Hyperefficient Orthodontic Treatment Using Tandem Mechanics

James J. Hilgers

This article presents an advanced and efficient noncompliance method of therapy referred to as *tandem treatment.* Tandem treatment was devised to harness the predictable orthodontic and orthopedic responses elicited by two proven fixed Class II correction devices, the pendulum and Herbst appliances. Tandem treatment involves two separate actions to resolve certain types of Class II malocclusions. First, the upper arch is expanded and the upper molars moved distally into a Class I relation. The pendulum appliance uses palatal and tooth-borne anchorage to move the upper molars distally. The pendulum is followed by a simplified version of the fixed Herbst appliance, which serves as anchorage to retract the remainder of the maxillary teeth to previously Class I positioned molars. This tandem of "pendex" appliance and fixed anchorage Herbst appliance has the ability to greatly improve treatment efficiency when used in appropriately selected patients. A case report is used to illustrate the treatment protocol. (Semin Orthod 1998;4:17-25.)

A new era is dawning in orthodontic mechanotherapy. It is driven both by changes in technology and by an improved ability to apply continuous, fixed orthodontic and orthopedic forces. The use of the headgear,[1,2,3,4] Class II elastics[5,6] and removable functional appliances[7,8,9] as primary forces in Class II correction is well documented. Each of these methods, however, requires a great deal of patient cooperation. Studies have shown that compliance levels in the United States are slowly waning.[10,11] Currently, the ability of the orthodontist to achieve a good result is determined primarily by the level of patient cooperation. The failure to comply adequately with an orthodontic regimen often results in extended treatment times, patient "burnout," degeneration of supporting tissues, decalcification, and other adverse health effects. Noncompliance, itself, can be viewed as an affliction with an epidemiology of its own.[12] The factors surrounding noncompliance in society, whether genetic, social, demographic, or psychological in origin, often dictate the prospect of success in orthodontics.

Many orthodontists believe that the doctor-patient relationship is pivotal to creating patient compliance.[13] Orthodontists often take full responsibility for initiating and maintaining proper compliance protocols. It is healthy from the caregivers' standpoint to take this responsibility, because it keeps their motivation skills highly tuned and positively reinforces those patients predisposed to elevated cooperation levels. It probably does little, however, to change patient cooperation in those children whose attitude and responsibility levels are inadequate. Because visits to the orthodontist's office typically occur only every 4 to 8 weeks, the provider's attempts to influence the patient favorably are overridden by daily pressures and incentives toward nonadherence. Researchers have found that external factors far outweigh the impact of periodic support.[14,15] Patient compliance patterns in other areas of their life are a better barometer of their cooperation levels during orthodontic therapy. The role of an ordered family life and satisfactory parent-child relationship has been shown to greatly influence children's disposition toward cooperation with authority figures. A variety of everyday interactions with family and peers primarily affect the child's attitude toward responsible behavior.

Investigators, using different methods and samples, have estimated compliance for pediatric populations generally to be less than 50%.[16,17] Humanistic and behavioral approaches that attempt either to detect symptoms and mete out punishment or reward appropriate behavior are largely ineffective, given the time

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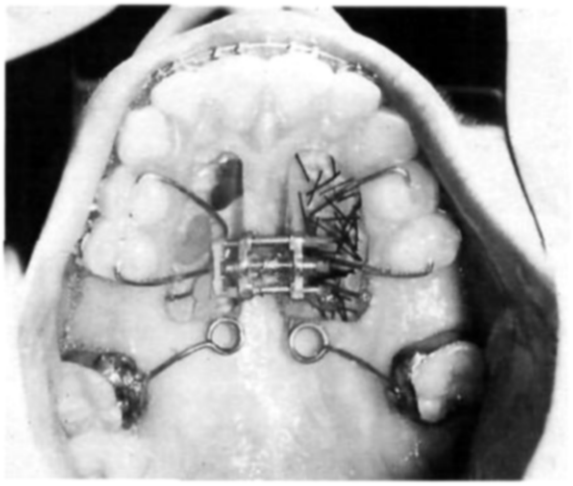

Figure 1. Pendex appliance in place after 3 months of therapy. Moderate expansion and distalization of the upper first molars has been achieved. The upper first molar bands have Herbst axles attached.

constraints of most orthodontic treatment. As the use of auxiliaries and treatment intervals increase, the impact of limited communication takes it toll. Changing a lifetime of behavioral patterns in a child, especially a pubescent one, is questionable. Simply put, orthodontists can be aware of patient psychology, but we are not psychologists. We can positively support the child who is willing, we can diffuse an autocratic environment that fuels negative responses in our patients, and we can improve our communication skills, but our ability to optimally motivate many of our patients is doubtful. Changing ingrained personality traits is unrealistic in most instances. Rather, it is important to detect individual compliance patterns and support them with an orthodontic regimen that allows for the most desirable outcome. Sometimes, this may mean not initiating treatment at all.

Figure 2. Mandibular occlusal view of the anchorage Herbst appliance showing separate left and right segments using stainless steel crowns. Lower occlusal rests are bonded on the lower molars, and canine to canine brackets are bonded and a segmental edgewise wire engaged.

The best approach to conflicts in compliance is to avoid them as much as possible. Reducing what we ask from our patients may not improve overall compliance, but it at least can improve our control over gross reduction of the malocclusion. Treatment that does not take the individual patient cooperation level into account is destined to be unpredictable. Hilgers states that "the difficulty in orthodontic diagnosis is generally not determining what *should* be done but rather what *can* be done."[18] New forms of treatment that require less patient compliance are being actively explored. Upper first premolar extractions, orthognathic surgery, fixed Herbst appliances, magnets, Jasper jumpers, implants for anchorage, and fixed coil springs, among others, may offer some solutions in problems of patient compliance.

The ability to be more effective in our application

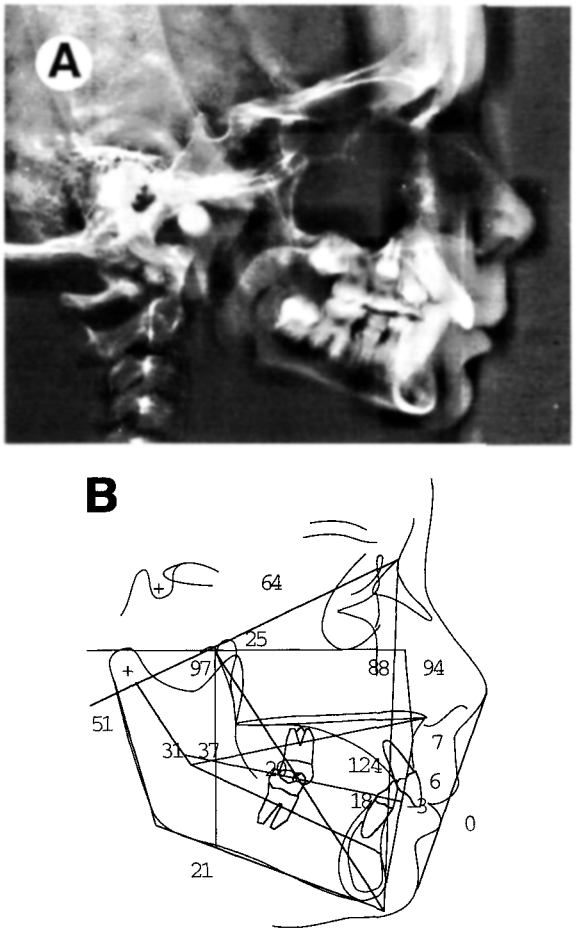

Figure 3. Cephalogram of a patient with ideal characteristics for tandem treatment. This patient has a brachyfacial morphogenetic pattern with maxillary dental protrusion and mandibular retrusion and a 10 mm overjet (A). Ricketts' cephalometric analysis (B).

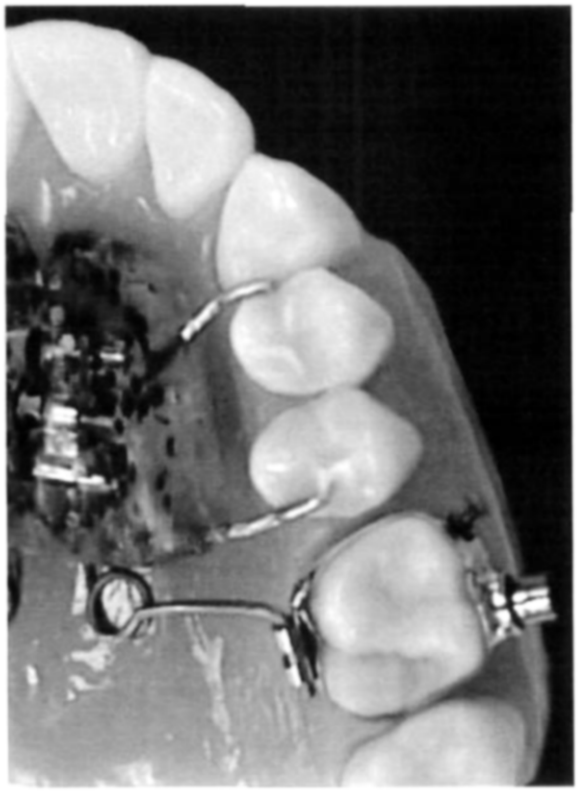

Figure 4. Upper molar band cemented and pendex appliance in place. Herbst axle is soldered onto the disto-buccal of the upper first molar band. The molar band is reinforced with a veneer of solder. Note the small metal button welded on the mesial of the band. This is used to attach elastomeric chain when "free-floating" the upper buccal segments back to the distally driven upper molars.

of forces is paramount to achieving a desirable result. It also drives treatment efficiencies and practice economics. Whether the patient is inherently compliant or not, the more control the orthodontist has over

Figure 5. Mandibular occlusal view of anchorage Herbst appliance using solder reinforced bands instead of stainless steel crowns. The reinforced bands (in lieu of crowns) can be used when the anchorage Herbst appliance will be in place for 6 months or less.

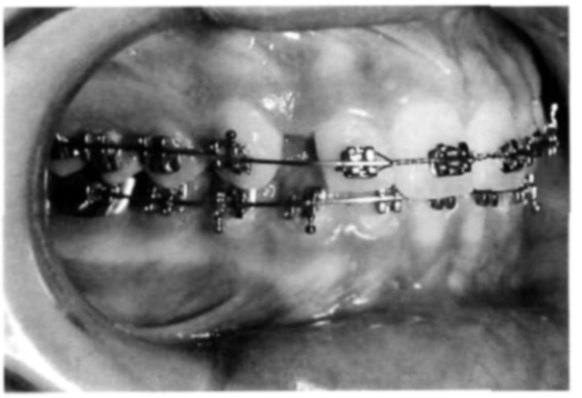

Figure 6. Lateral intraoral view showing spacing mesial to the upper cuspids after distalization of the upper molars and retraction of the buccal segments. This results in a good Class I buccal segment occlusion. Retraction and intrusion of the upper anterior segments is needed to complete antero-posterior correction of the malocclusion.

mechanotherapy, the more predictable and timely the result will be. Without question, patient compliance cannot be totally avoided. Proper tooth-brushing, appliance care, and elastic wear are essential for optimal treatment outcome. Complex compliance requirements make it more difficult for patients to cooperate. Reducing treatment time, improving the predictability of results, and limiting requests for patient cooperation to critical times would be most helpful to the clinician.

Theory Behind Tandem Treatment

The purpose of this article is to present an advance in efficient, noncompliance therapy referred to as *tandem*

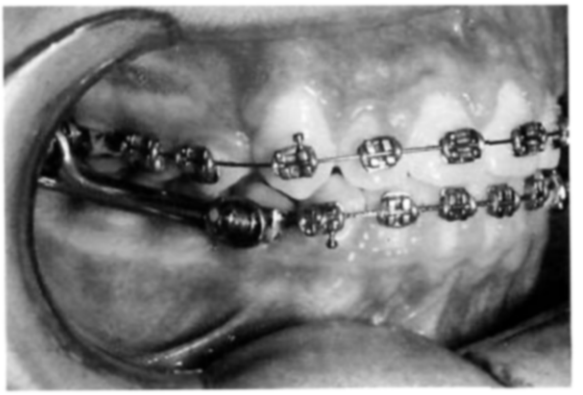

Figure 7. Lateral view showing anchorage Herbst appliance in place after distalization of the upper buccal segments and retraction of anterior teeth. When the anchorage Herbst appliance is removed, the antero-posterior Class II correction is complete, leaving only the final leveling, alignment, and detailing to be carried out.

Figure 8. Upper asymmetrical "T" loop arch wire formed in a .016″ × .022″ TMA wire. The "T" loop has a short (3 mm) mesial and long (7 mm) distal extensions to allow for the vertical height adjustments often necessary when retracting upper incisors.

treatment. Tandem treatment was devised to harness the predictable orthodontic and orthopedic responses elicited by two proven fixed Class II correction devices, the pendulum ("pendex") and Herbst appliances. Tandem treatment involves two separate actions to resolve certain types of Class II malocclusions.

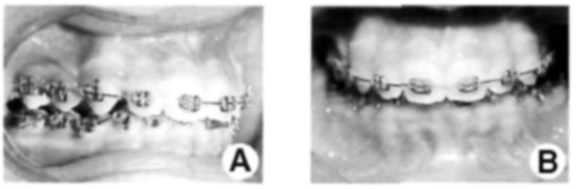

Figure 10. Immediately after removal of anchorage Herbst appliance (A). Note overcorrection of Class I molar relationship and beginning of overbite correction (B).

First, the upper arch is expanded and the upper molars moved distally into a Class I relation. Litowitz[19] notes that 3 mm to 5 mm distalization of the molars is adequate to correct many Class II malocclusions. The pendulum appliance serves several purposes. It allows for the correction of crossbites caused by the arch form incongruity that exists in most Class II malocclusions. It avoids crossbites that may occur when maxillary molars are moved distally. (The incongruent arch form problem is exacerbated when the lower jaw is advanced by the Herbst appliance.) The pendulum appliance uses palatal and tooth-borne anchorage to move the upper molars distally. The pendulum is followed by a simplified version of the fixed Herbst

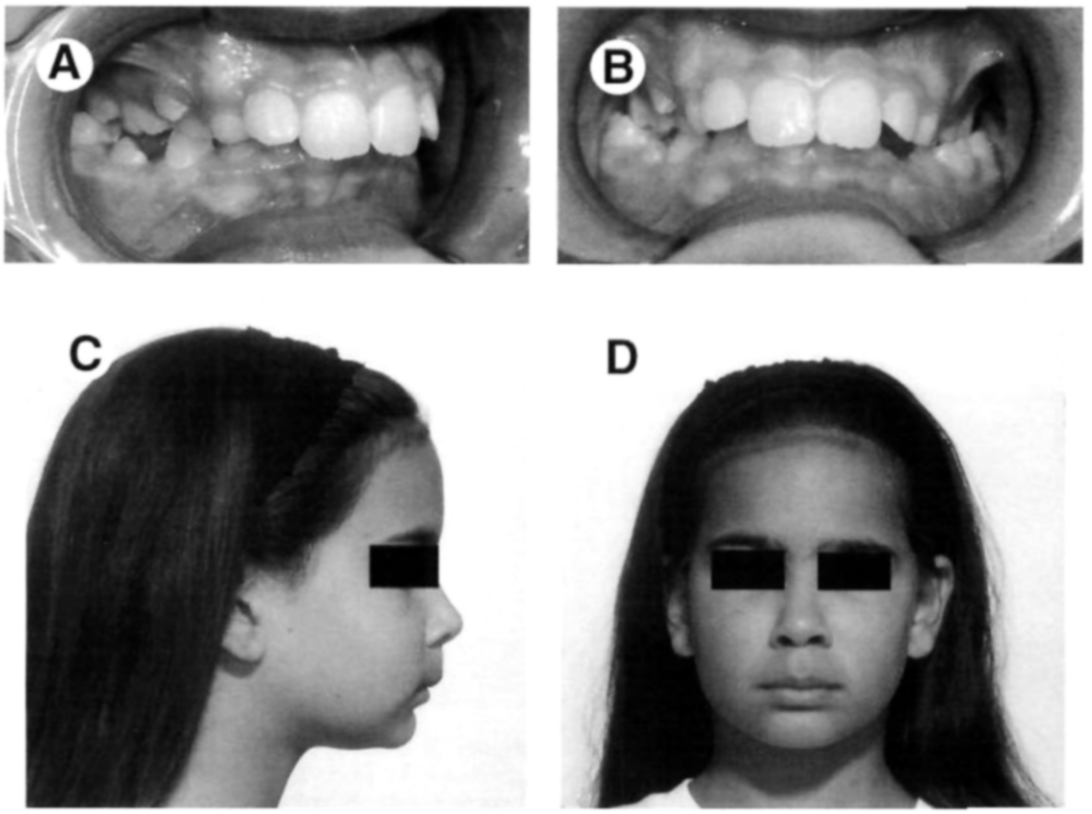

Figure 9. Initial right lateral (A) and frontal intraoral photographs showing original malocclusion (B). Note deep overbite, posterior crossbite, and severe overjet. Initial profile (C) and frontal photographs (D).

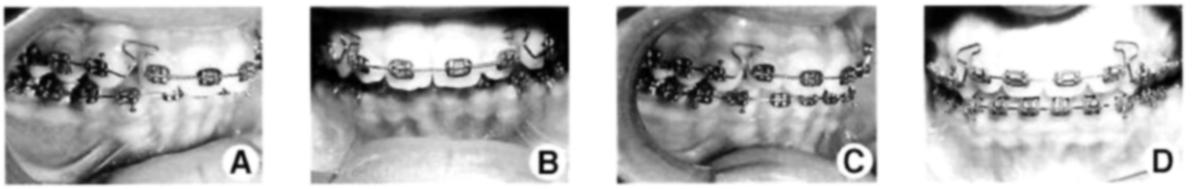

Figure 11. Lateral and frontal views at time of placement of asymmetrical "T" loop closing arch wire to intrude and retract upper incisors (A, B). Lateral and frontal views of the same patient after 6 weeks showing simultaneous upper incisor retraction and bite opening (C, D).

appliance that serves as anchorage to retract the remainder of the maxillary teeth to the now corrected Class I molar relationship. This "tandem" of pendex appliance and fixed-anchorage Herbst appliance has the ability to greatly improve treatment efficiency when used in appropriately selected patients.

The Pendulum Appliance

The pendulum appliance[20,21,22] has proven to be effective in distalizing upper molars in the treatment of Class II malocclusions. This molar distalizer/expansion appliance uses .032" TMA springs (Ormco Corp, Glendora, CA) to deliver a moderate (200 g to 300 g) continuous distal pressure to the upper first molars. Using cephalometric superimposition on the maxillae in 151 subjects, Bussick[23] showed an average 78% distal movement of the upper first molars compared with a 22% forward movement of the buccal segment anchorage units. Bennett and Hilgers[24] note that "although distalizing the upper molars is a relatively easy and predictable procedure, the difficulty lies in maintaining that gain." The Pendulum appliance is bonded in the upper arch and the total expansion expected is in the 2 mm to 6 mm range. The upper molars are only moved distally a moderate amount to avoid excessive tipping. It is not necessary to overcorrect the molar relationship. The Herbst appliance is employed as a secure anchorage unit to retract the upper buccal segments and also to advance the mandible, which aids in Class II correction. It generally is the combination of maxillary molar derotation and distalization together with forward mandibular movement that produces the overall Class II correction. Figure 1 illustrates the Pendex appliance.

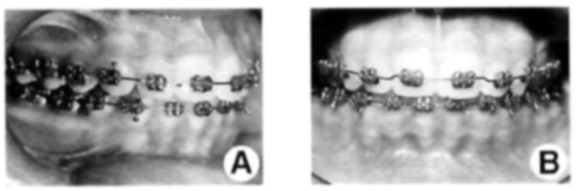

Figure 12. Final idealization (A). Minimal Class II elastics have been worn up to this time (B).

The Anchorage Herbst Appliance

The anchorage Herbst appliance is a simplified form of the traditional fixed Herbst appliance. It consists of two separate units on each side of the lower arch to which the axles are soldered. There is no complete lingual arch. The lower anterior dental segment is bracketed from canine to canine, and a segmental edgewise arch wire is placed. The placement of brackets on the lower anterior teeth acts to maintain lower arch form integrity. The simplified Herbst is used more as an anchorage unit during the retraction of the upper arch and less for its orthopedic effect, although the orthopedic effect is advantageous in most instances. The anchorage Herbst uses bands or crowns on the lower first premolars and a bonded .045" lingual stabilizing wire on the occlusal surface of the lower first molars (Fig 2).

Patient Selection

Tandem treatment is used ideally in patients whose malocclusion results from a combination of maxillary dental protrusion and slight to moderate mandibular retrusion and who have a brachyfacial morphogenetic pattern (Fig 3). Treating hyperdivergent patterns with distalizing molar mechanics is contraindicated because of the tendency to create or aggravate an anterior open bite. The great advantage of tandem treatment lies in its ability to distalize the upper molars rapidly (3 months). This phase is followed by short-term wear of the Herbst appliance (6 to 9 months) during which the upper buccal segments and incisors are retracted. Gross reduction of most Class II malocclusions selected for this therapy can be completed within 1 year. The remainder of the orthodontic treatment consists of detailing and finishing. It is not the primary intent of this mechanotherapy to treat patients more rapidly, but rather it is intended to provide the clinician more time to finish and detail the occlusion.

Treatment Sequencing

The Pendex appliance is bonded in the upper arch, and the lower units of the anchorage Herbst appliance

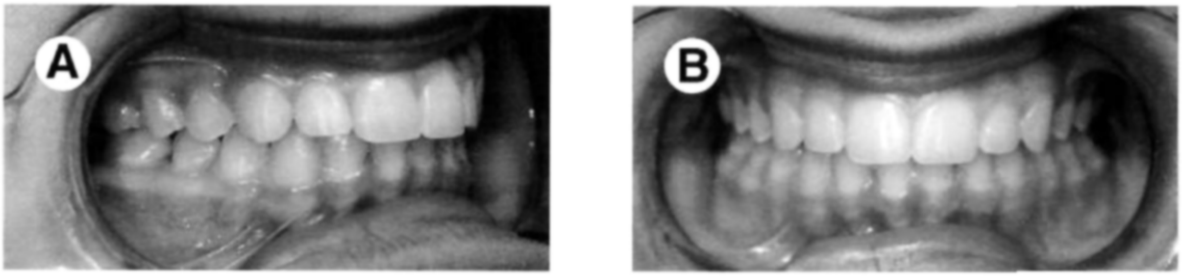

Figure 13. Final occlusion at end of tandem treatment (A,B). Note the alleviation of crossbite, Class II correction, overbite reduction, and idealized occlusion. Total treatment time was 19 months.

are placed at the outset of treatment. The upper arch is expanded, and the molars are moved distally without excessive tipping. Usually the upper molars do not need to be moved distally more than 3 mm to 5 mm. The upper molar bands have the Herbst axles attached so that the only portion of the Herbst appliance remaining to be placed are the rods and sheaths (Fig 4). The latter will be carried out once the upper molars are in place and the upper arch expanded. Retraction of the remainder of the upper teeth is completed using the Herbst appliance for anchorage. The following is the general sequence and timing of the first year of treatment:

First three months of treatment. (A) Placement of the upper pendex appliance and the lower units of the anchorage Herbst appliance. The Herbst axles on both the upper and lower Herbst appliance are in place. Lower canine to canine brackets are bonded and a lower .017″ × 025″ CuNiTi (Ormco Corp) segmental arch wire is inserted (Fig 5). (B) The upper arch is expanded by activating the midpalatal jackscrew one turn each day until moderate overcorrection is achieved. (C) The molars are moved distally until a Class I molar relationship is achieved.

Second three months of treatment. (A) The rods and sheaths of the Herbst appliance are measured and placed. The mandible is advanced, leaving some overjet so the upper anterior teeth can be retracted. (B) Brackets are bonded on the upper arch and the upper buccal segments "free-floated" (ie, not on an arch wire) using elastomeric chain attached posteriorly from the maxillary molars that had been previously positioned in a Class I relationship with the mandibular molars. The upper incisors then are aligned employing a segmental arch wire. (C) The space created by the previous distalization of the upper molars is now evident between the upper canines and lateral incisors (Fig 6).

Third three months of treatment. (A) The upper arch is leveled and aligned, employing a continuous edgewise arch wire. Figure 7 illustrates a clinical example of this stage.

Fourth three months of treatment. (A) The upper incisors are retracted (reducing residual overjet) us-

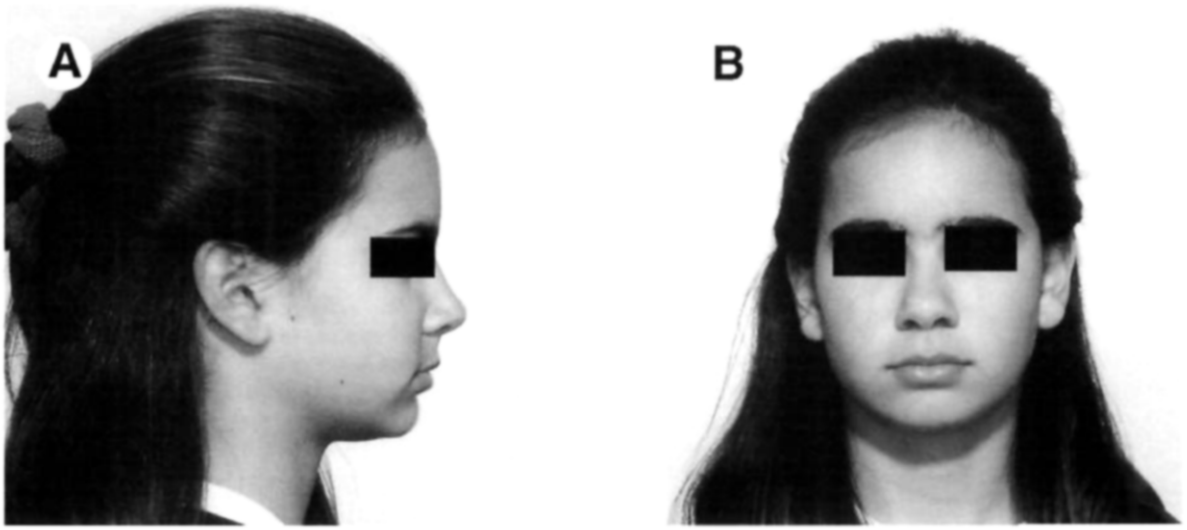

Figure 14. Final facial profile and frontal photographs (A,B). Note the reduced naso-labial angle, softened contour of the upper lip, slight downward cant of the nares, and improved prominence of the soft tissue chin.

ing a .016″ × .022″ TMA "T" loop closing arch (Ormco Corp). This wire acts to intrude the anterior teeth, extrude the buccal segment teeth, and create an overcorrection step-up at the upper incisors. This procedure avoids incisal interference during anterior retraction. Figure 8 illustrates a clinical example of this stage (not the same patient as illustrated in Fig 7).

Case Report

An example of an ideal patient for tandem treatment (Fig 9) is as follows:

> *Class II, Division 1, deep-bite malocclusion (Figs 10 and 11); brachyfacial type with mild maxillary protrusion and mild mandibular retrusion. Bilateral crossbite with lateral maxillary deficiency, blocked upper canines. Mild (−4 mm) mandibular crowding, but "E" space available. The lower incisor position is optimal.*

This patient had an acute nasolabial angle with good overall upper face proportions. The lower jaw was deficient, but not incongruous with her facial pattern. (Figs 9C and D). The optimal treatment would require both orthodontic and orthopedic correction. This patient had a strong brachyfacial pattern. The patient differed from the typical "ideal" Herbst appliance patient in that the Class II malocclusion was the result of a combination of mandibular deficiency and maxillary dental protrusion. The patient did not require long-term Herbst appliance therapy.

Sequence of Treatment

A tandem treatment plan was devised for this patient that employed the following treatment sequence:

1. Cement the upper first molar bands (with Herbst axles in place) and make an impression for a Pendex appliance.
2. Fit lower first premolar crowns (or bands) and make an impression to fabricate the lower unit of the anchorage Herbst appliance.
3. Fit and cement the upper Pendex and lower unit of the anchorage Herbst appliance. The Herbst axles should be in place, but the sheaths and rods are not attached at this time.
4. Activate the jackscrew one turn per day to achieve moderate expansion of the upper arch. Allow molar distalization into a Class I relationship to occur.
5. Remove the Pendex appliance and place a transpalatal bar in the lingual sheaths of the maxillary first molar bands. Bond brackets on the entire upper arch and to the lower canines and incisors and place a .017″ × .025″ CuNiTi (Ormco Corp) wire in the anterior segment of the lower arch. Place a .014″ stainless steel arch wire in the upper anterior segment from the lateral incisor to the contralateral lateral incisor.
6. Place rods and sheaths into the previously-cemented Herbst axles and advance the mandible to an ideal overbite and overjet relationship.
7. Free float (ie, not on a wire) the upper buccal segments back to the molars using elastomeric chain.
8. Remove the Herbst appliance and refit and cement the upper first and second molar bands. At this time, the mandibular first and second molar bands are cemented. Reinsert a transpalatal bar. Direct bond the lower premolars. Place a lower arch wire (eg, .016″ × .022″ NiTi; Ormco Corp) and level and align the lower arch.
9. Place an upper alignment arch (eg, .016″ × .022″ CuNiTi; Ormco Corp). (Figs 10A and B).

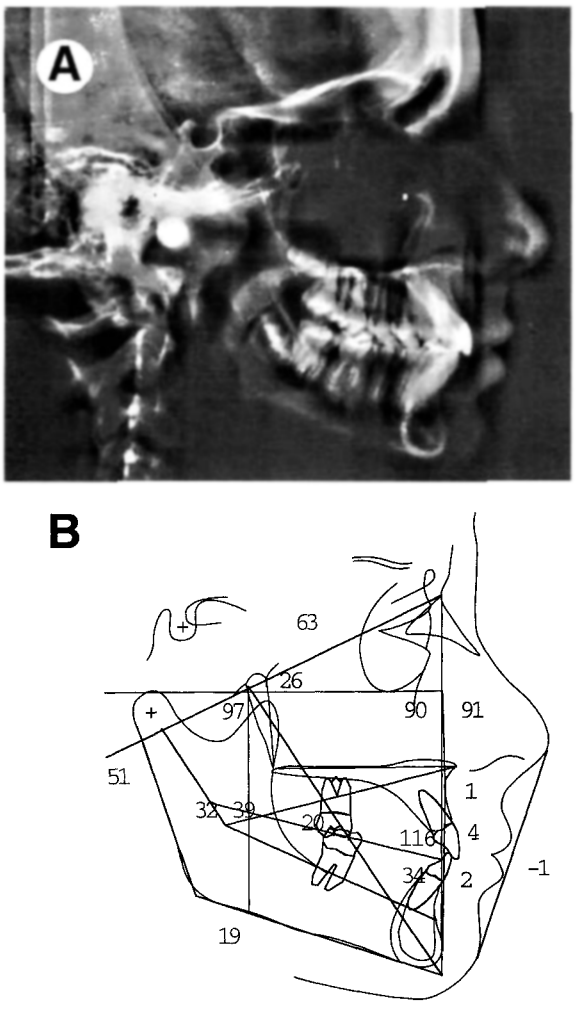

Figure 15. Final lateral headfilm (A) and Ricketts' analysis (B).

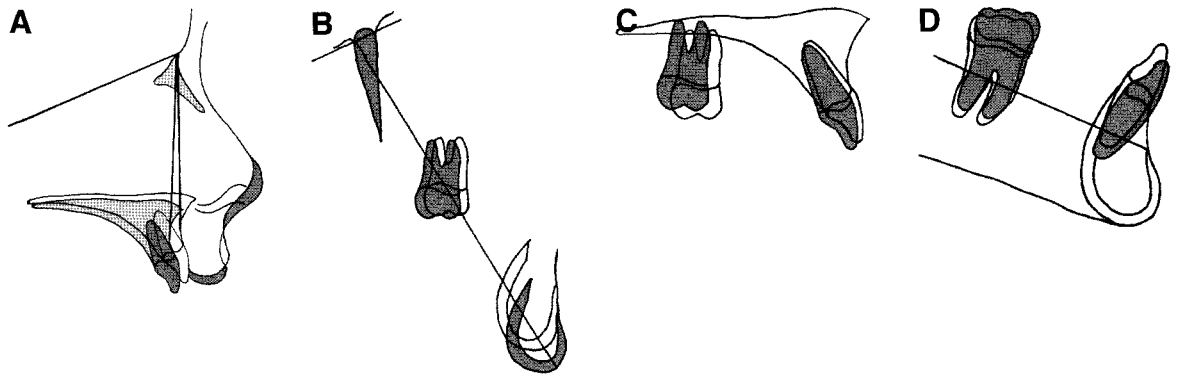

Figure 16. (A) Superimposition on Ba-Na line at Nasion to detect orthopedic changes in the maxillary complex. Note slight downward, backward rotation of maxillae followed by a slight change in the cant of nares. (B) Superimposition of Ba-Na at the crossing of the facial axis to detect orthopedic changes in the mandibular complex. Note the mandibular length increase while maintaining growth down the facial axis (ie, no opening or closing of the facial growth pattern). (C) Superimposition ANS-PNS at the incisive canal to detect changes in the maxillary arch. The upper molar is distally moved and intruded slightly. The upper incisors are retracted slightly. (D) Superimposition on the mandibular corpus at supra-pogonion to detect changes in the mandibular arch. Note the slight forward movement of the lower arch.

10. Intrude and retract the upper incisor segment with a .016″ × .022″ TMA asymmetrical "T" loop (Ormco Corp) arch wire.[25] (Figs 11A through D).
11. Place a lower ideal arch (eg, .016″ × .022″ TMA) and an upper flexion archwire (eg, .016″ × .022″ Force-9) (Ormco Corp).
12. Detail the occlusion with vertical seating elastics.[26] (Fig 12A and B).

Figure 17. Comparison of initial and final lateral facial photos.

13. Follow routine retention procedures.[27] Figure 13A and B shows final occlusion at completion of treatment.
14. Postretention analysis of patient (Figs 14-17).

Discussion

The term *non-compliance therapy* seems to imply that this approach is used only in noncompliant patients. That is, traditional (cooperation-dependent) orthodontic therapy is initiated and if that fails then noncompliance approaches are resorted to. This assumption is inaccurate because reducing the need for compliance in all patients is an optimal goal. When cooperation is needed (as it always is in all patients), compliant patients will take responsibility for their own treatment outcomes. The ultimate goal is quality treatment and treating in as short a time as possible without compromising treatment results.

The term *hyperefficient orthodontics* is used to describe controlled (through the use of fixed rather than removable appliances) correction of gross orthodontic/orthopedic problems. The ability to control and adequately predict treatment time and outcome is one of the most important aspects of optimal clinical orthodontics. Control and treatment outcome has an influence on patient compliance issues, chairside time, overhead expenses, quality of treatment, and stability of result. Orthodontists who are proactive in their treatment strategies and less dependent on patient compliance are more likely to improve their efficiency and decrease patient and operator frustration. It is of significance if we can avoid protracted treatment times with their possible negative sequelae.

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