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Based on the “bite jumping” idea introduced by Kingsley in 1877, Emil Herbst developed his appliance in the early 1900s and presented it for the first time at the International Dental Congress in Berlin in 1909. Twenty-five years later, in 1934, Herbst wrote about his experiences with the appliance in 3 articles. After that time, very little was published about the subject until Pancherz reintroduced the treatment method in 1979.

Initially, Pancherz used the Herbst bite jumping mechanism as a scientific tool in clinical-experimental orthodontic-orthopedic research. Through the years, however, it became obvious that the appliance is most useful in the therapy of severe Class II malocclusions. In comparison to conventional functional appliances (eg, activator, bionator, Fränkel), the Herbst appliance has several clinical advantages: The appliance is (1) fixed to the teeth, (2) works continuously 24 hours a day, (3) does not interfere with speech, and (4) requires no patient compliance to attain the desired treatment effects.

In 1979, Pancherz used a banded design of the Herbst appliance with a simple anchorage system. In the maxillary dental arch, the anchorage units on each side comprised the first premolar and the first permanent molar connected to each other by a lingual sectional arch wire. In the mandibular dental arch, the first premolars were interconnected by a lingual arch wire touching the lingual surfaces of the anterior teeth. The telescoping tube was attached to the maxillary molar band and the plunger to the mandibular premolar band (Figs 1a and 1b).

In 1982, the anchorage system of the banded Herbst appliance was changed. In the maxilla, the canines and the incisors were incorporated into the anchorage unit by placing brackets on the teeth and connecting them to the premolar bands with a labial sectional arch wire. In the mandible, the lingual arch wire was extended to the first permanent molars, which also were banded (Figs 1c and 1d).

In the modern Herbst appliance, which has been used on a regular basis since 1995, most teeth in the maxilla and mandible are incorporated into the appliance for maximum anchorage. The bands have been replaced by cast splints of cobalt-chromium alloy covering the teeth in the lateral segments. Additionally, the maxillary and mandibular anterior teeth are incorporated into the anchorage unit by connecting them to the splints with labial sectional arch wires. The axes for the telescoping tube and plunger are soldered to the splints in the region of the maxillary first permanent molars and the mandibular first premolars, respectively (Figs 1e and 1f). The splints are fixed to the teeth with a glass-ionomer cement.
In comparison to the banded Herbst appliance, the cast splint appliance has many advantages: It has a precise fit on the teeth, is strong and hygienic, and saves chair time because it is easy to insert and causes few clinical problems (no broken bands).

Due to the higher laboratory costs of the cobalt-chromium splints, acrylic splints have been advocated by some clinicians. However, acrylic splints break more easily and are less hygienic. To overcome the hygiene problem, many orthodontists use the acrylic splint Herbst appliance as a removable bite jumping device. However, the major advantage of the Herbst method, as a fixed functional appliance, working 24 hours a day, independent of patient cooperation, is lost with this adaptation.
In current dentofacial orthopedics, Herbst appliance therapy, followed by a conventional multibracket appliance treatment phase, is a most efficient 2-step approach in the management of severe Class II malocclusions. In the first step, Class II correction is accomplished with the Herbst appliance (6 to 8 months of therapy). Final tooth alignment, in the second step, is performed with conventional multibracket appliances (8 to 12 months of treatment).

When the appliance is placed at the start of Herbst treatment, the mandible is usually advanced to an incisal edge-to-edge position and the condyles are positioned on the top of the articular eminence. During the course of therapy, however, the condyles return to their original fossa position. This is accomplished by adaptive dental and skeletal changes: posterior movement of the maxillary dentition and anterior movement of the mandibular dentition,1 stimulation of sagittal condylar growth in a more favorable direction,2,3 and remodeling of the glenoid fossa.3 Throughout treatment, a normal disc-to-condyle relationship is maintained (Fig 2). At the end of treatment, the disc has either returned to its original pretreatment position or has attained a slightly retrusive position.4

**Fig 2** Female Class II, Division 1 subject, 16 years of age, treated with the cast splint Herbst appliance. Parasagittal MRIs of the right TMJ exhibiting a physiologic disc-to-condyle relationship during different phases of therapy. (a) Before treatment. (b) Start of treatment when the Herbst appliance was placed. (c) After 12 weeks of treatment. (d) After 7 months of treatment when the appliance was removed. (e) One year posttreatment. Tracings of the articular structures (condyle, disc, fossa) are given for better orientation.
Fig 3  Female Class II, Division 1 subject, 13 years of age, treated with a cast splint Herbst/multibracket appliance system in combination with a rapid maxillary expander. (a) Before treatment. (b) Start of treatment when the cast splints (without the telescope mechanism) were placed. (c) After 2 weeks of rapid maxillary expansion (when the telescope mechanism was placed). Note the diastema and the open bite. (d) After 6 months of Herbst treatment, before the appliance was removed. (e) During the second phase of treatment with a multibracket appliance. (f) After 18 months of Herbst/multibracket appliance treatment. (g) Retention with a maxillary Hawley plate and a mandibular canine-to-canine retainer. (h) Lateral head films from before treatment (left), after the Herbst treatment phase (middle), and after the multibracket treatment phase (right).
The Herbst/multibracket appliance approach makes it possible to treat severe Class II malocclusions, which otherwise would have been very difficult, if not impossible, to handle without extraction or orthognathic surgery. Our clinical-experimental research throughout the years has shown that the Herbst appliance is most useful in the Class II subjects and situations described below.

**Class II, Division 1 malocclusions**

This malocclusion is the main indication for Herbst therapy. In cases with a narrow maxilla, it is advantageous to combine the maxillary splints with a rapid maxillary expander (Fig 3) or a quad-helix.

In analyzing the treatment effects in consecutively treated subjects, it has been demonstrated that Class II correction is the result of both skeletal and dental changes. Skeletal changes are more pronounced in early adolescent subjects, and dental changes are more pronounced in late adolescent or young adult patients (Fig 4).

In most Class II, Division 1 cases, an undesirable side effect of the Herbst appliance is the proclination of the mandibular incisors. This effect is the result of anchorage loss, due to the forces exerted by the telescope mechanism on the anterior teeth. The incisor proclination is difficult to control independently of the anchorage system used. However, no increased incidence of mandibular anterior crowding could be found several years posttreatment despite a spontaneous uprighting of the teeth after Herbst therapy.

**Class II, Division 2 malocclusions**

The Herbst appliance is also very effective in Class II, Division 2 cases (Fig 5). In this type of malocclusion, the mandibular incisors (as well as the maxillary incisors) have a retroclined position. Therefore, the mandibular anchorage loss (proclination of the mandibular anterior teeth) during Herbst treatment can be used advantageously to reduce the interincisal angle and to create a stable anterior occlusion. This would be a prerequisite for the prevention of a deep bite relapse (Fig 5).

Furthermore, the changes in incisor tooth angulations during Herbst therapy will improve the vertical lower lip to maxillary incisor relationship (Fig 5). A high lip line (the lower lip covering the maxillary incisors) is a common finding in Class II, Division 2 malocclusions and is considered to be both an etiologic and a relapse factor for a deep bite. Therefore, the improvement in lip position will favor the stability of the corrected overbite.

**High-angle malocclusions**

Class II malocclusions with a hyperdivergent jaw base relationship are generally considered to have an unfavorable growth pattern, making their treatment difficult. As the Herbst appliance has been shown to increase condylar growth in the therapeutically desired sagittal direction (Fig 6) without resulting in a posterior (backward) rotation of the mandible, high-angle Class II subjects are good candidates for successful Herbst therapy (Figs 7 and 8).

**Maxillary anterior crowding**

Besides the orthopedic effect on the mandible, the Herbst appliance has a pronounced high-pull headgear effect on the maxillary molars. During therapy, the molars are distalized and significantly intruded. The headgear effect is most useful in gaining anterior space and relieving crowding in the maxillary canine and incisor areas (see web appendix Fig A-1).
Fig 4  Maxillary and mandibular skeletal and dental changes contributing to overjet (left) and sagittal molar (right) correction in (a) 25 early adolescent, (b) 21 late adolescent, and (c) 14 young adult subjects treated with the banded and the cast splint Herbst appliances for a period of 6 to 9 months. Negative (-) values indicate changes counteracting overjet and molar correction.

Fig 5  (Facing page) Male Class II, Division 2 subject, 14.5 years of age, treated with a cast splint Herbst/multibracket appliance system. (a) Before treatment. Note the high lip line (the lower lip covering the maxillary incisors). (b) Proclination of the maxillary incisors. (c) During Herbst treatment. Note 2 mandibular advancement shims added to the plunger for reactivation of the telescope mechanism. (d) After 7 months of Herbst treatment, when the appliance was removed. Note the Class I dental arch overcorrection, the lateral open bite, and the improvement of the lower lip to maxillary incisor relationship. (e) During the multibracket phase of treatment. (f) After 2.4 years of Herbst/multibracket appliance treatment. Note the stability of the lower lip to maxillary incisor relationship.
"High angle" treatment  
(n = 16)

Overjet correction  
7.6 mm  
100%

Skeletal  
2.8 mm  
37%  
Maxilla  
-0.2 mm  
-2%  
Mandible  
3.0 mm  
39%  
Maxilla  
1.8 mm  
24%  
Mandible  
3.0 mm  
39%

Dental  
4.8 mm  
63%  
Maxilla  
1.8 mm  
24%  
Mandible  
3.0 mm  
39%

"Low angle" treatment  
(n = 15)

Overjet correction  
5.5 mm  
100%

Skeletal  
1.4 mm  
25%  
Maxilla  
-0.5 mm  
-9%  
Mandible  
1.9 mm  
34%  
Maxilla  
1.9 mm  
35%  
Mandible  
2.2 mm  
40%

Dental  
4.1 mm  
75%  
Maxilla  
1.9 mm  
35%  
Mandible  
2.2 mm  
40%

Fig 6  Maxillary and mandibular skeletal and dental changes contributing to overjet (left) and sagittal molar (right) correction in (a) 16 high-angle and (b) 15 low-angle Class II, Division 1 malocclusions treated with the banded Herbst appliance for a period of 6 to 8 months.12 Negative (−) values indicate changes counteracting overjet and molar correction.

Fig 7  (Facing page) Male high-angle Class II, Division 1 subject, 15 years of age, treated with a banded Herbst appliance in combination with a quad helix for maxillary expansion (not shown). (a) Before treatment. (b) During Herbst treatment. Note mandibular advancement shims added to the plunger. (c) After 6 months of Herbst treatment when the appliance was removed. Note the Class I overcorrection and the open bite. (d) At 6 months posttreatment. Note the spontaneous closure of the open bite. No multibracket or retention appliances were used after Herbst treatment.
Fig 8 Male high-angle Class II, Division 1 subject, 14 years of age, treated with a banded Herbst/multibracket appliance system in combination with extraction of the 4 first premolars. (a) Before treatment. (b) Start of Herbst treatment when the appliance was placed. (c) After 6.5 months of Herbst treatment when the appliance was removed. (d) After 12 months of multibracket appliance treatment and extraction of the 4 first premolars. (e) At 12 months posttreatment.
Retrognathic facial profile

The excessive facial profile convexity characteristic of Class II malocclusions is generally reduced by Herbst therapy. This effect is obvious both in subjects treated during growth and those treated at the end of growth ("late" treatment, described below). The most favorable soft tissue profile changes are seen in Class II malocclusions with a retrognathic chin, retruded lower and protruded upper lips (Fig 9).

Postpubertal/Young adult patients

Herbst therapy has been shown to be very successful not only in adolescent patients, but also in postadolescent and young adult patients. Although mandibular growth is almost completed in these older patients, our recent magnetic resonance imaging (MRI) studies have shown that some condylar growth can be reactivated in subjects at the end of growth (Fig 10).
Furthermore, in comparison to an “early” treatment approach (early adolescence/mixed dentition), “late” treatment (late adolescence/permanent dentition) can more easily accomplish a stable post-treatment cuspal interdigitation, preventing a relapse. Additionally, the retention time can be reduced since the residual growth period (with a possible unfavorable growth pattern) is relatively short (Fig 11).

In our opinion, after extensive clinical experiences, early Class II treatment should be performed with removable functional appliances (not the Herbst appliance) because these appliances are more effective and easier to handle in young children. Herbst treatment, on the other hand, should be confined to patients who are in the pubertal-postpubertal growth period and have their permanent dentition; at these late somatic and dental developmental stages, removable appliances are less efficient and patient compliance is more difficult.

**Alternative to orthognathic surgery**

As mentioned above, our recent clinical, cephalometric roentgenographic, and MRI research has shown that the Herbst appliance is very efficient in Class II subjects at the end of their growth (radius union). Thus, we consider the method to be an alternative to orthognathic surgery in many adult Class II subjects (Figs 12 and 13). Our conviction is substantiated by the findings from an ongoing study that compares young Class II adults treated with either the Herbst appliance or with mandibular sagittal split osteotomy. Comparable changes in sagittal maxillary/mandibular jaw base relationship and skeletal profile convexity were seen in the 2 groups at the end of treatment (after final tooth alignment with multibracket appliances) (Fig 14). Furthermore, in comparison to surgery, Herbst treatment implies lower costs and lower risks for the patient without increasing total treatment time.

**TMJ patients**

Our short- and long-term TMJ research using tomography and MRI has shown no adverse effects of Herbst treatment on the different hard and soft tissue joint structures. However, many cases have demonstrated that Herbst therapy results in a retrusion of the articular disc. This effect can be used in the therapy of Class II malocclusions with milder forms of anterior disc displacement to attain a reduction of the disc malposition (Fig 15).

**NEW CONCEPT OF CLASS II THERAPY**

With respect to age and growth development, the dominant current concept of Class II treatment is:

- Growth adaptation in children and adolescents
- Camouflage orthodontics in postadolescents
- Surgical correction in adults

However, when considering the fact that skeletal facial growth continues many years after cessation of body height growth and that the adult TMJ is capable of remodeling, it seems logical to revise the above treatment concept. Thus, with respect to age and growth development, the following modified new concept for Class II therapy is proposed:
Fig 12  Adult female Class II, Division 1 subject, 18 years of age, treated with the cast splint Herbst/multibracket appliance system. (a) Before treatment. (b) Start of Herbst treatment when the appliance was placed. (c) After completion of Herbst/multibracket appliance treatment. Note the improvement in the hard and soft tissue profile. Total treatment time was 24 months.

Fig 13  Adult female Class II, Division 1 subject, 34 years of age, treated with the cast Herbst/multibracket appliance system. (a) Before treatment. (b) During the Herbst phase of treatment. (c) After completion of Herbst/multibracket appliance treatment. Note the improvement in the hard and soft tissue profile seen in the cephalogram. Total treatment time was 15 months.
Fig 14  Sagittal inter-jaw base relationship (Wits appraisal) and skeletal profile convexity (N-A-Pg). Changes in young adults treated with either the cast splint Herbst appliance (n = 12) or with mandibular sagittal split osteotomy (n = 16).

Fig 15  Male Class II, Division 1 subject, 12 years of age, with an anterior disc displacement with reduction. Treatment with the cast splint Herbst appliance. Analyses of parasagittal TMJ-MRIs. (a) Before treatment. Note the anterior disc displacement. (b) Start of treatment when the Herbst appliance was placed. Note the disc reduction accomplished when the condyle was placed on the articular eminence. (c) After 12 weeks of treatment. Note the return of the condyle to its original fossa position and the physiologic disc-to-condyle relationship. (d) After 7 months of Herbst treatment when the appliance was removed. Note the stability of the normal disc-to-condyle relationship.
• Growth adaptation in children, adolescents, postadolescents, and young adults
• Camouflage orthodontics in older adults
• Surgical correction in older adults

Growth adaptation

Growth adaptation should be performed with removable functional appliances in children and adolescents with mixed dentition. However, in adolescents who have their permanent dentition, in postadolescents, and in young adults, the Herbst appliance is usually indicated. The approximate age for young adulthood would be 18 to 24 years in females and 20 to 25 years in males. An upper age limit for successful Herbst treatment is, however, difficult to define (Fig 15).

Camouflage orthodontics

Camouflage orthodontics mainly comprises tooth sacrifice in the maxillary dental arch to create space for retraction of the anterior teeth. By this approach, however, the skeletal Class II problem (mandibular retrusion) remains.

Surgical correction

Surgical correction implies that the mandible is advanced to a Class I skeletal jaw relationship using either sagittal split osteotomy or mandibular distraction osteogenesis. Occasionally, mandibular advancement is combined with maxillary setback surgery (Le Fort I). The philosphical question is based on potential iatrogenic sequelae for a primarily cosmetic problem: “What price surgery?”

REFERENCES

**WEB APPENDIX**

**Fig A-1**  Female Class II, Division 1 subject, 15 years of age, with almost complete space closure, after traumatic loss of the left permanent maxillary central incisor at the age of 10 years. Treatment with the cast splint Herbst/multibracket appliance system in combination with a rapid maxillary expander. (a) Before treatment. (b) Start of treatment with the Herbst appliance and the maxillary expander were placed. (c) During Herbst treatment. Note the transverse maxillary expansion and the spaces that developed distally to the maxillary canines as a result of the headgear effect of the Herbst appliance moving the lateral teeth posteriorly. (d) After 12 months of Herbst treatment, when the appliance was removed. Note the overcorrected Class I dental arch relationships and the space opening for the left central incisor. (e) During the multibracket phase of therapy. Note the maxillary plate replacing the missing central incisor. (f) After 6 months of multibracket appliance treatment. Note the complete space opening for the central incisor, and the correction of the midline and the Class I dental arch relationships. After completion of growth, an incisor implant in planned.