History, Background, and Development of the Herbst Appliance

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According to a recently performed unpublished survey of 6 major orthodontic laboratories in the United States, the Herbst appliance has grown to be the most popular functional appliance for the treatment of Class II malocclusions. This article gives a historical overview of the development of the Herbst appliance with special reference to the different anchorage forms used in the past and in the present. The development of Herbst appliance hybrids and derivatives will also be addressed. (Semin Orthod 2003;9:3-11.)

Emil Herbst (1872-1940) was a German orthodontist who lived in Bremen, Germany. He was a student of dentistry at the University of Leipzig where he graduated in 1894. Thereafter, he went to the United States for 1 year and studied at the Dental Colleges in Buffalo, NY, and Philadelphia, PA. Herbst got his American doctorate of dental surgery in 1895. After returning to Germany, he worked in his father's dental office as a general practitioner for several years. However, Herbst became more and more interested in orthodontics and made his Doktor der Zahnheilkunde in 1921 with the thesis "Atlas und Grundriss der Zahnärztlichen Orthopädie." In 1923, he defended his PhD thesis "Die Bedeutung des Zwischenkiefers für die Missbildungen und Anomalien des menschlichen Gebisses." In 1930, Herbst was appointed professor in orthodontics at the University in Bremen, which made him the first-acting orthodontic professor and chairman in Germany.

In a beautifully written doctoral thesis by Eva Geiss[1] entitled "Emil Herbst: Sein Leben, Werk und Einfluss auf die heutige Kieferorthopädie," it was shown what a remarkable man Herbst was. In 1910, he was one of the founders of the Deutsche Gesellschaft für Orthodontie (the predesessor of the present Deutsche Gesellschaft für Kieferorthopädie) and in 1924 of the Deutsch-Österreichische Gesellschaft für Kieferorthopädie.

Herbst was far ahead of his time. Much of what we know about orthodontic appliances today was already described by him more than 90 years ago (eg, rapid palatal expansion devices).[2] His main contribution to modern orthodontics was, however, the development of the *Okklusionsscharnier* or *Retentionsscharnier* (Herbst appliance) (Fig 1). Scharnier means joint, and the word retention was added because the upper part of the appliance served as a retainer for an expanded maxillary dental arch by the incorporation of a circumferential palatal platinum-gold arch wire.

Herbst presented his appliance for the first time at the 5th International Dental Congress in Berlin in 1909. In 1934, he reported on his long-term experiences with the appliance in 3 articles in *Zahnärztliche Rundschau*.[3] At the same time, Martin Schwarz[4] from Vienna wrote 2 more or less critical articles about the Herbst appliance in the same journal. According to Schwarz, the Herbst appliance could result in an overload of the anchorage teeth with periodontal damage as a consequence. This claim has, however, been disproved in a recent thesis of Pietz.[5] After 1934, very little was published about the Herbst appliance, and the treatment method was more or less forgotten until it was rediscovered by Pancherz in the late 1970s.[6]

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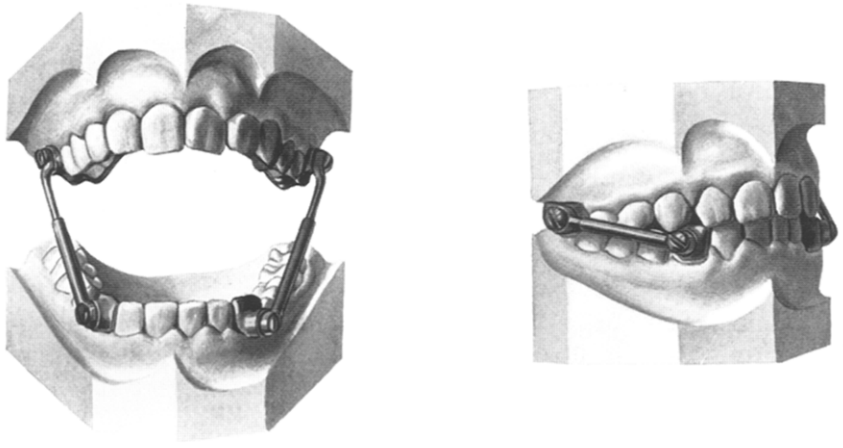

Figure 1. The original Herbst appliance.[2]

Basic Design of the Herbst Appliance

The Herbst appliance is a fixed bite-jumping device for the treatment of skeletal Class II malocclusions. It can be compared with an artificial joint working between the maxilla and mandible. A bilateral telescope mechanism keeps the mandible in an anterior-forced position during all mandibular functions such as speech, chewing, biting, and swallowing. The telescope mechanism (tube and plunger) is attached to orthodontic bands, crowns, or splints. The tube is positioned in the maxillary first molar region and the plunger in the mandibular first premolar region. The telescopes allow mandibular opening and closing movements and when constructed properly lateral jaw movements are also possible.[6]

Development of the Herbst Appliance

Originally, the telescoping parts of the Herbst appliance were curved (Fig 2) conforming to the Curve of Spee.[3] The later designs were, however, straight as they are today. Until 1934, Herbst made the telescopes of German silver but recommended gold in cases in which the appliance had to be worn for a longer period of time (more than 6 months). Bands or crowns/caps were used on the abutment teeth. The material was German silver or gold.

When looking at the illustrations (Fig 1) of the Herbst appliance in the textbook of 1910,[2] it can be noticed that the telescope mechanism was placed upside down (with the plunger attached to the maxillary molar crown and the tube on the mandibular canine crown). Furthermore, the tube had no open end, thus not allowing the plunger to extend behind the tube as was the case in later designs.

Anchorage Forms of the Herbst Appliance

The Herbst appliance aims to stimulate mandibular growth in the treatment of Class II malocclusions.[6-10] However, because of anchorage loss, maxillary and mandibular tooth movements during treatment cannot be avoided.[11] In some

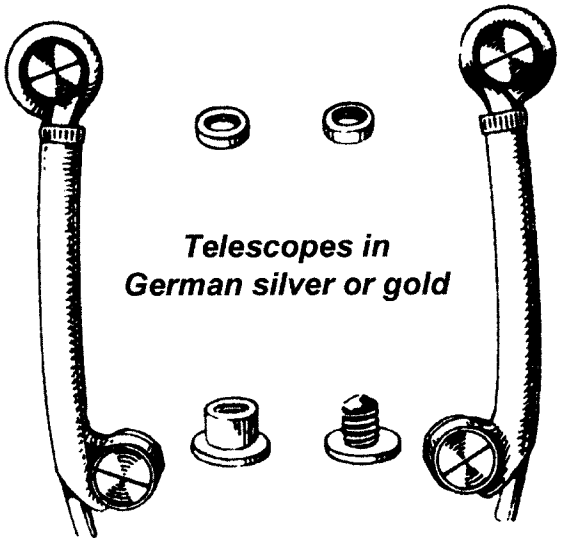

Figure 2. The original curved Herbst telescopes.[3]

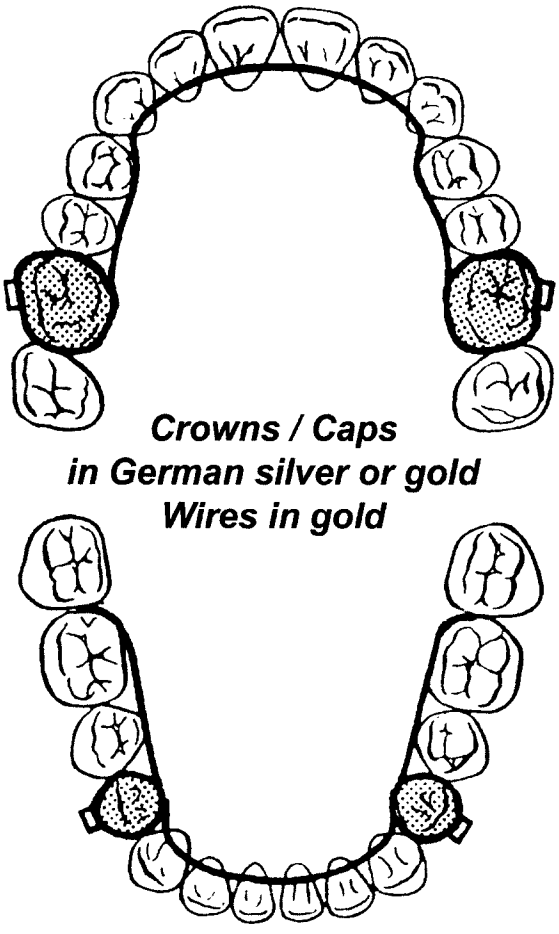

Figure 3. The standard anchorage system of Herbst.[3]

cases, this can be a clinical problem, especially in the mandible. Throughout the years, several anchorage systems have been developed to control unwanted tooth movements.

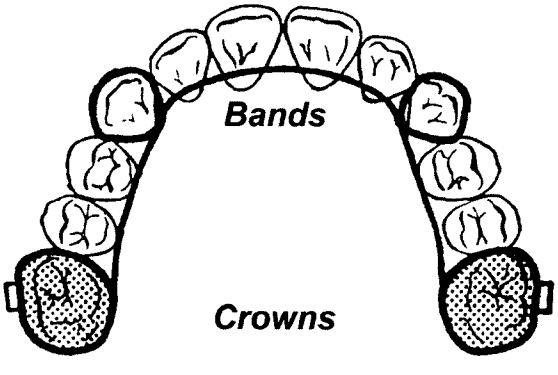

Figure 4. The maxillary anchorage system of Herbst, when the second permanent molars were not erupted—bands on the canines.[3]

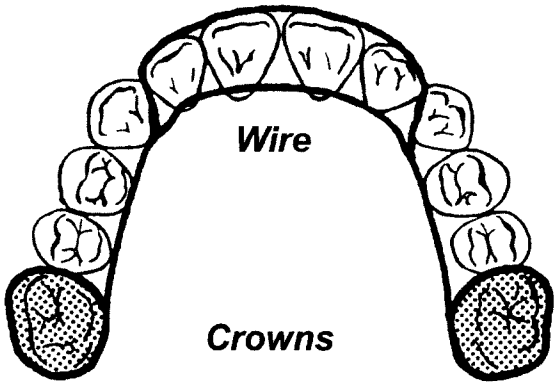

Figure 5. The maxillary anchorage system of Herbst, when the second permanent molars were not erupted—wires on the front teeth.[3]

Anchorage Forms Used From 1909 to 1934

The standard anchorage system used by Herbst is shown in Figure 3. Crowns or caps were placed on the maxillary permanent first molars and mandibular first premolars (sometimes canines). The crowns/caps were joined by wires that run along the palatal surfaces of the upper

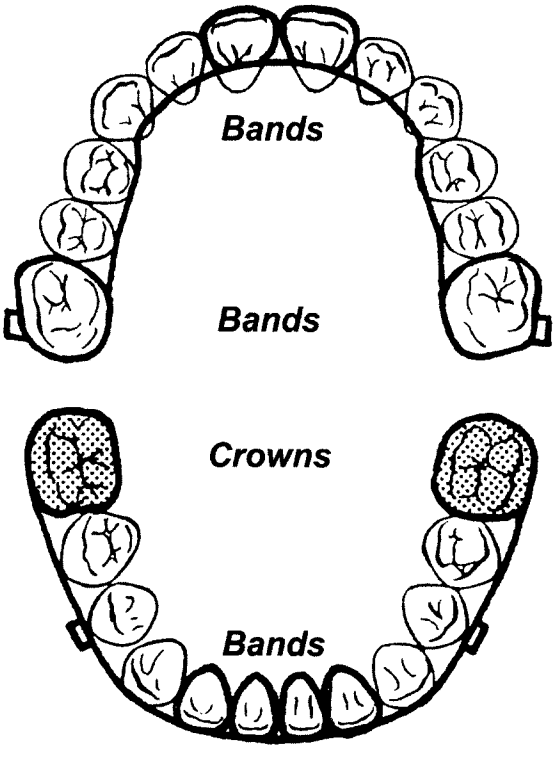

Figure 6. The early mixed dentition anchorage system of Herbst.[3]

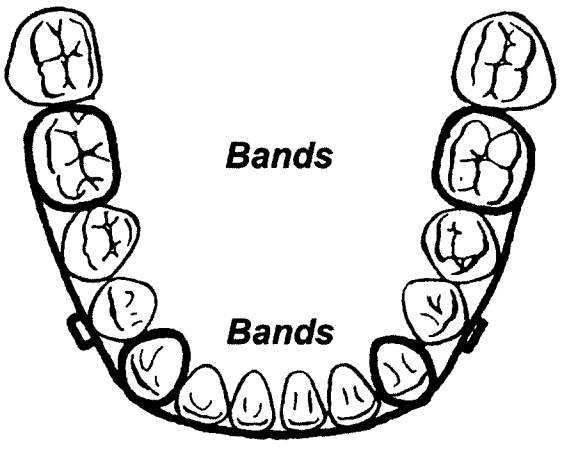

Figure 7. The late mixed dentition anchorage system of Herbst.[3]

teeth and the lingual surfaces of the lower teeth, respectively.

In cases in which the upper second permanent molars were not erupted, Herbst found it advisable to anchor the appliance more firmly in the upper jaw by placing bands also on the upper canines, which were soldered to the palatal arch wire as were the upper molars (Fig 4). Alternative to bands on the upper canines, a thin gold wire was placed on the labial surfaces of the upper incisors of the upper incisors and soldered to the palatal arch wire (Fig 5).

When using the Herbst appliance in the early mixed dentition, Herbst had the following solution: in the maxilla, the permanent central incisors were used for anchorage instead of the cuspids (Fig 6), and in the mandible, crowns were placed on the first permanent molars and bands on the 4 permanent incisors (Fig 6). A 1.2-mm thick gold wire was then used to join the lower incisors and molars on their labial surfaces. The telescoping axes were than soldered onto this wire in the region of the first deciduous molars.

In the late mixed dentition when the permanent canines had erupted but the lower premolars still were missing, the design of the appliance was modified by using the canines as anchorage teeth instead of the incisors (Fig 7).

The necessity to incorporate as many teeth as possible for anchorage to avoid unwanted side effects was realized early by both Herbst and

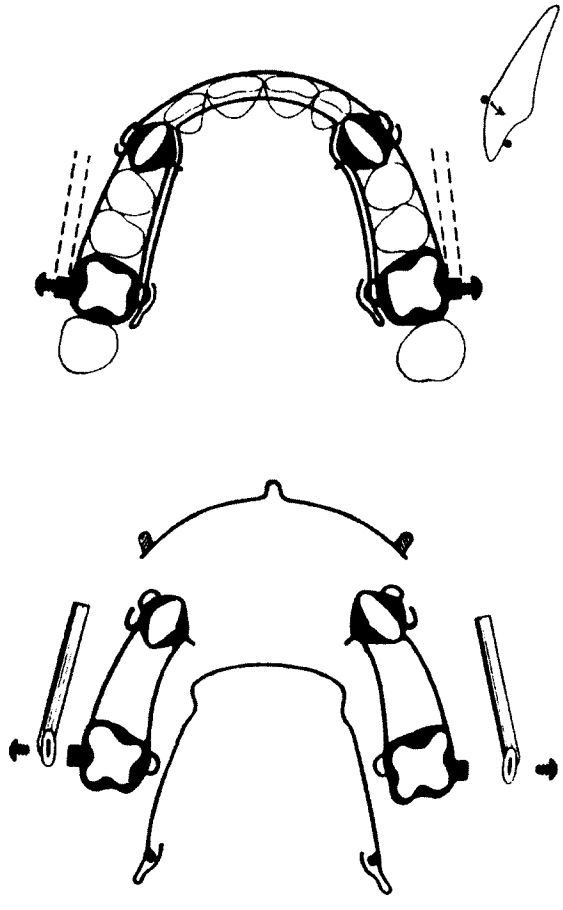

Figure 8. The maxillary block anchorage system of Schwarz.[4]

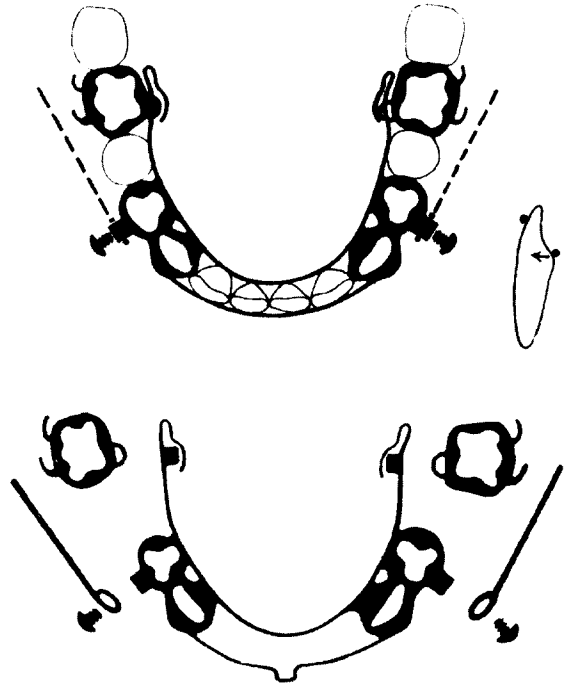

Figure 9. The mandibular block anchorage system of Schwarz.[4]

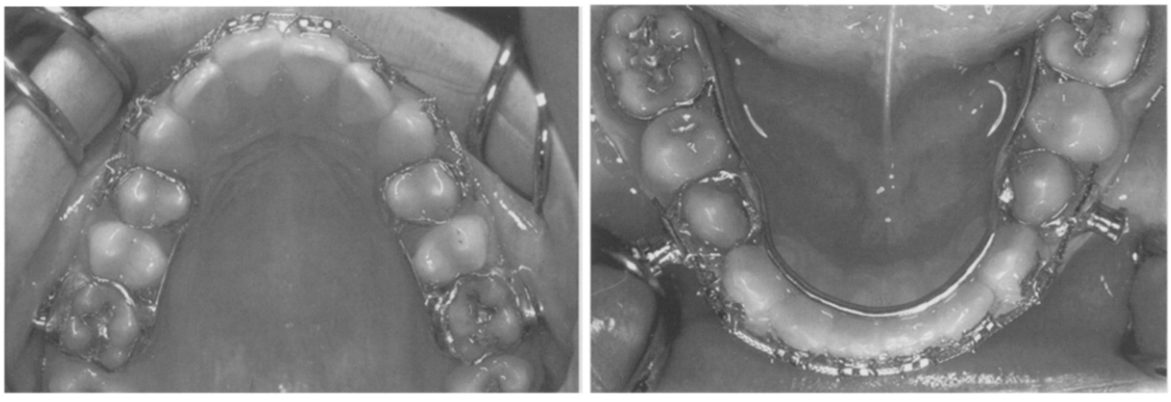

Figure 10. The simple anchorage system with bands of Pancherz.[6]

others. In Figures 8 and 9, the solution offered by Schwarz[4] is shown. Most teeth in the maxilla and mandible were interconnected by labial as well as lingual arch wires (block anchorage).

Anchorage Forms Used From 1979 Onward

Pancherz[6] originally used a banded type of Herbst appliance. Individually made stainless steel bands of a thick material (0.15-0.18 mm) were used. In the maxilla, the bands were placed on the first permanent molars and first premolars and on each side connected by sectional arch wires. In the mandible, bands were placed on the first premolars and connected by a lingual arch wire (Fig 10). The indirect fabrication of the bands using thick band material is of significance because breakage can occur if ordinary bands are used.

After having used this anchorage system for a couple of years, Pancherz found several unwanted side effects that could not be controlled. The maxillary side effects included space opening distally to the maxillary canines, excessive intrusion of the first permanent molars, and buccal tipping of the first premolars, and the mandibular side effects included intrusion of the first premolars and a large proclination of the incisors. Thus, anchorage had to be increased by incorporating more teeth. Therefore, the maxillary and mandibular front teeth were incorporated in the anchorage system by labial sectional arch wires, and the mandibular lingual arch wire was extended to the first permanent molars (Fig 11).

Since 1995, cast chrome-cobalt splints are used routinely in our department in Giessen. The splints cover all buccal teeth in the maxillary and mandibular arches and also the mandibular canines. In addition, the upper and lower front teeth are included in the anchorage system by way of labial arch wires that are connected to the splints (Fig 12). This design of the appliance has the following advantages: the

Figure 11. The increased anchorage system with bands of Pancherz.

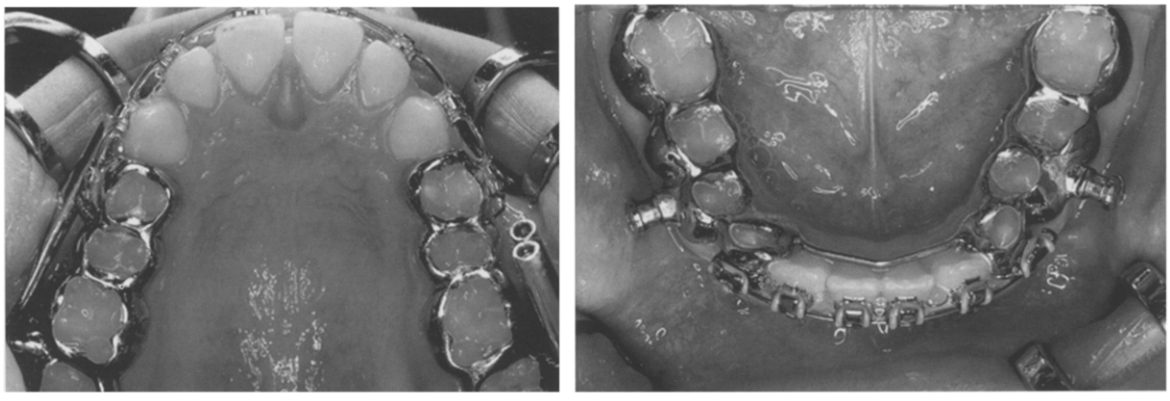

Figure 12. The total anchorage system with cast chrome-cobalt splints of Pancherz.

chair time is short and the appliance is strong, hygienic, and causes few clinical problems.

Parallel to the design evolution by Pancherz, clinicians in the United States began using stainless steel crowns instead of bands[12-14] to avoid the problems of band breakages. In the early 1980s, Howe[15] and Howe and McNamara[16] developed the acrylic splint Herbst appliance (Fig 13), which is used both as a fixed (bonded to the teeth) and removable appliance. However, use of the Herbst as a removable device is not recommended because the main advantage of a fixed Herbst appliance is that it works 24 hours a day without the dependence on patient cooperation.

A special variant of the stainless steel crown Herbst appliance that has become very popular in the United States is the so-called cantilever Herbst appliance[14,17] (Fig 14). This design is mainly indicated in the early mixed dentition before the eruption of the mandibular permanent canines and first premolars. The lower part of the cantilever Herbst features heavy metal extension arms that are soldered to the permanent first molar crowns. The arms extend anteriorly lateral to the dentition and terminates in the premolar region in which the telescoping axles are soldered. Support wires attached to the cantilever arms working as occlusal rests on the first or second deciduous molars are important. Without these rests (as seen in earlier designs of this appliance), the vertical force vector of the telescopes acting as lever arms will result in uncontrolled mesial tipping and extrusion (extraction) of the molar teeth. In the opinion of the author of the present article, anchorage control of the mandibular molars with the cantilevers (even when using occlusal rests on the deciduous molars) is questionable.

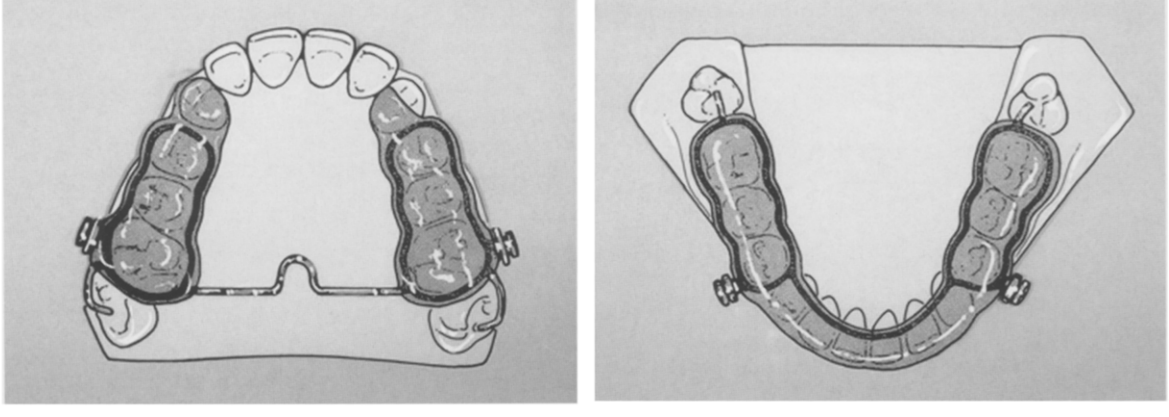

Figure 13. The acrylic splint anchorage system of Howe and McNamara.[15,16] (Reprinted with permission from McNamara JA, Brudon WL. Orthodontics and Dentofacial Orthopedics. Ann Arbor, MI: Needham Press, 2001.)

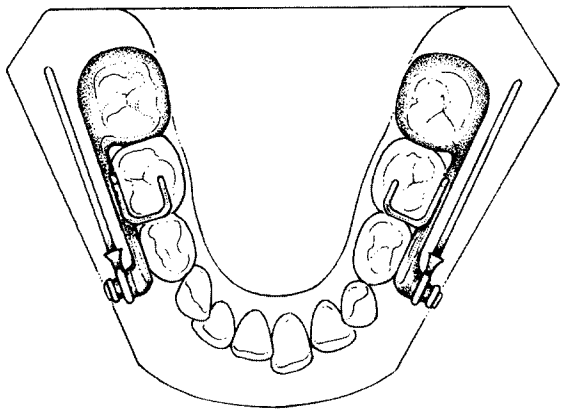

Figure 14. The cantilever anchorage system of Dischinger[14] and Mayes.[17] (Reprinted with permission from McNamara JA, Brudon WL. Orthodontics and Dentofacial Orthopedics. Ann Arbor, MI: Needham Press, 2001.)

Herbst Appliance Hybrids

The Herbst appliance has stimulated the development of several other fixed appliances that work according to the same bite-jumping philosophy and do not require special patient compliance.

As early as 1922, Herbst[18] presented the *Bisslenker* (occlusion guide) for mandibular advancement (Fig 15). This joint device is attached to bands or crowns on the upper and lower permanent first molars or deciduous second molars. The joint is only attached with a screw on the lower molar. On the upper molar, the appliance is hooked on an axle.

Using the Herbst appliance as a model, Fränkel in 1956[19] developed the *Federgelenk* (spring joint) (Fig 16). The appliance is attached to removable upper and lower plates keeping the mandible in a protrusive position on mouth closure. In contrast to the Herbst appliance, the *Federgelenk* allows free mandibular movements in all directions and the force of the coil spring is individually adjustable. According to Fränkel,[19] Class II treatment with the *Federgelenk* for about 6 months is very successful, and the results are stable.

Selected modern hybrids of the Herbst appliance that have become very popular are the Jasper Jumper,[20] the Eureka Spring,[21] and the mandibular anterior repositioning appliance (MARA).[22]

The Jasper Jumper™ (American Orthodontics, Sheboygan, WI) (Fig 17) is a flexible bite-jumping device. The force module is composed of a stainless steel coil spring attached to the maxillary molar tube and to the mandibular main arch wire or to an auxiliary arch wire. When the force module is straight, it is passive. When the teeth come into occlusion, the spring of the force module is curved, producing a distal directed force to the maxillary jaw and molars and a mesial-directed force to the mandibular jaw and front teeth. To avoid uncontrolled tooth movements, proper maxillary and mandibular anchorage is important.

The Eureka Spring™ (Eureka Spring, San Louis Obispo, CA) (Fig 18) is a triple telescoping assembly to permit very wide mouth opening before the plunger becomes disengaged. The telescoping parts are attached to the maxillary molar tube and the mandibular main arch wire.

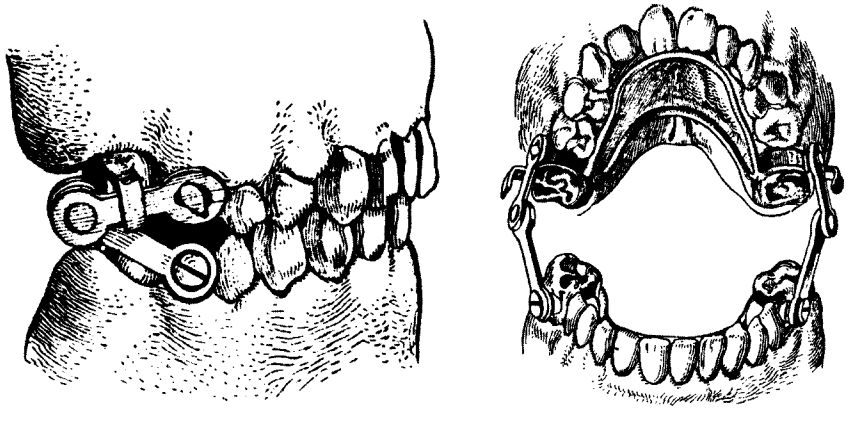

Figure 15. The "Bisslenker" (occlusion guide) of Herbst.[18]

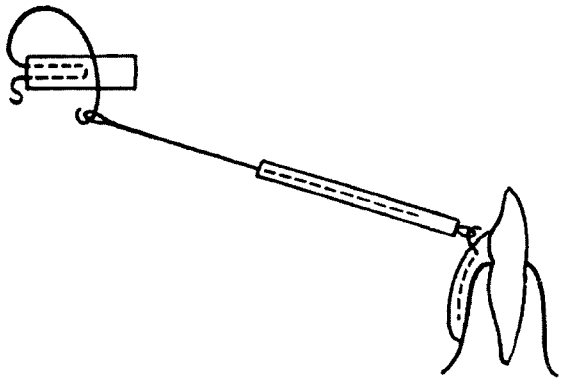

Figure 16. The *"Federgelenk"* (spring joint) of Fränkel.[19]

Through compression of an open-wound coil spring, a push force is directed against the maxillary molars and to the mandibular front teeth. As with the Jasper Jumper, maxillary and mandibular anchorage is critical.

The MARA (Fig 19) is attached to stainless steel crowns or rigid bands on the first upper and lower permanent first molars. In a large .062 square tube on the upper molar, an adjustable .060 square "elbow" hangs vertically. The lower molar has a .059 round wire arm projecting buccally from the mesial. The only way for the patient to occlude his/her teeth is to hold the lower jaw forward so that the lower arm is in front of the elbow. The lower crowns or bands are stabilized by a lingual arch wire to prevent mesiolingual rotation of the lower molars resulting from the pressure of the elbows. The upper crowns are not stabilized, which may result in

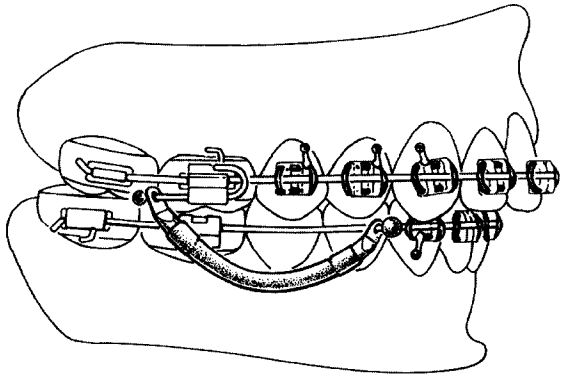

Figure 17. The Jasper Jumper of Jasper.[20] (Reprinted with permission from McNamara JA, Bruden WL. Orthodontics and Dentofacial Orthopedics. Ann Arbor, MI: Needham Press, 2001.)

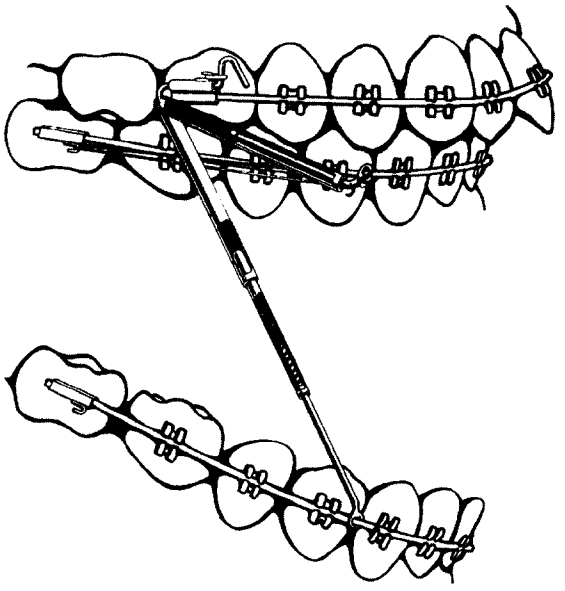

Figure 18. The Eureka Spring of De Vincenco.[21] (Reprinted with permission from McNamara JA, Bruden WL. Orthodontics and Dentofacial Orthopedics. Ann Arbor, MI: Needham Press, 2001.)

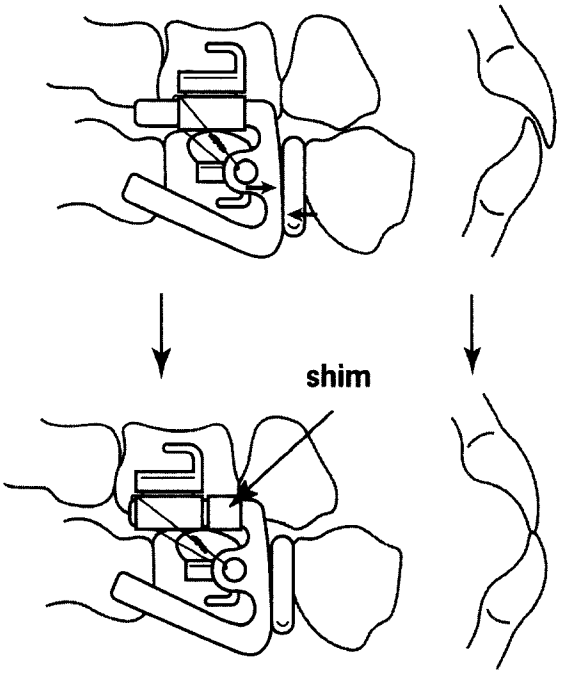

Figure 19. The MARA of Eckhart.[22] (Reprinted with permission from McNamara JA, Bruden WL. Orthodontics and Dentofacial Orthopedics. Ann Arbor, MI: Needham Press, 2001.)

unwanted and uncontrolled movements of the molars. To cause more mandibular advancement, shims are placed on the elbows (Fig 19).

Final Remarks

It is apparent when looking historically at the development of the Herbst appliance, its derivatives, and hybrids that there are many examples of copying and reinvention of the wheel. Furthermore, it is frightening to see that in the construction of these new devices basic anchorage principles have been neglected to make the appliances look simple and to sell better. Finally, many of the new inventions have never been tested scientifically or used clinically in a sufficient number of unselected patients when offered on the market.

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