63.7% (SUB) and 72.7% (SYM). A unilateral or bilateral Class III molar relationship was more frequent in the SUB group (T3: +4.6%; T4: +13.6%). For overjet, similar mean values were seen in both groups after treatment (T3: SUB, 2.7 mm; SYM, 2.3 mm) and after retention (T4: SUB, 3.0 mm; SYM, 3.4 mm). This was also true for the midline shift (T3: SUB, −0.4 mm; SYM, 0.0 mm; T4: SUB, −0.3 mm; SYM, 0.0 mm).

Conclusion: Class II subdivision Herbst treatment was successful similarly to symmetric Class II Herbst treatment. However, a slight overcompensation of the molar relationship (Class III tendency) was more frequent in the subdivision patients (original Class I side). (Angle Orthod. 2013;83:327–333.)

KEY WORDS: Class II subdivision; Herbst; Stability

INTRODUCTION

Angle described the Class II subdivision as a separate group of Class II malocclusions characterized by a unilateral Class II molar relationship. Several articles have investigated and discussed the development of this asymmetric molar relationship in Class II subdivision cases. According to results derived from two-dimensional imaging studies, most Class II subdivision malocclusions are dentoalveolar in origin, while a skeletal contribution—due to an asymmetric mandible—seems to exist in only some patients. On the other hand, Sanders et al. using cone-beam computed tomography to evaluate a group of Class II subdivision malocclusions concluded that the etiology is mainly skeletal and due to an asymmetric mandible that is shorter and more posteriorly positioned on the Class II side.

The treatment of Class II subdivision malocclusions is generally considered challenging. Perhaps this is the reason that relatively few studies on Class II subdivision treatment exist in literature. Articles about more than case reports can be found for only the following treatment options: (1) nonextraction treatment using tip-back mechanics and (2) extraction treatments with one, three, or four premolar extraction protocols. A comparison of treatment options for Class II subdivision treatments demonstrated three premolar extraction protocols to be slightly superior to four premolar extraction protocols in terms of treatment success.

All of the above mentioned treatment options for Class II subdivision treatment are purely dentoalveolar and as such naturally not able to address skeletal deviations or specifically mandibular asymmetry. Although it seems logical that functional appliance...
therapy could be an appropriate treatment approach for Class II subdivision malocclusions, only a few case reports on removable and fixed functional appliances have been published. The same is true for surgical Class II subdivision treatments.

As no study has been published on the correction of Class II subdivision malocclusion using functional appliances and no data at all are available concerning the stability of Class II subdivision treatment, the purpose of the present study was to evaluate the success and short-term stability of Class II subdivision Herbst appliance treatment.

MATERIALS AND METHODS

After obtaining ethic approval (Protocol No. 37/10, Faculty of Medicine, University of Giessen, Germany), the records of all 400 Class II patients treated with a Herbst appliance at the Orthodontic Department at the University of Giessen, Germany, until 2008, were retrospectively examined for the following inclusion criteria: Class II subdivision molar relationship with a right-left difference of at least 0.75 cusp widths (CW), fully erupted premolars and canines at start of treatment, no history of asymmetric extractions or aplasia of permanent teeth, nonextraction treatment, no craniofacial syndromes or severe facial asymmetry, and a follow-up examination at least 12 months after the end of all active treatment.

Twenty-two consecutively treated subjects (11 boys, 11 girls) fulfilled the inclusion criteria for the subdivision group (SUB). The mean age at the start of treatment was 15 years (SD = 3.27; range = 12–27 years). The mean treatment length amounted to 8 months (SD = 1.59; range = 6–13 months) for the Herbst phase and 15 months (SD = 4.66; range = 7–24 months) for the subsequent multibracket (MB) phase. The mean follow-up period was 27 months (SD = 9.78; range = 12–53 months), and the mean total observation period was 50 months (SD = 11.00; range = 30–68 months).

The group for comparison was also generated from the whole sample of 400 Herbst patients. The inclusion criteria were the same except for the molar relationship, which had to be a symmetric Class II relationship of at least 0.75 CW on both sides. The subjects were matched based on the severity of the malocclusion and the pretreatment skeletal maturity stages (assessment of hand wrist radiographs according to Hägg and Taranger). If more than one subject from the control group fulfilled the matching criteria, the one in whom treatment had started chronologically closest to the one in the SUB group was selected.

The symmetric group (SYM) also consisted of 22 subjects (11 boys, 11 girls). The mean age at the start of treatment was 15 years (SD = 3.19; range = 12–26 years). The mean treatment length amounted to 8 months (SD = 1.96; range = 4–14 months) for the Herbst phase and 13 months (SD = 5.78; range = 5–27 months) for the subsequent MB phase. The mean follow-up period was 36 months (SD = 18.72; range = 12–93 months), and the mean total observation period was 56 months (SD = 18.1; range = 34–110 months).

All subjects of both groups were treated with a bilateral Herbst telescope mechanism attached to cast splints, which was activated unilaterally or bilaterally to a bilaterally overcorrected Class I molar and incisal edge-to-edge relationship at the start of treatment.

Study models (centric occlusion) from before (T1) and after Herbst treatment (T2), as well as after MB treatment (T3) and after retention (T4), of all subjects were analyzed.

The study models were evaluated for the following variables:

- MR, ML: Sagittal molar relation (Right, Left)
- OJ: Overjet (mean right/left)
- MS: Mandibular midline shift

Visual ratings of the molar relationship were performed to the nearest 0.25 CW and classified as Class I, II, or III. Linear measurements were made to the nearest 0.5 mm using a manual caliper. The investigator was blinded concerning the group affiliation (except for the study models from T1).

To minimize the error of the method, all assessments were performed twice with a time interval of at least 2 weeks between evaluations. The mean value of both measurements was used as the final measurement value.

For statistical reasons, data modification (mirroring of values) was performed to have all study models of the SUB group exhibit the Class II relationship on the same side ("right" side). As no comparable data were found in the literature, the statistical method was defined as explorative. To evaluate group differences, the Fisher's exact test was used for the variable molar relationship, while the rank sum test was used to evaluate overjet and midline shift.

RESULTS

The detailed results are presented in Figure 1 (molar relationship), Table 1 (overjet), and Table 2 (midline shift).

Molar Relationship

Before treatment (T1)—and in accordance with the inclusion criteria—a Class II molar relationship was seen in all subjects of both groups (SUB and SYM) on the right side and in all subjects of the SYM on the left.

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side. Therefore, a group difference ($P < .001$) existed for the molar relationship on the left side only.

After Herbst treatment (T2), a bilateral Class I or super Class I ($\leq 0.25$ cusp widths mesial) molar relationship was seen in 18.2% of the subjects of the SYM subjects only. A unilateral or bilateral Class III molar relationship ($\geq 0.25$ cusp widths mesial) was seen in 100.0% of the SUB subjects and 81.8% of the SYM subjects.

After subsequent MB treatment (T3), a bilateral Class I or super Class I molar relationship was seen in 72.7% of the SUB subjects and 77.3% of the SYM subjects in the SYM. The remaining subjects exhibited either a unilateral or bilateral Class III molar relationship (SUB: 9.1%, SYM: 4.5%) or a unilateral or bilateral Class II molar relationship (SUB: 18.2%, SYM: 18.2%).

After retention (T4), a bilateral Class I or super Class I molar relationship was seen in 63.7% of the subjects of the SUB and 72.7% of the subjects in the SYM group. The remaining subjects exhibited either a unilateral or bilateral Class III molar relationship (SUB: 13.6%) or a unilateral or bilateral Class II molar relationship (SUB: 22.7%, SYM: 27.3%).

Statistically, the only group difference ($P = .0463$) was seen for the molar relationship on the left side (pretreatment Class I side in the SUB group) after retention. At this time, the frequency of a mild Class III tendency was higher in the SUB group, while a mild Class II tendency was seen more often in the SYM group.

**Overjet**

While the overjet values differed moderately between SUB and SYM before treatment (SUB: mean 6.3 mm; SYM: mean 7.8 mm; $P > .05$) and immediately after Herbst treatment (SUB: mean $-1.6$ mm; SYM: mean $-0.1$ mm; $P < .05$), no difference was seen either after MB treatment (SUB: mean 2.7 mm; SYM: mean 2.3 mm; $P > .05$) or after retention (SUB: mean 3.0 mm; SYM: mean 3.3 mm; $P > .05$).

**Midline Shift**

Concerning the midline shift, a moderate difference existed between SUB and SYM before treatment (SUB: median $-2.0$ mm; SYM: median 0.0 mm; $P < .01$), expressing the fact that a midline deviation toward the Class II side was more frequent in the SUB group. However, this difference decreased during treatment, and no further statistical difference ($P > .05$) was seen thereafter (T2, T3, T4 – SUB = SYM: median 0.0 mm).

**DISCUSSION**

The present investigation is the first to evaluate functional appliance treatment of Class II subdivision malocclusions systematically and to deal with stability of Class II subdivision treatment. Accordingly, the possibility for literature comparison was limited.

The investigation is based on a retrospective evaluation of study models, which were evaluated by a blinded examiner. Even if no untreated control group was available, a group of symmetric Class II malocclusion subjects was matched according to the severity of the malocclusion and the skeletal maturity during which treatment was performed. Furthermore, both groups were homogeneous concerning the treatment protocol (Herbst-MB treatment, nonextraction), which was identical in all subjects, naturally except for the symmetric/asymmetric mandibular advancement.

During Herbst treatment (T2–T1), nearly all subjects in both groups (SUB and SYM) were treated to an overcorrected Class I or Class III molar relationship. While for a symmetric advancement this has clearly been shown to be the result of a stimulation of mandibular growth in conjunction with dentoalveolar effects, a corresponding unilateral effect for the SUB group can be expected based on the case reports by Paulsen and Karle and Paulsen et al. During the subsequent MB phase (T3–T2), the occlusion settled, and in most cases of both groups (73%–77%), a bilateral Class I or super Class I molar relationship could be established. This occlusal settling is in concordance with previous Herbst studies. For other treatment protocols, no comparable data were found in the literature.

The main difference between the two groups was seen after the retention period when there was a clear tendency ($P = .0463$) toward more frequent Class III molar relationships in the SUB on their former Class I side and more frequent Class II molar relapse in the SYM group. For the former Class II side of the SUB group, neither a difference in comparison to the SYM group nor to previous Herbst publications was found. Therefore, the overall short-term stability of Class II subdivision treatment with the Herbst appliance can be considered as good. No comparable data concerning the stability of treatment results in Class II subdivision patients were found in the literature.

Although there were slight differences between the groups regarding the overjet before treatment, it was corrected to similar average and median values both after treatment and after retention. Comparable data were reported by Janson et al., who compared asymmetric and symmetric extraction protocols in Class II subdivision patients and found mean post-treatment overjet values of 2.4–2.6 mm.

While interpreting the changes of the follow-up period of the present investigation in terms of stability, it must be taken into account that fixed retainers were still in place in most of the cases during this period.
Figure 1. (a) Individual molar relationship (right side) in the subdivision (SUB) and symmetric (SYM) Class II groups at T1 (before treatment), T2 (after Herbst treatment), T3 (after MB treatment) and T4 (after retention).
Figure 1. Continued. (b) Individual molar relationship (left side) in the subdivision (SUB) and symmetric (SYM) Class II groups at T1 (before treatment), T2 (after Herbst treatment), T3 (after MB treatment), and T4 (after retention).
This could have influenced the stability of the overjet by preventing a proclination of the upper and a retroclination of the lower incisors. However, it seems unlikely that these retainers had an influence on the above mentioned stability of the sagittal molar relationship. Furthermore, it seems even more unlikely that they had differing effects in the SUB and SYM groups that could account for the reported differences.

The midline shift before treatment was more pronounced (average and median) in the SUB group, in which it tended to deviate to the Class II side. Nevertheless, it should be noted that there were also large interindividual differences regarding midline shifts in the SYM group. Furthermore, it cannot be ruled out that part of the pretreatment group difference was due to the value mirroring in the SUB group. Because, for natural reasons, no such mirroring could be performed in the SYM group, possible left/right midline shifts might arithmetically have compensated themselves. Although no further group difference existed after T1, large interindividual differences prevailed in both groups. Therefore, in some of the Class II subdivision subjects, even a midline shift to the original Class I side could be seen, for example, if the malocclusion was not only caused by skeletal but also dentoalveolar reasons. Changes in midline shift during Class II subdivision treatment were also assessed by Janson et al., who found an average midline deviation after fixed appliance treatment of 0.6 mm in the group of four premolar extractions and 0.1 mm in the group of three premolar extractions.

Overall, the present investigation showed that nonextraction Herbst-MB treatment of Class II subdivision malocclusions proved to be quite successful. Furthermore, good short-term stability of the treatment results was observed. However, because of the limited number of subjects, the influence of covariables (ie, skeletal maturity at start of treatment) could not be assessed.

Furthermore, the evaluation of skeletal and facial asymmetry would have been desirable. However, the available records did not enable drawing significant conclusions as PA radiographs did not exist at all and enface photographs were not available for all patients and time points. On the other hand, patients with severe facial asymmetry had been excluded and mild asymmetries might even have been present in the symmetric group. From the clinical point of view, the asymmetric advancement in the SUB group did not seem neither to improve nor worsen the degree of facial symmetry.

**CONCLUSIONS**

- Class II subdivision Herbst treatment was similarly as successful as symmetric Class II Herbst treatment with respect to the occlusal correction.
- After retention, a slight overcompensation of the molar relationship (Class III tendency) was more frequent in Class II subdivision patients (original Class I side).

### Table 1. Overjet (OJ) in the subdivision (SUB) and symmetric (SYM) Class II group at T1 (before treatment), T2 (after Herbst treatment), T3 (after Multibracket treatment) and T4 (after retention). The median (MEDIAN), arithmetic Mean (MEAN), standard deviation (SD), minimum (MIN) and maximum (MAX) are shown as well as the statistical group differences (p-value)

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### Table 2. Midline Shift (MS) in the Subdivision (SUB) and Symmetric (SYM) Class II Group at T1 (Before Treatment), T2 (After Herbst Treatment), T3 (After Multibracket Treatment), and T4 (After Retention)*

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* The median, arithmetic mean, standard deviation, minimum, and maximum are shown as well as the statistical group differences (P value). Minus (−) means a midline shift to the right side (Class II side in SUB).
REFERENCES