Dental Research Journal

Original Article

Comparison between Herbst appliances with or without miniscrew anchorage

Antonio Manni[1], Marco Pasini[2], Cozzani Mauro[3]

[1]Dentist, Private Practice, Lecce, [2]Dentist, Private Practice, Massa, [3]Dentist, Private Practice, La Spezia, President, Scientific Committee, UO Odontoiatria IRCCS G. Gaslini Largo G. Gaslini 5 16100 Genova, Italy

ABSTRACT

Background: Herbst appliance is largely used in orthodontics for the correction of Class II. The aim of this paper was to analyze dental and skeletal effects of a splints Herbst-miniscrews combined device in comparison to a mandibular splints Herbst appliance.

Materials and Methods: Fifty Class II division 1 patients (27 males and 23 females with a mean age of 11.8 ± 1.7 years) were included in the study. Lateral headfilms of 25 patients with a mandibular resin splint and a miniscrew anchorage (test group) and of 25 patients with mandibular acrylic resin splints (control group) were analyzed before (T0) and after (T1) the Herbst treatment. The mean and standard deviation (SD) of each variable were calculated; paired *t*-test was used to evaluate statistical changes before and after the treatment, in each group and Student *t*-test was used to compare the two groups.

Results: Significant differences were observed for $P < 0.05$. At the end of the Herbst treatment, mandibular incisor proclination was significantly lower in the test group (2.8°) in comparison to the control group (7.4°).

Conclusions: The miniscrew-Herbst system, described in the present study, allows correction of Class II malocclusion, with a lower anchorage loss, in form of mandibular incisor proclination, during the treatment, in comparison to mandibular acrylic splints Herbst.

Key Words: Herbst, miniscrews, skeletal anchorage

Received: August 2012
Accepted: November 2012

Address for correspondence:
Dr. Cozzani Mauro,
Via Fontevivo, 21N,
La Spezia (SP), 19125 Italy.
E-mail: maurocozzani@gmail.com

INTRODUCTION

Herbst appliance is largely used in orthodontics for the correction of Class II. The main points in favor are the short time required for the treatment and the fact that it does not need patient compliance.[1,2] Its effects are dental, including a posterior displacement of the upper dental arch and anterior displacement of the lower dental arch, and skeletal, such as a reduced sagittal growth of the maxilla and an enhanced sagittal growth of the mandible. It should be kept in mind that these skeletal effects vary among subjects, between sexes and with time of the therapy.[2] Several genetic studies have been done during the years.[3-6]

It is well known that a point in disfavor of the Herbst treatment is a proclination of lower incisors due to the forces exerted on the lower teeth by the same telescope device.[7]

Various modifications of the original Herbst such as the use of class III elastics, reduced and total cast splints, have been proposed, but none has been able to completely stop the proclination of mandibular incisors.[8]

Weschler and Pancherz stated that the mandibular anchorage loss in Herbst treatment is a reality with which the orthodontist has to live and up until now there has been an agreement that flaring of the lower incisors cannot be prevented by any kind of anchorage system.[7]

Access this article online

Website: www.drj.ir

Not only did the introduction of the skeletal anchorage allow the simplification of many procedures conventionally employed for the control of anchorage, but also the reduction of the undesirable effects of many appliances too.[8] Moreover, miniscrews present many advantages, including low cost, low invasive insertion procedures and great versatility. Many authors have demonstrated that they can be used as successful sources of anchorage during orthodontic therapy.[9-13]

To our knowledge, the possibility of combining Herbst appliance with skeletal anchorage has not been previously described in literature.

Therefore, the aim of this study was to analyze dental and skeletal effects of an acrylic Herbst-miniscrews combined device in comparison to a acrylic cast splints Herbst appliance, in the correction of Class II malocclusion.

MATERIALS AND METHODS

Patients who could benefit from Herbst treatment, who had a bilateral Angle Class II division 1 malocclusion, ≥1/2 cusp width, who were in the permanent or late mixed dentition, whose parents signed an informed consent form, were eligible for inclusion in the study. Patients were not included in the study if any of the following exclusion criteria were present: Poor oral hygiene and motivation, tooth agenesis or premature loss of permanent teeth, presence of second molars, transverse or vertical discrepancies, and incomplete available records.

All parents received thorough explanations and a written informed consent form prior to being enrolled in the study. Each case was accurately evaluated by a unique operator (AM) to assess the inter-arch relationships, panoramic radiographs, and lateral head films.

A total of 56 subjects were considered eligible for this study. Patients were allocated to either a test (combination of Herbst appliance with reduced mandibular acrylic splint, from first molar to first molar, and miniscrews) or control (Herbst with mandibular acrylic splint) group using a computerized random allocation process. A computer generated restricted randomization list was created. Only one of the investigators, not involved in selection and treatment of the patients, was aware of the randomization sequence and could have access to the randomization list. The randomized codes were enclosed in sequentially numbered, identical, opaque, and sealed envelopes.

Six patients refused to take part in this study and the final sample consisted of 50 patients, including 27 males and 23 females with a mean age of 11.8 ± 1.7 years.

In the test group, the miniscrews were applied in mandibular bone at the level of marginal or attached gingiva or mucogingival junction, between the lower first molar and second premolar.[14] The miniscrews employed (MAS, Micerium, Avegno, Italy) were titanium, 11 mm long, and shaped like a truncated cone with a diameter of 1.5 or 1.3 mm (according to the bone level) at the point and 2.2 mm at the neck. The shank of the screws was 1 mm in diameter, the threaded part had a length of 8 mm, and the heads featured a hexagonal slot to house the head of the screwdriver or contra-angle hand piece.

The mouth of each test patient was rinsed with 0.1% chlorhexidine gluconate solution and predrilling was carried out, and the miniscrews were inserted by means of a manual screwdriver.

According to the randomization sequence, a metallic or elastic ligature (100 g) linked the miniscrews to metallic buttons bonded to the lower canines of each side.

All patients included in the present study were treated by the same orthodontist (AM).

Lateral cephalograms were obtained for all patients before (T0) and at the end (T1) of the Herbst treatment to evaluate the outcome of the orthodontic therapy. No patients dropped out during the study.

The Sagittal Occlusion analysis of Pancherz (analysis of changes in sagittal occlusion)[15] was carried out manually for each patient by the same researcher blinded to the type of treatment received by the patient (MP), in order to analyze quantitatively the skeletal and dental structures.

This methodology was chosen in order that the results of this study would be comparable with the effects of various other Herbst devices described by other authors.[7]

Occlusal line (OL) and Occlusal Line perpendicular (OLp) were transferred from the first lateral head film to the second by superimposition of the radiographs on stable bone structures of anterior cranial base. Furthermore, other parameters, including mandibular incisor proclination and cranial base-mandible angle were considered [Figure 1].

All linear and angular measurements were taken to the nearest 0.5 mm and 0.5°, respectively. Moreover, all these measurements were performed twice, with a 7-day interval between the two recordings, in order to calculate Dahlberg's formula Method errors of the cephalometric variables were less than 1 mm, for linear measurements, and less than 1° for angular measurements.

The mean and standard deviation (SD) of each variable were calculated and paired *t*-test was used to evaluate statistical changes before and after the treatment, in each group. Student *t*-test was used to compare the two groups and significant differences we observed for $P < 0.05$.

RESULTS

All subjects of both groups had been successfully treated to an overcorrected bilateral Class I molar relationship.

Pretreatment and posttreatment records are shown in Table 1.

Total treatment duration (T0-T1) was comparable in the two groups, being 7.6 months for the test group and 7.5 months for the control group. No miniscrews were lost, or replaced, or became mobile during the treatment.

Maxillary and mandibular base

A slight maxillary base retrusion was achieved in both groups at the end of the Herbst treatment. At T0, the test group had an average A/OLp of 79.1 ± 4.3 mm, which had decreased by 0.4 to 78.7 ± 4.4 mm at T1 ($P > 0.05$) and the control subjects had an average A/OLp of 76.6 ± 3.4 mm at T0, which had decreased by 1 to 75.6 ± 3.7 mm at T1 ($P > 0.05$).

Comparing the groups with the *t*-test, no significant differences were observed ($P > 0.05$).

In the test group, an advanced position of Pg/OLp by 2.2 mm (from 81.1 ± 5.1 mm at T0 to 83.3 ± 5.8 mm at T1) was found at the end of the treatment ($P < 0.05$).

In the control subjects, Pg/Olp slightly decreased by 0.3 mm from 78 ± 4.6 mm at T0 to 77.7 ± 6.1 mm at T1 ($P > 0.05$).

Comparing the groups with the *t*-test, no significant differences were recorded ($P > 0.05$).

Skeletal discrepancy decreased both in the test group, from −2 ± 3 mm at T0 to −4.5 ± 3.4 mm at T1 ($P < 0.05$), and in the control group, from −1.4 ± 3.3 mm at T0 to −2.1 ± 4 mm at T1 ($P < 0.05$).

No significant difference between the two groups was found ($P > 0.05$).

Maxillary and mandibular incisors

Maxillary incisors showed at the end of the treatment a slight incisal edge retrusion both in the test group (from

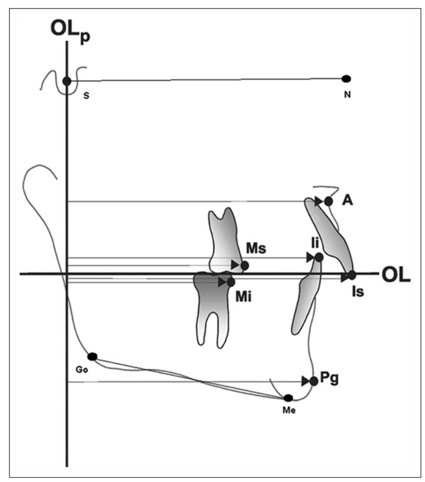

Figure 1: Modified SO Pancherz analysis: Measuring landmarks and measuring distances

Table 1: Records of test and control group before treatment (T0) and after treatment (T1)

Variables	Test (T0)	Test (T1)	Control (T0)	Control (T1)	Group differences
Maxillary base: A/Olp	79.1±4.3	78.7±4.4	76.6±3.4	75.6±3.7	n.s
Mandibular base: Pg/Olp	81.1±5.1	83.3±5.8	78±4.6	77.7±6.1	n.s
Maxillary incisor: Is/Olp	86.6±5.4	86.5±5	83.5±4.3	82.5±5.1	n.s
Mandibular incisor: Ii/Olp	80±5.1	83±4.9	76.9±4.2	78.9±4.9	n.s
Maxillary molar: Ms/Olp	55±4.9	53.9±4.4	51.7±4.2	49.6±4.9	n.s
Mandibular molar: Mi/Olp	53.9±5.7	57.6±5.1	49.8±4.7	52.5±5.4	n.s
Skeletal discrepancy: A/Olp minus Pg/Olp	−2±3	−4.5±3.4	−1.4±3.3	−2.1±4	n.s
Overjet: Is/Olp minus Ii/Olp	6.6±2.4	3.4±1.4	6.6±2.2	3.6±1.5	n.s
Molar relation: Ms/Olp minus Mi/Olp	1±1.8	−3.8±2.6	1.8±1.8	−2.6±2.9	n.s
Mandibular incisor proclination: Ii/GoMe	100.5±6	103.3±5.7	94.5±4.7	101.9±7.4	$P<0.05$
Maxillary-mandibular plane angle: SN-GoMe	33.5±6.4	32.6±6.3	32.8±5.6	33±6.6	n.s

86.6±5.4 mm at T0 to 86.5±5 mm at T1; $P > 0.05$) and in the control subjects (from 83.5±4.3 mm at T0, to 82.5±5.1 mm at T1; $P > 0.05$). No significant differences between the groups were observed ($P > 0.05$).

Mandibular incisal edge advanced more in the test group (by 3 mm, from 80 ± 5.1 mm at T0 to 83±4.9 mm at T1; $P < 0.05$), than in the controls (by 2 mm, from 76.9 ± 4.2 mm at T0 to 78.9 ± 4.9 mm at T1; $P < 0.05$), although the difference between the groups was not statistically significant ($P > 0.05$).

The Herbst treatment improved similarly the overjet in both groups. At T0, the test group had an average overjet of 6.6 ± 2.4 mm, which at T1 had significantly decreased to 3.4 ± 1.4 mm ($P < 0.05$).

The control subjects had an average overjet of 6.6 ± 2.2 mm at T0, which had significantly decreased to 3.6 ± 1.5 mm at T1 ($P < 0.05$).

Comparing the groups with the *t*-test, no significant differences were recorded ($P > 0.05$).

Flaring of the lower incisors was noticed in all subjects. However, the mean mandibular incisor proclination in the test group, at the end of Herbst treatment, was lower (by 2.8°, from 100.5° ± 6° at T0 to 103.3 °± 5.7° at T1; $P < 0.05$) compared with the controls (by 7.4°, from 94.5° ± 4.7° at T0 to 101.9° ± 7.4° at T1; $P < 0.05$) and the difference between the two groups was statistically significant ($P < 0.05$).

Maxillary and mandibular molars

A similar maxillary molar distalization was achieved in both groups at end of the treatment. At T0, the test group had an average Ms/OLp of 55 ± 4.9 mm, which at T1 had decreased to 53.9 ± 4.4 mm ($P < 0.05$) and the control group had an average Ms/OLp of 51.7 ± 4.2 mm at T0, which had decreased to 49.6 ± 4.9 mm at T1 ($P < 0.05$). Comparing the groups with the *t*-test, no significant differences were recorded ($P > 0.05$).

A mesialization of lower molars was found both in the test group (by 3.7 mm, from 53.9 ± 5.7 mm at T0 to 57.6 ± 5.1 mm at T1; $P < 0.05$) and in the control subjects (by 2.7 mm, from 49.8 ± 4.7 mm at T0 to 52.5 ± 5.4 mm at T1; $P < 0.05$). The difference between the groups was not statistically significant ($P > 0.05$).

At T0, the test group had an average molar relationship of 1 ± 1.8 mm, which at T1 had significantly decreased to –3.8 ± 2.6 ($P < 0.05$). At T0, the control group had an average molar relationship of 1.8 ± 1.8 mm, which at T1 had significantly decreased to –2.6 ± 2.9 ($P < 0.05$).

Considering molar relationship, differences between the groups were not statistically significant ($P > 0.05$).

Cranial base-mandible angle

A slight anterior rotation of the mandible was found in the test group (SN/GoMe decreased from 33.5° ± 6.4° at T0 to 32.6° ± 6.3° at T1; $P > 0.05$), whereas in the control subjects a posterior rotation of the mandible was observed (SN/GoMe increased from 32.8° ± 5.6° at T0 to 33° ± 6.6° at T1; $P > 0.05$). However, the difference between the groups was not significant ($P > 0.05$).

DISCUSSION

Our results highlight that both types of Herbst treatments are efficient in the correction of Class II malocclusion. At the end of the therapy a bilateral first Class molar relationship was achieved in all patients, with a significant decrease of the overjet and the skeletal discrepancy.

Several factors contributed to these changes including: A slightly backward movement of the maxillary incisors, a forward movement of the mandibular incisors, a restraint of the forward movement of the maxilla and, in the test group, a forward movement of the mandible. Lucchese *et al*. and other authors conducted studies about the prediction of third molar eruption.[3-6,12,16,17]

The treatment did not determine significant alterations of the cranial base-mandibular angle, and this is in agreement with that of other Herbst studies.[18,19]

Results of the present study showed that in both groups of patients there was an increase of lower incisor proclination that is a general side effect of Herbst appliance treatment.

However, the combination of Herbst and miniscrews allowed a significantly better control of mandibular incisor proclination, in comparison with the control patients.

The combined miniscrew system has been shown to be able to consistently reduce mandibular incisor proclination, in comparison with other studies.[7]

Hansen *et al*.[20] found a mandibular incisor proclination of 10.8° as a result of the total mandibular cast splint Herbst treatment.

Ruf *et al*.[21] observed a mean lower incisor proclination of 8.9° in 98 Class II total mandibular splint Herbst patients.

Von Bremen *et al*. in 2005[22] observed the anchorage loss with reduced and total mandibular cast splints, during Herbst treatment, and found a mean proclination of mandibular incisors of 11.8° and 9.3°, respectively.

El-Fateh and Ruf[23] analyzed 100 Class II patients treated with reduced mandibular splint Herbst and recorded at the end of the treatment a mean lower incisors proclination of 12.9° ±4.6°.[17]

Recently, a lingual appliance and Herbst combination with full control over mandibular incisor was introduced by Wiechmann *et al*.[24] However, these preliminary results need further investigations because of the small number of subjects included and the retrospective nature of the study.

In our research, the test group had lower proclination of incisors but a slightly more protruded mandibular incisor position (Is/OLp) than the control group.

These findings are contradictory as it is expected that a higher incisor proclination will result in increased incisal edge protrusion.

One possible explanation would be that the test group showed a slightly enhanced sagittal position of the mandible (Pg/OLp) in comparison to the control group. Furthermore, in the test group a slight anterior rotation of the mandible was observed.

The amount of forward movement of the mandible recorded in the test group was similar with that of other studies: Wigal *et al*. observed twenty-two patients with Class II division 1 malocclusion treated with an edgewise crowned Herbst appliance in the early mixed dentition and found a mean forward movement of the mandibular base of 2.0 mm.[25]

According to our results, it might be speculated that a better mandibular incisor proclination control would allow a slightly mesial displacement of the mandible.

Taira *et al*. evaluated the effects of mandibular advancement plus prohibition of lower incisor movement on mandibular growth in rats and found that mandibular growth was accelerated before and during the pubertal period by mandibular advancement with a fixed functional appliance combined with prohibition of labial movement of the lower incisor.[26]

We also have to consider that skeletal effects vary between sexes and with time of the treatment. A point in favour of this study is that the two groups of subjects were similar for age and sex.

On the other hand a limitation of the study was the relatively small sample size.

Another sign of anchorage loss due to the Herbst appliance is the advancement of the lower molars observed at the end of the treatment, despite the fact that in both groups splints reached the first mandibular molars. Thus, an active sagittal displacement of the mandibular molars was not avoided by the use of dental or skeletal anchorage systems. It might be assumed that the lower arch mesial displacement is partly due both to the mandible advancement and dental anchorage loss.

CONCLUSION

It can be concluded that the miniscrew-Herbst system, described in the present study, allows correction of Class II malocclusion, with a slight lower incisor proclination during treatment.

Further investigations should be carried out increasing the number of patients involved in the survey, in order to confirm the present findings.

REFERENCES

1. Keim RG, Gottlieb EL, Nelson AH, Vogels DS, 3rd. 2002 JCO study of orthodontic diagnosis and treatment procedures. Part 3. More breakdowns of selected variables. J Clin Orthod 2002;36:690-9.
2. Du X, Hagg U, Rabie AB. Effects of headgear Herbst and mandibular step-by-step advancement versus conventional Herbst appliance and maximal jumping of the mandible. Eur J Orthod 2002;24:167-74.
3. Lucchese A, Carinci F, Brunelli G, Monguzzi R. Everstick® and Ribbond® fiber reinforced composities: Scanning electron microscope (sem) comparative analysis. Eur J Inflamm 2011;9:73-80.
4. Palmieri A, Zollino I, Clauser L, Lucchese A, Girardi A, Farinella F, *et al*. Biological effects of resorbable plates on normal osteoblasts and osteoblasts derived from Pfeiffer syndrome. J Craniofac Surg 2011;22:1-4.
5. Sollazzo V, Pezzetti F, Massari L, Palmieri A, Brunelli G, Zollino I, *et al*. Evaluation of gene expression in MG63 human osteoblastlike cells exposed to tantalum powder by microarray technology. Int J Periodontics Restorative Dent 2011;31:e17-28.
6. Lucchese A, Storti E. Morphological characteristics of primary enamel surfaces versus permanent enamel surfaces: SEM digital analysis. Eur J Paediatr Dent 2011;12:179-83.
7. Weschler D, Pancherz H. Efficiency of three mandibular anchorage forms in Herbst treatment: A cephalometric investigation. Angle Orthod 2005;75:23-7.
8. Gracco A, Luca L, Siciliani G. Molar distalisation with skeletal anchorage. Aust Orthod J 2007;23:147-52.
9. Gracco A, Cirignaco A, Cozzani M, Boccaccio A, Pappalettere C, Vitale G. Numerical/experimental analysis of the stress field

around miniscrews for orthodontic anchorage. Eur J Orthod 2009;31:12-20.
10. Kinzinger GS, Gulden N, Yildizhan F, Diedrich PR. Efficiency of a skeletonized distal jet appliance supported by miniscrew anchorage for noncompliance maxillary molar distalization. Am J Orthod Dentofacial Orthop 2009;136:578-86.
11. Lucchese A, Manuelli M. Prediction of eruption or impaction of the third molar: Comparative analysis. Prog Orthod 2003;4:4-19.
12. Lucchese A, Carinci F, Brunelli G, Monguzzi R. An *in vitro* study of resistance to corrosion in brazed and laser welded orthodontic Eur J Inflamm 2011;9:67-72.
13. Lucchese A, Sfondrini MF, Manuelli M, Gangale S. Fixed space maintainer for use with a rapid palatal expander. J Clin Orthod 2005;39:557-8.
14. Manni A, Cozzani M, Tamborrino F, De Rinaldis S, Menini A. Factors influencing the stability of miniscrews. A retrospective study on 300 miniscrews. Eur J Orthod 2011;33:388-95.
15. Pancherz H. The mechanism of Class II correction in Herbst appliance treatment. A cephalometric investigation. Am J Orthod 1982;82:104-13.
16. Lucchese A, Sfondrini MF, Cacciafesta V, Gangale S. Mechanical properties of FRCs and orthodontic twisted wires: A three point bending test. Am Ass of Orthod book of paper; 2005;1:48. San Francisco, California.
17. Byahatti S, Ingafou MS. Prevalence of eruption status of third molars in Libyan students. Dent Res J 2012;9:152-7.
18. Ruf S, Pancherz H. Herbst/multibracket appliance treatment of Class II division 1 malocclusions in early and late adulthood. a prospective cephalometric study of consecutively treated subjects. Eur J Orthod 2006;28:352-60.
19. Ruf S, Pancherz H. The effect of Herbst appliance treatment on the mandibular plane angle: A cephalometric roentgenographic study. Am J Orthod Dentofacial Orthop 1996;110:225-9.
20. Hansen K, Koutsonas TG, Pancherz H. Long-term effects of Herbst treatment on the mandibular incisor segment: A cephalometric and biometric investigation. Am J Orthod Dentofacial Orthop 1997; 112:92-103.
21. Ruf S, Hansen K, Pancherz H. Does orthodontic proclination of lower incisors in children and adolescents cause gingival recession? Am J Orthod Dentofacial Orthop 1998;114:100-6.
22. von Bremen J, Pancherz H, Ruf S. Reduced mandibular cast splints an alternative in Herbst therapy? A prospective multicentre study. Eur J Orthod 2007;29:609-13.
23. El-Fateh T, Ruf S. Herbst treatment with mandibular cast splints–revisited. Angle Orthod 2011;81:820-7.
24. Wiechmann D, Schwestka-Polly R, Pancherz H, Hohoff A. Control of mandibular incisors with the combined Herbst and completely customized lingual appliance–a pilot study. Head Face Med 2010;6:3.
25. Wigal TG, Dischinger T, Martin C, Razmus T, Gunel E, Ngan P. Stability of Class II treatment with an edgewise crowned Herbst appliance in the early mixed dentition: Skeletal and dental changes. Am J Orthod Dentofacial Orthop 2011;140:210-23.
26. Taira K, Iino S, Kubota T, Fukunaga T, Miyawaki S. Effects of mandibular advancement plus prohibition of lower incisor movement on mandibular growth in rats. Angle Orthod 2009;79:1095-101.

How to cite this article: Manni A, Pasini M, Mauro C. Comparison between Herbst appliances with or without miniscrew anchorage. Dent Res J 2012;9:S216-21.

Source of Support: Nil. **Conflict of Interest:** None declared.