Current Herbst Appliance Therapy

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Expanding on the work of Stockli and Willert,[1] McNamara's 1979 study[2] alerted U.S. orthodontists to the possibility of using cemented appliances to permanently advance the mandible. Soon afterward, Pancherz reported the effects of a "bite jumper" originally proposed and used by Emil Herbst in 1905 to treat Class II malocclusions and other dental defects.[3]

Herbst had published a paper on the "retention-joint" in 1935,[4] but this article wasn't translated into English until recently. Every English-speaking orthodontist using the appliance should have Bachmayer's translation,[5] since Herbst learned or anticipated almost every problem a clinician might encounter.

Heretofore, Class II nonextraction treatment had depended upon the patient's cooperation with a removable functional appliance, Class II elastics, and/or a maxillary retractor. The Herbst* appliance, by contrast, uses a cemented tube-and-piston assembly to permanently position the mandible forward, and relies on the retractor muscles of the face and head to supply a distalizing force to the maxillary teeth while simultaneously delivering a mesial force against the mandibular arch (Fig. 1). The Bachmayer translation illustrates several of Herbst's methods for constructing the appliance.

Pancherz clearly ignited great interest with his rediscovery, because several authors were soon offering articles on their own experiences with the technique.[6-8] McNamara aroused further interest with a study showing that only about 30% of a group of 9-year-old children with Class II malocclusions had protrusive maxillae.[9]

Mastorakos later demonstrated that 12-year-old children with comparable Class II malocclusions had much less mandibular retrognathia, shorter anterior face height, and considerably

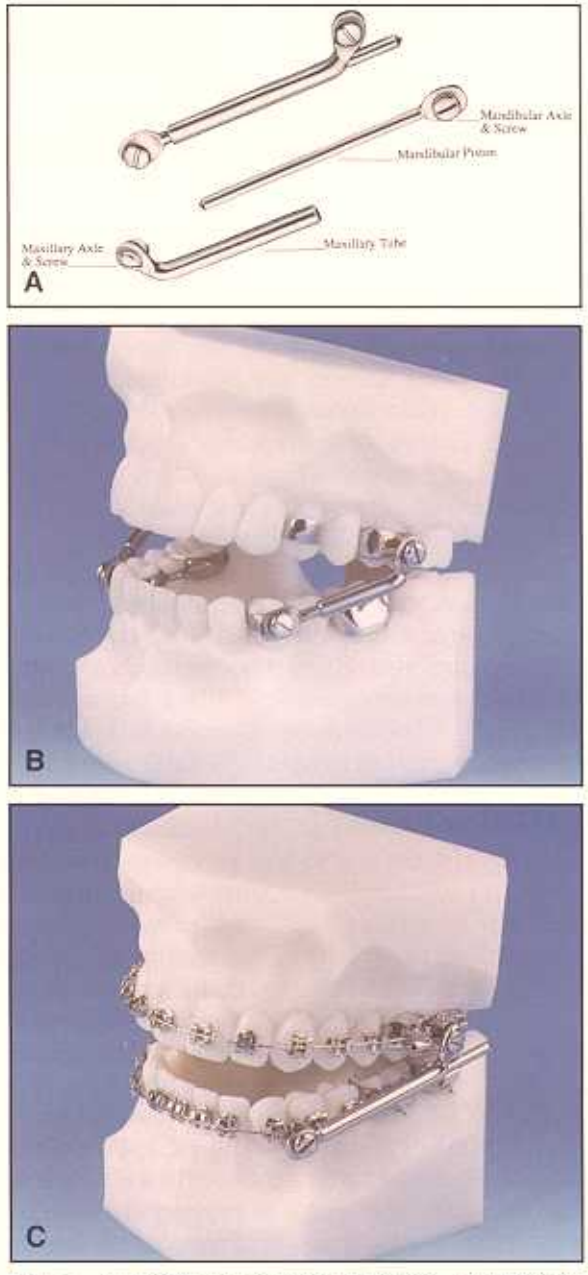

Fig. 1 A. Parts of Herbst appliance. B. Herbst I appliance. C. Herbst II appliance, with addition of fixed appliances.

*Trademark of Dentaurum, Inc., 2 Pheasant Run, Newtown, PA 18940.

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more maxillary protrusion than McNamara's group, but the point was well made.[10] Why should we treat any mandibular retrognathia by pushing a normally sized and positioned maxilla distally to fit a diminished mandible? No wonder many Class II nonextraction patients ended treatment with concave profiles.

Meanwhile, Frankel, Harvold, Wieslander, and others were showing that mandibular repositioning appliances could reliably and permanently move the mandible forward, and that excellent orthodontic results could be achieved by what orthodontists began to call "orthopedic therapy".[11-13]

Measuring Herbst Effects

As with many dental therapies, the clinical application of the Herbst appliance outpaced the understanding of how and why it worked. Woodside and Metaxas were among the first to seriously study the appliance's effect on the temporomandibular joint.[14,15] They discovered that not only did the condyle remodel in a superior and posterior direction, but, equally important, the entire TMJ fossa remodeled to accommodate the condyle's new, anterior position.

Pancherz has made significant contributions to our understanding of the Herbst mechanism.[16-21] In addition, a study by Valant and Sinclair showed that the lower dentition advanced significantly during Herbst therapy, and that at least 52% of the Class II correction came from dentoalveolar changes, with the rest resulting from mandibular growth.[22]

Several investigators agreed that the mandibular condyle could grow about twice as much as normal with the Herbst appliance, at least in adolescents, but others such as Gianelly and Creekmore remained skeptical about the ability of orthopedic appliances to "grow" the mandible more than would otherwise occur.[23-25]

There hasn't been much doubt that exceptional condylar growth occurs with the Herbst, but whether such growth is significant and permanent remained debatable until the seminal work of DeVincenzo.[26] He confirmed that the amount of condylar growth was, indeed, about twice the norm in adolescents, but that the ultimate mandibular length was no greater than would be expected. Essentially, DeVincenzo discovered that we can accelerate condylar growth in adolescents, but that we can't exceed the growth that seems genetically preordained. His study explains both the enthusiasm of the Herbst's devotees and the reservations of its detractors. Claims for an ultimate orthopedic effect from the Herbst appliance (and probably any other mandibular advancer) now seem dubious.

Herbst's Suggestions

Emil Herbst's intuition and sagacity are all the more remarkable considering he didn't have cephalometric measurements, histological techniques, or electronic muscle-monitoring devices to show him how his appliance worked. Nonetheless, he understood enough about form and function to guess correctly about the nature of most of its effects.[4]

Herbst listed the uses of his appliance as:

- Mainly for patients with retrognathic mandibles
- For condyle resection patients after surgery
- For mandibular fracture (particularly ramus) patients after surgery
- For prevention of bruxism
- For diseases of the TMJ

He further noted these advantages of the appliance:

- Immediate esthetic improvement
- No damage to the pulp or periodontium
- Reduction in the number of appointments
- Usable in patients of any age

Clearly, we have only begun to exploit this appliance's potential. Little has been written and hardly any serious study has been made of its effects on post-pubertal patients (Fig. 2). If more than 50% of the treatment effect is due to dentoalveolar changes, then perhaps we should use the Herbst more in adult patients.

Herbst Designs and Uses

The original design used by Pancherz was a composite of many types tried by Herbst. Essentially, the maxillary first molars and first bicuspids were fitted with bands in both quadrants and connected by soldered lingual wires. Lower first molar and first bicuspid bands in each quadrant were connected by a continuous lingual arch. The axles to which the telescoping mechanisms attached were soldered to the facial surfaces of the two lower bicuspids and upper molars.

Pancherz used custom-made bands that were much thicker than usual. Soldering the axles to

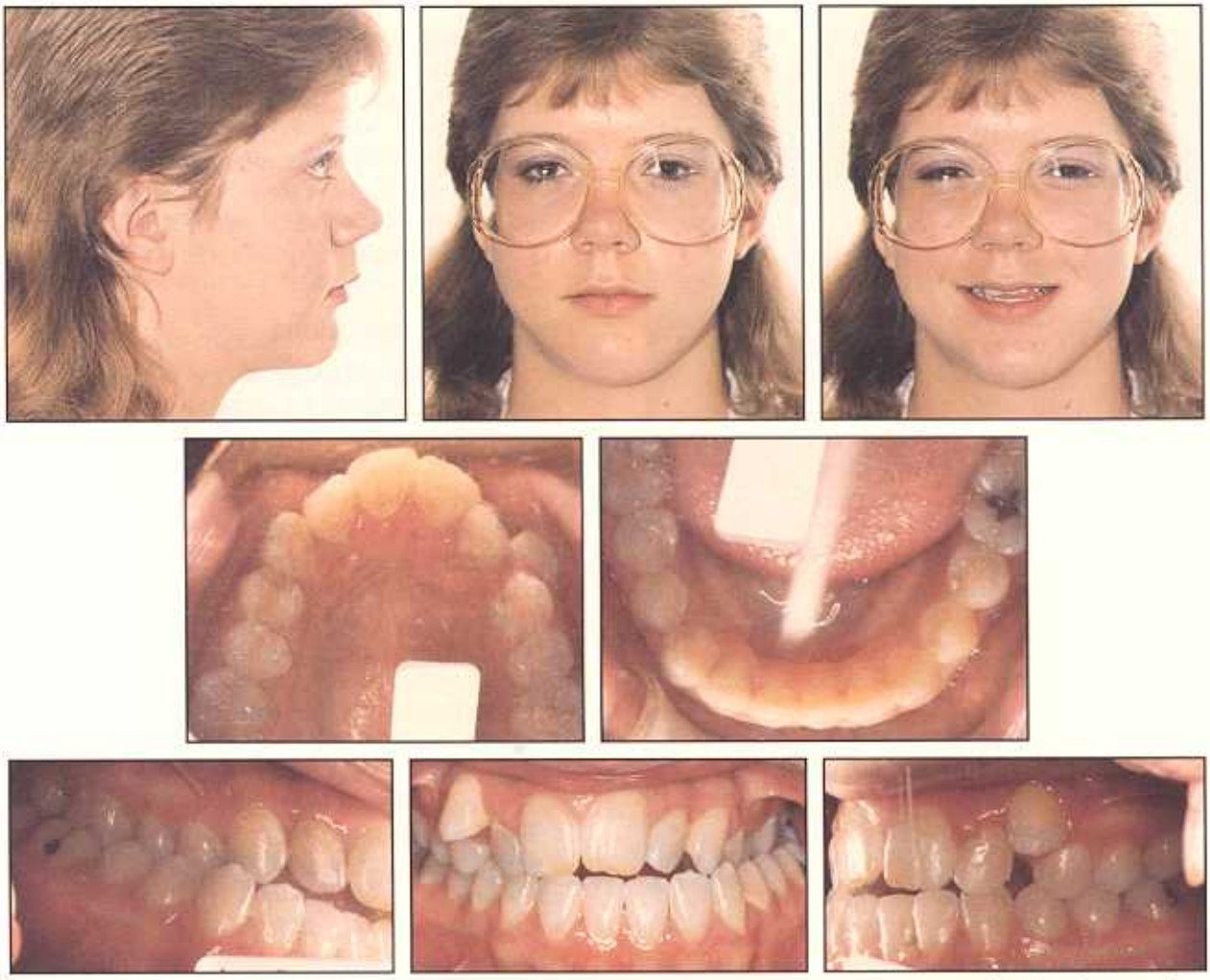


Fig. 2 Treatment of post-pubertal female patient with Herbst appliance, aided by prior rapid palatal expansion and extraction of upper second molars. A. Before Herbst treatment, at age 15 (continued on next page).

ordinary manufactured bands will result in 100% failure due to band fracture. The force generated by the Herbst is simply too great for ordinary bands to withstand.

Pancherz recommended, as did others, six months of appliance wear.[3] This contrasts with Herbst's advice: "The appliance must be worn for nine to 15 months, and only in rare cases with very sharp cusped teeth is six months sufficient. When bite-catchers are used, the period that the appliance must be worn can also be shortened."[4]

Herbst believed, and I concur, that the key to successful Herbst therapy retention is a firm bicuspid occlusion. If flat-planed primary posterior teeth are present at the conclusion of Herbst treatment, then the clinician must use some kind of retention that locks the mandible forward, such as a Hawley retainer with a bite ramp.

Herbst often used crowns instead of bands on anchor teeth, but Langford was the first contemporary orthodontist to suggest using preformed stainless steel crowns. His suggestion

Fig. 2 (continued) B. After 16 months of treatment, including five of Herbst therapy (continued on next page).

rescued the Herbst from clinical abandonment in this country[27] (Fig. 3).

Dischinger expanded on the idea of using stainless steel crowns on the upper first molars and lower first bicuspids. By adding tubes to the upper molar crowns and mandibular molar bands, he was able to simultaneously place bonded brackets on the anterior teeth and use utility arches to unravel crowding, remove rotations, and intrude incisors[28] (Fig. 4).

For many years I have used a Herbst design with axles soldered to the mesiobuccal surfaces of the maxillary stainless steel crowns (Fig. 5). Buccal tubes are also soldered to the maxillary crowns, permitting simultaneous archwire placement in the maxillary anterior region. In the mandible, stainless steel crowns on the 6-year molars are connected with a lingual arch. The mandibular axles are soldered to buccal wires extending from the 6-year molar crowns to the

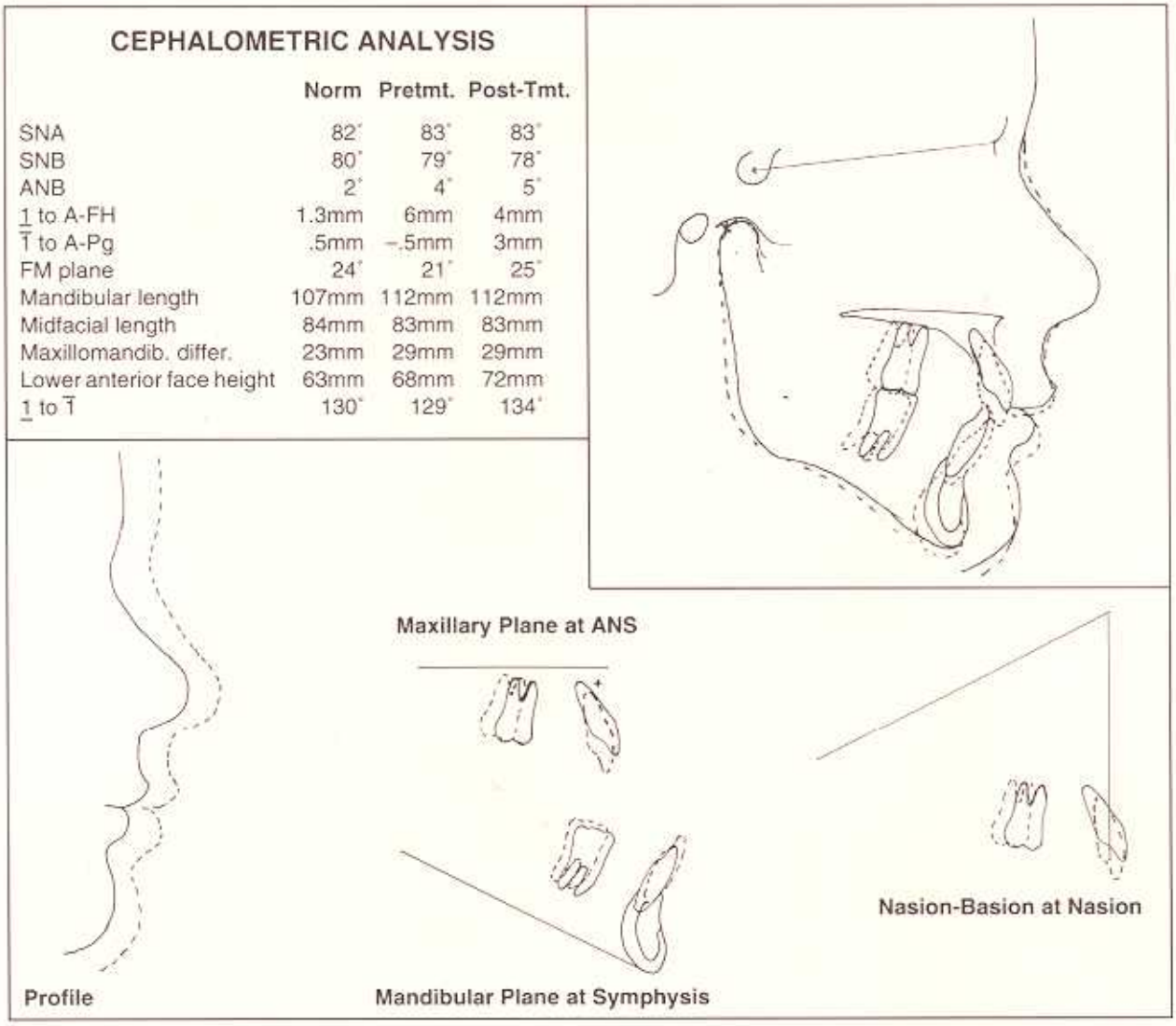


Fig. 2 (continued) C. Superimpositions before and after Herbst treatment (dashed line = post-treatment).

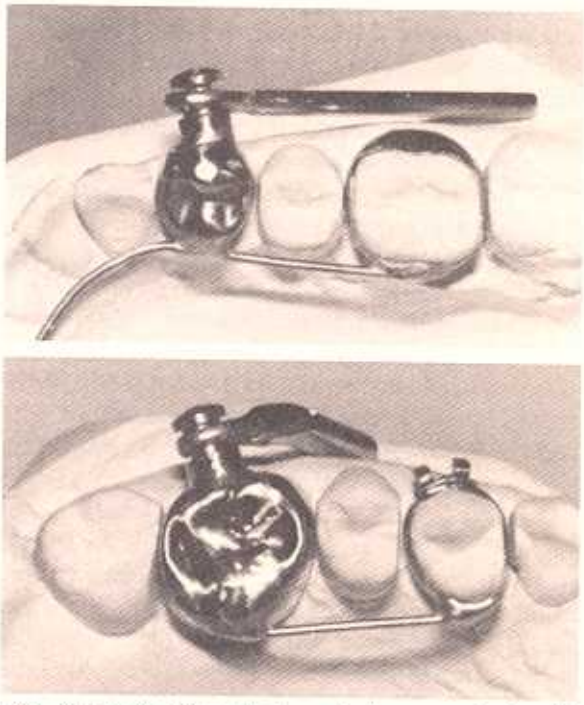


Fig. 3 Langford's stainless steel crown design.[27]

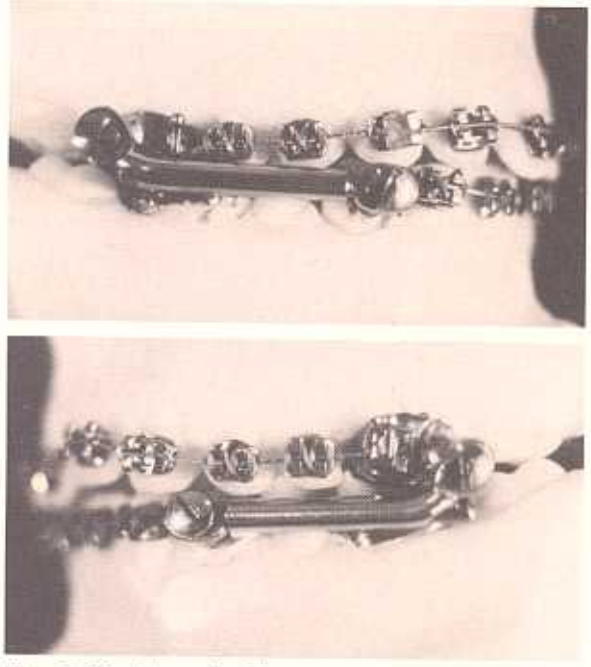


Fig. 4 Dischinger's Bioprogressive Herbst appliance design.[28]

buccal embrasures between the bicuspids. The buccal cantilever wire is made by doubling an .045″ wire and soldering between the two strands, which makes the wire almost unbreakable (Fig. 6).

At first glance, it would seem that this cantilevered Herbst appliance would be easily dislodged by the direction of force. Fortunately, this almost never happens—particularly if the crowns are attached with glass ionomer cement. The design can be used with patients of any age, and is particularly useful when mandibular bicuspids are absent or the primary molars cannot withstand functional forces.

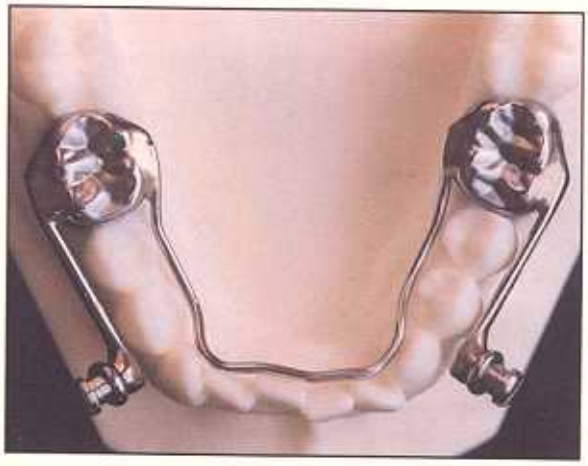
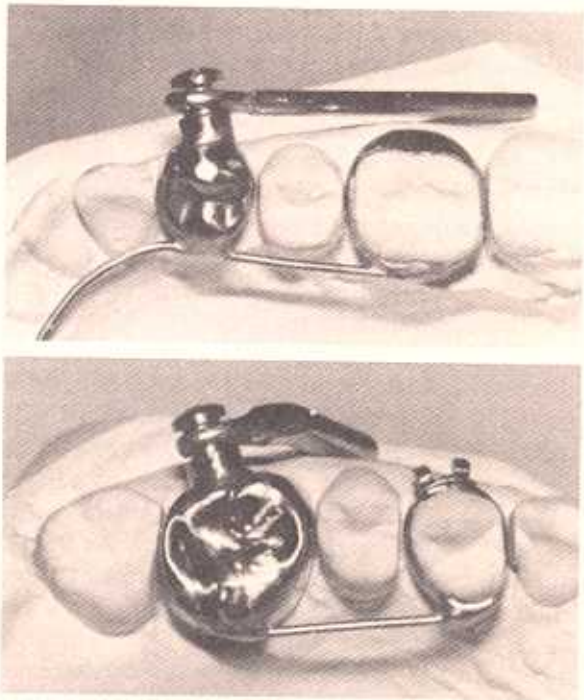


Fig. 5 Cantilever Herbst design.

Fig. 6 Buccal cantilever wire made by doubling .045″ wire and soldering the two strands together.



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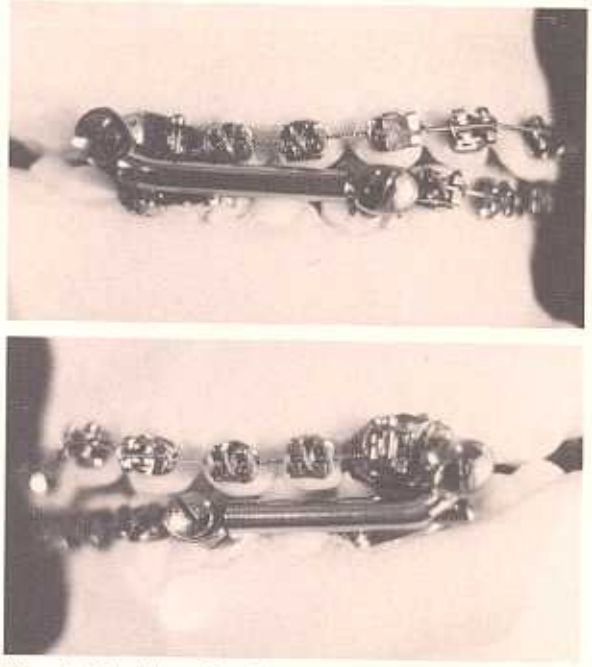

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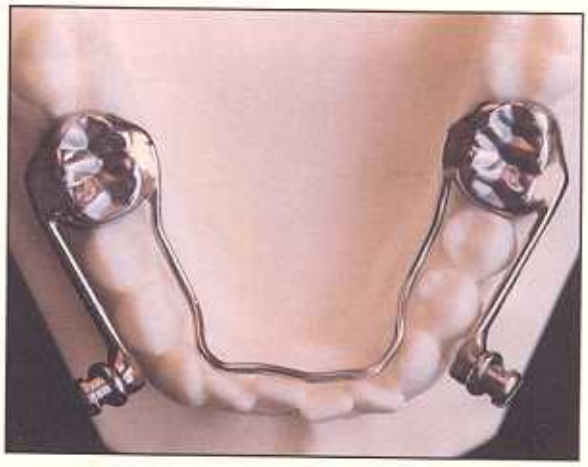

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Fig. 6 Buccal cantilever wire made by doubling .045″ wire and soldering the two strands together.

Clinical Problems with the Herbst Appliance

Following Herbst's suggestion, Pancherz advanced the mandible to an incisal edge-to-edge position. This discludes the posterior teeth and places the dental arches in an overcorrected Class I relationship.

Every Herbst design displaces the lower dentition forward. Pancherz found the amount of displacement to range from 1.5mm to 3.5mm.[29] However, a design using a lower removable acrylic matrix, suggested by White in the Valant report[22] (Fig. 7), was not tested by Pancherz. Since this design produced less forward displacement of the lower incisors than any in Pancherz's study, it would seem to be preferable if forward displacement of the lower incisors must be minimized.

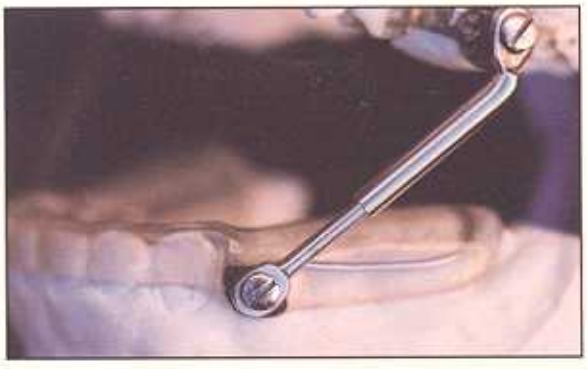

Fig. 7 Mandibular acrylic matrix Herbst design.

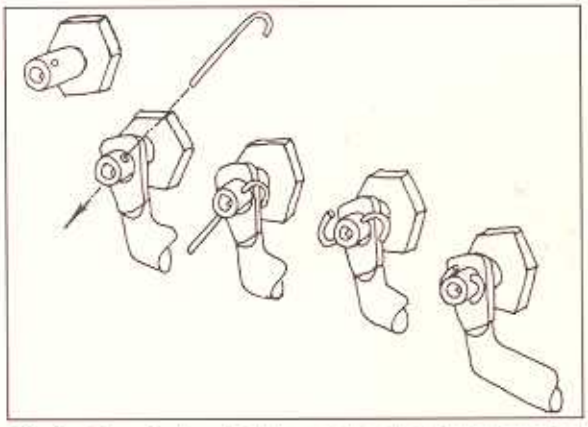

Fig. 8 Atlas Axle with tube and piston held together by cotter pin.

Because the acrylic matrix is removable, the patient can leave it out of the mouth. However, that makes the maxillary tubes hang down uncomfortably against the mandibular buccal vestibule. Others have suggested cementing such matrices, but the difficulty and danger of removing them from the mandibular arch guarantees you will do it only once.

No appliance works flawlessly 100% of the time. One of the most common distractions with the Herbst appliance is the loss of the maxillary axle screws that hold the tubes in place. If the axles are soldered too far distally on the upper molar crowns, it is difficult to stretch the mouth distally enough to reinsert the screws. Some clinicians suggest using acrylic, Loktite, or Super Glue to secure the screws, but these alter the threads in the axle so that if the screws do come out, it is nearly impossible to reinsert them.

Recent new axle designs have alleviated this

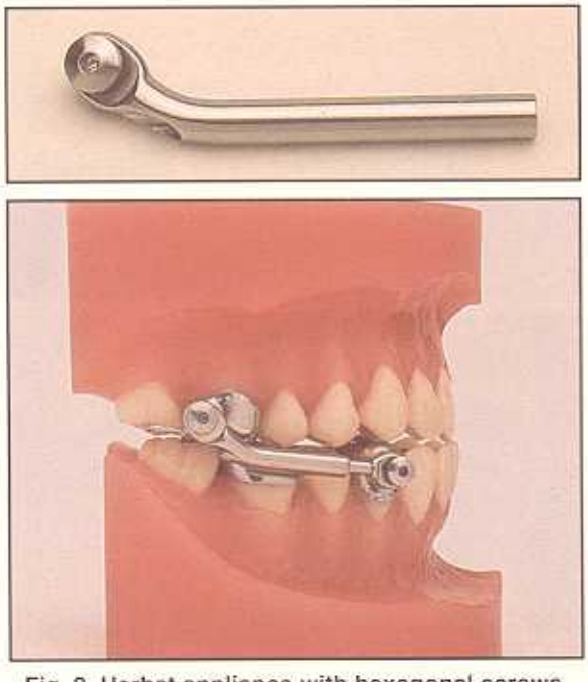

Fig. 9 Herbst appliance with hexagonal screws.

problem. Allesee's Atlas Axle** secures the tube and piston with cotter pins (Fig. 8). Ormco's hexagonal screw*** fits snugly against the axle and is adjusted with a small Allen wrench that can easily be maneuvered in the maxillary buccal vestibule (Fig. 9).

The mandibular axle screws are seldom a problem to reinsert. Therefore, it is preferable to use some type of screw that can be readily removed and reinserted to permit adjustments to the lower piston, which determines mandibular position.

One of the most intriguing of the recent Herbst design modifications is the Malu attachment† (Fig. 10). This uses a dead-soft wire to secure the maxillary tube to the headgear tube of the upper molar band. By eliminating a solder joint, the attachment reduces direct stress enough to prevent band fracture. A special Malu attachment for the lower archwire likewise eliminates a solder joint, but requires large archwires, such as .021″×.025″, to prevent breakage or serious wire deformation. Those who prefer .018″ brackets can't use the mandibular Malu attachment without enormous frustration (Fig. 11).

Another common problem with the Herbst appliance is ulceration of the buccal mucosa caused by the mandibular rod extending distally beyond the maxillary tube (Fig. 12). This can be remedied by shortening the rod, but if the mandi-

**Allesee Orthodontic Appliances, P.O. Box 725, Sturtevant, WI 53177.

***Ormco Corporation, 1332 S. Lone Hill Ave., Glendora, CA 91740.

†Saga Dental USA Inc., 1712 Hollinwood Drive, Alexandria, VA 22307.

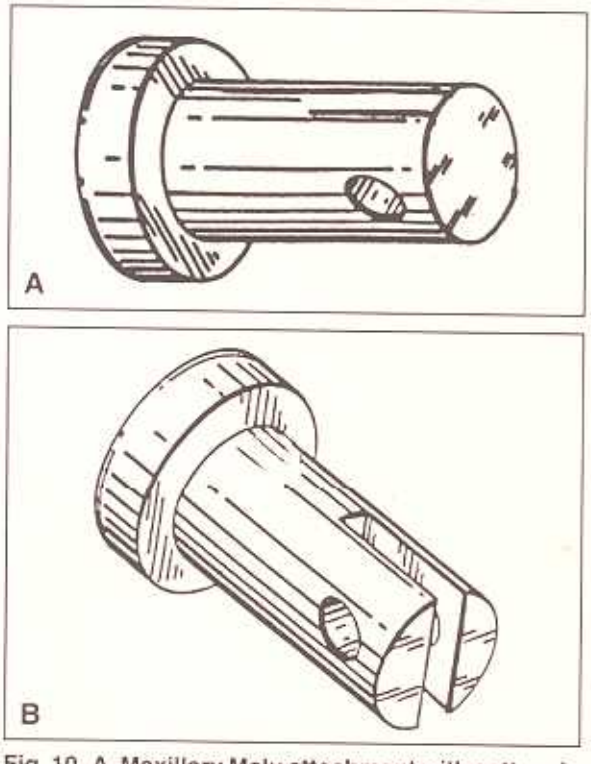

Fig. 10 A. Maxillary Malu attachment with cotter pin opening. B. Mandibular Malu attachment with archwire slot and cotter pin opening.

Fig. 11 Assembled Herbst with Malu attachments.

Fig. 12 Ulceration caused by overextension of mandibular rod.

Fig. 13 Ulceration of cheek caused by mandibular screw.

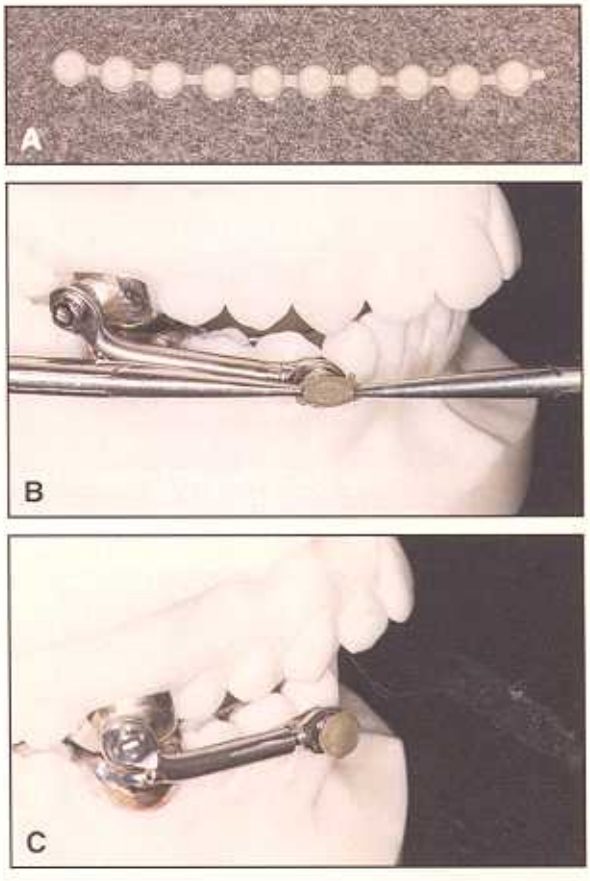

Fig. 14 A. Chain of individual Hug-Caps. B. Hug-Cap stretched between two hemostats for placement. C. Hug-Cap in place on mandibular screw of Herbst appliance.

bular rod is shortened too much, it is easily dislodged from the tube when the mouth opens. A compromise must often be worked out to make the patient comfortable and yet keep the appliance from coming apart during chewing. A cable cutter‡ is an excellent instrument for quickly cutting the thick piston, as well as other large dental wires.

Frequently, the screws protrude enough to encroach on the mucosa of the cheek and cause ulcerations (Fig. 13). This problem is relieved by covering the screws with Hug-Caps†† (Fig. 14).

Loose bands and crowns can be avoided by selecting the correct sizes with a Dentometer‡‡ (Fig. 15). The correct band or crown is quickly found by converting the tooth measurement to a band or crown size with the conversion chart.

Further retention can be added mechanically by sandblasting the inside of the band or crown with a Microetcher,* which abrades the metal with air-driven aluminum oxide and greatly increases its surface area and cementability (Fig. 16).

Zinc phosphate cement will not hold the crowns and bands well because of its weakness, fragility, and low adhesion. Glass ionomer cement is an ideal material for retaining Herbst crowns and bands because it is strong and chemically adhesive, and it acts as a fluoride reservoir that protects the cemented teeth. New light-cured glass ionomer cements have some promise, but their diminished adhesion to enamel and steep prices currently limit their usefulness with this appliance.

When a band or crown does loosen, it can be tightened by welding pieces of screen mesh to its inside surface until it is snug (Fig. 17). This not only physically tightens the attachment, but also increases the interior metal surface area.

Using American Orthodontics' new pho-

‡Small Parts Co., 13980 N.W. 58th Court, Miami Lakes, FL 33014.

††Kreative Koncepts, 105 E. First St., Hinsdale, IL 60521.

‡‡Feather River Dental Laboratory, P.O. Box 2089, Grass Valley, CA 95945.

*Danville Engineering Inc., 115-A Railroad Ave., Danville, CA 94526.

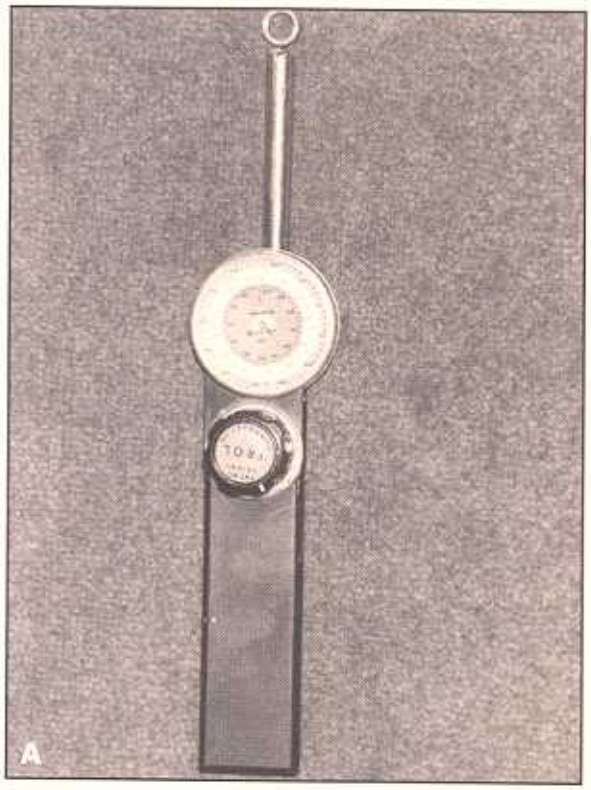

Fig. 15 A. Dentometer for selecting band and crown sizes. B. Dentometer conversion chart.

Fig. 16 A. Microscopic view of unetched stainless steel. B. Stainless steel after micro-etching.

Fig. 17 Screen mesh added to interior of crown for tighter fit.

toetched band** increases the surface area even more than micro-etching (Fig. 18). Combined with glass ionomer cements, this development may make loose bands a distant memory.

Some have suggested acid-etching the teeth and using a bonding composite or auto-catalytic acrylic as an adhesive. I have found it is difficult to keep both sides of the mandibular arch dry while cementing the lingual arch, but if absolute dryness can be maintained, these alternative cementation techniques will work well.

Additional Advantages

In addition to the uses and advantages mentioned by Herbst, others have come to light over the past decade through studies and clinical experience:

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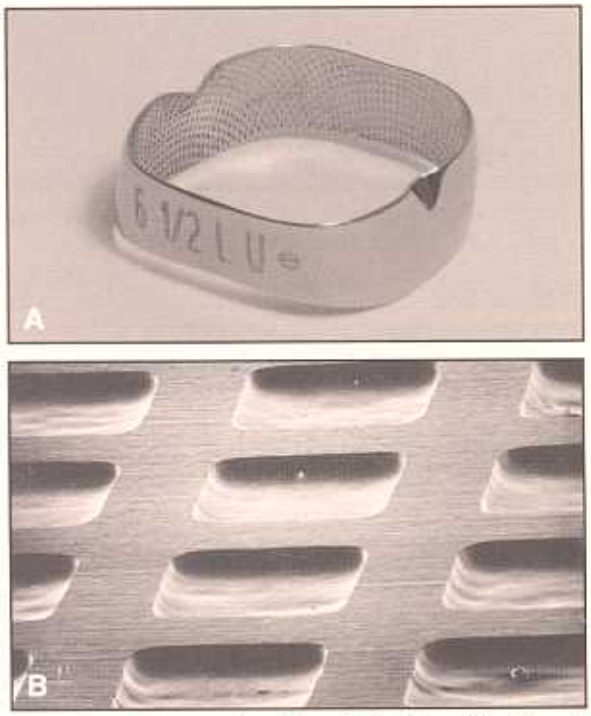

Fig. 18 A. Photoetched band. B. Magnification of interior surface of photoetched band.

- Acceleration of condylar growth in children makes it reasonable to encourage a retrognathic mandible to catch up in growth, and then permit the alveolar processes to adapt normally to the new dental Class I occlusion.
- Every study has shown some anterior displacement of the mandibular incisors with the Herbst appliance. This can be particularly useful in the treatment of Class II, division 2 patients, when it is usually desirable to move the lower incisors forward.
- The upward and backward force generated by the Herbst prevents eruption of the maxillary molars and has proven useful in the treatment of high mandibular angle patients by overcoming the vertical alveolar growth that often accompanies Class II malocclusions.
- The minimal cooperation requirement has proven especially valuable in patients with low sensitivity thresholds.[30,31]
- The Herbst appliance works with a constant force, which discomforts patients much less than intermittent pressures from headgears, elastics, or removable appliances.
- The appliance reduces maxillary convexity minimally, greatly diminishing the possibility of changing upper lip contour. Most retractors, when worn well, have a significant effect on upper lip contour and cause substantial distal movement of hard- and soft-tissue A point.

Fig. 19 Mandibular bicuspid Herbst axles soldered to crowns.

• Approximately one-half of the changes are dentoalveolar, so the Herbst can be useful in minimally growing patients as well as growing patients.
• The ability to alter mandibular position permits the Herbst appliance to correct midline deviations of mandibular origin.
• When mandibular second bicuspids are missing, the axles can be placed on the first bicuspids to provide excellent anterior anchorage and prevent the lower incisors from retracting while the molars are brought forward (Fig. 19).
• Few appliances maximize upper molar anchorage as much as the Herbst appliance. When maxillary molars must not erupt or move forward, this appliance excels.
• Multiple design possibilities allow the appliance to use whatever teeth are present.
• It is difficult to totally destroy or lose a Herbst, in contrast with other mandibular advancement appliances.

Limitations of the Appliance

The Herbst appliance has certain disadvantages that must be considered when diagnosing a case and planning treatment:

• A Class II bimaxillary protrusive patient will become even more protrusive with a Herbst appliance.
• Clinicians shouldn't expect to permanently alter condylar position when treating adults.
• Since the Herbst affects the maxilla minimally, it shouldn't be used when the Class II malocclusion is due to a protracted maxilla. In such a case, a retractor is indicated.
• For best results, the appliance should be worn for nine to 15 months. Since good retention depends on sharp-cusped bicuspids to stabilize the correction, the absence of bicuspids at the conclusion of Herbst therapy jeopardizes the retention.
• During the long treatment, the mandible has a limited range of motion, and patients must learn to chew in a vertical pattern with minimal horizontal movement.
• The size of the appliance may make it impossible to use with some patients.
• Finally, one must consider the cost of the appliance, since construction currently requires a rather expensive laboratory procedure.

Conclusion

We need to remember Maslow's observation: "If your only instrument is a hammer, then every problem looks like a nail." If your only orthodontic tool for treating Class II malocclusions is a retractor, then every Class II will seem like a maxillary protrusion—and clearly, not every one is.

The Herbst appliance is not a therapeutic panacea, but when the diagnosis and patient selection are correct, it can routinely treat difficult, noncooperative Class II patients successfully (Fig. 20).

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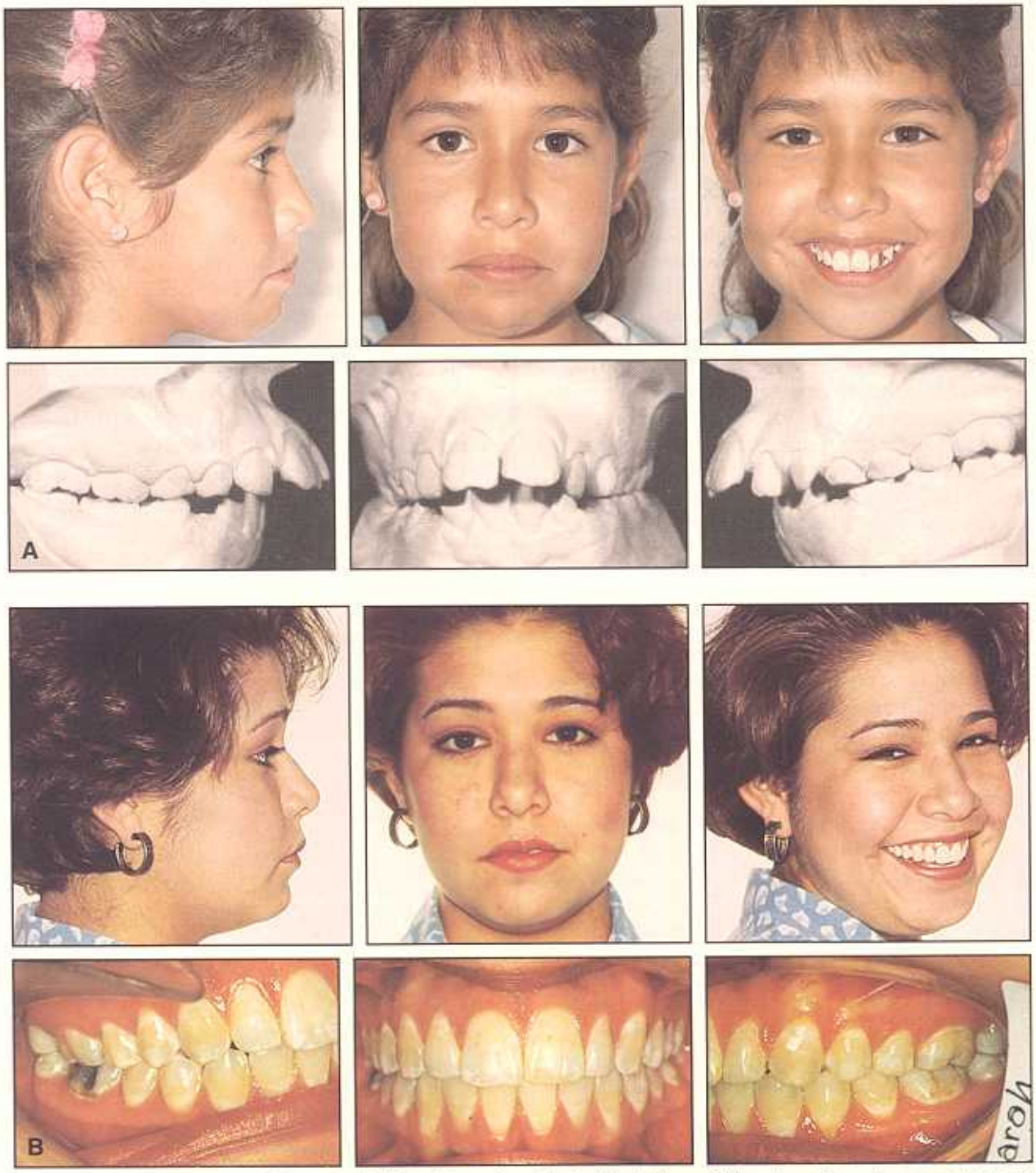

Fig. 20 Herbst treatment of Class II, division 1 female patient with history of thumbsucking, large overjet, and lip incompetence. A. Patient at age 10. B. Patient six years after 30 months of treatment, including 10 months of Herbst treatment (continued on next page).

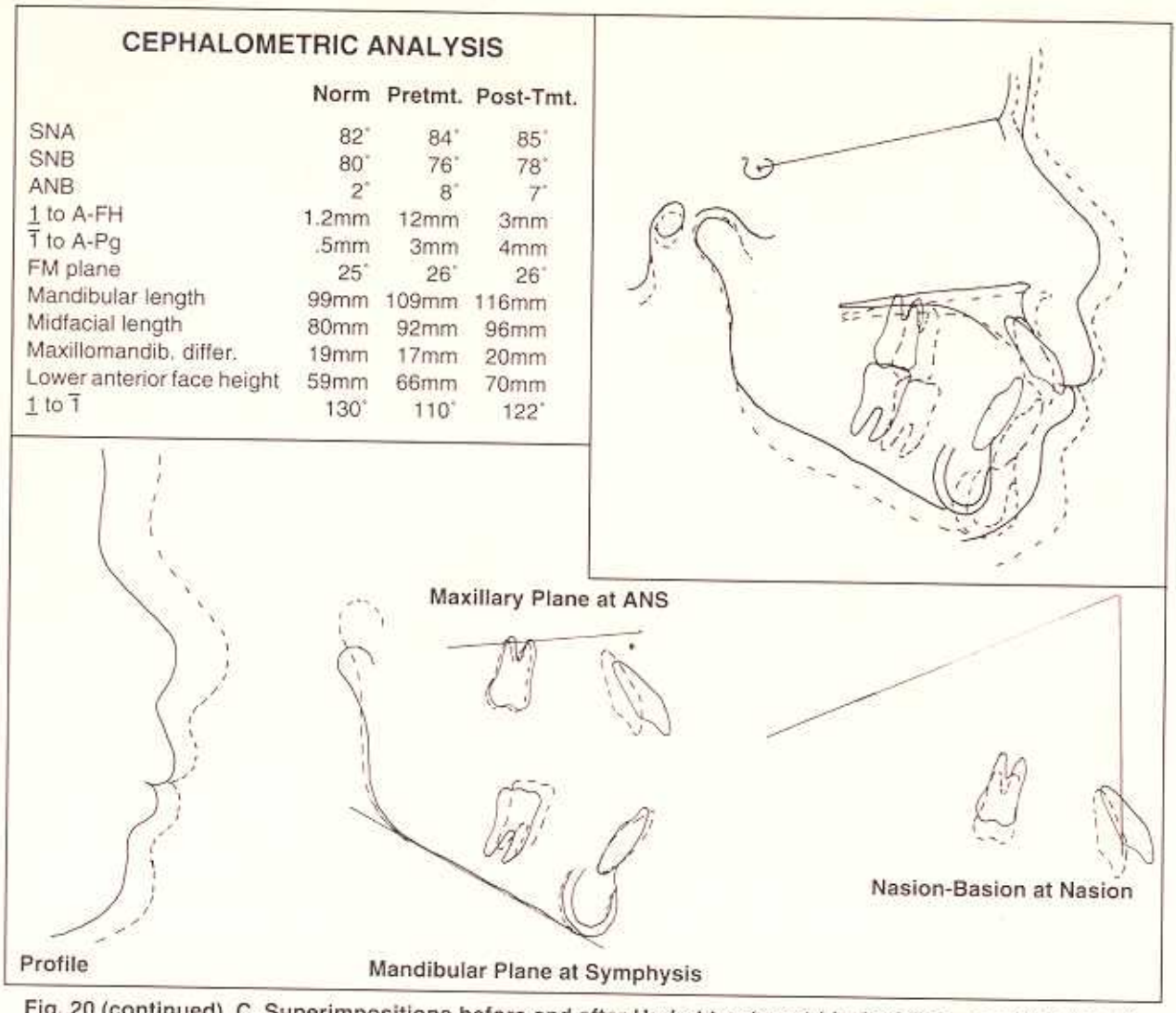

Fig. 20 (continued) C. Superimpositions before and after Herbst treatment (dashed line = post-treatment).

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