The Amalgamated Technique, a Mechanically and Biologically Efficient Method for Controlled Tooth Movement

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The amalgamated technique, introduced in 1976 after ten years of development, combines biomechanical principles of both the edgewise and Begg techniques for efficient and controlled tooth movement. Appliance design, treatment concepts, and clinical results have been reported previously.[1]

Rapid bite opening is achieved early in treatment by a combination of extrusion of posterior teeth and intrusion of anterior teeth. Correction of overjet is also obtained early through the tipping of incisors and canine crowns *to,* but not *beyond,* their projected angulation, followed by translation until contact of maxillary and mandibular incisors is established. These tooth movements are within limits of physiologic tolerance of periodontal tissues and alveolar bone, as well as cementum and dentin of the roots. Although free tipping of teeth has been claimed to be a *sine qua non* for differential force distribution, the results with the present technique demonstrate that controlled tipping with an edgewise bracket and a round light wire edgewise system provides an effective mechanism for correction of malocclusion.

While impressed in earlier years by rapid reduction of overbite and overjet with the Begg technique, the author considered tipping roots of teeth, first in a direction opposite to their projected final position and thereafter correcting by torquing and uprighting, was not only mechanically inefficient, but also potentially harmful biologically.[2] The possibility of dehiscences and fenestrations within alveolar bone and the potential for root resorption following "round tripping" of teeth was supported by the laminagraphic findings of ten Hoeve and Mulie.[3]

Correction of overjet without displacement of the root apices in the opposite direction should be a desirable and fundamental objective of orthodontic mechanotherapy and can be achieved with the amalgamated technique. The movement of incisors is monitored carefully until the proper position and axial inclination is attained. At this point, root uprighting at the extraction sites is virtually achieved owing to bracket angulation. Additional incisor root torque can be obtained with auxiliaries, supported by headgear and/or Class II elastics, depending on the availability and location of residual extraction spaces in extraction treatment. The position of mandibular incisors is controlled throughout treatment with round and rectangular archwires and intermaxillary or intramaxillary elastics. Although translation of teeth may seem to be a slower procedure than tipping, the duration of treatment is not increased, because uprighting and torquing of teeth occurs gradually and is not postponed until the final stage of treatment.

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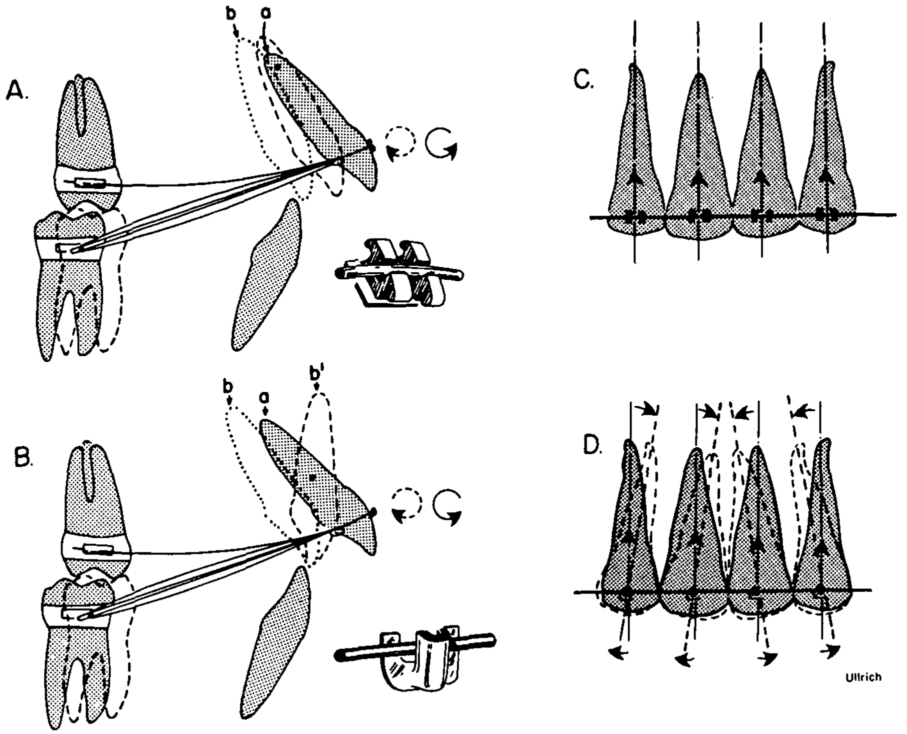

Fig. 1 A, Controlled tipping followed by translation of maxillary incisors. Note that the root apex moves efficiently from point *a* to *b* as a result of the interaction between an exaggerated curve of Spee in the archwire (a counterclockwise moment) and Class II elastic traction (a clockwise moment). When the incisor inclination is favorable relative to line N-A, bodily retraction is achieved to eliminate the remaining overjet. B, Excessive and uncontrolled tipping of the maxillary incisors results in unnecessary movement of the root apex from point *a* to point *b′*. The apex must then be brought back through point *a* to the desirable end-point *b* by torquing procedures. C, the wide Siamese brackets minimize mesiodistal tipping of incisors, as they are retracted. Therefore, the intrusive force delivered by an exaggerated curve in the archwire has maximum effectiveness against the clockwise movement of force from Class II elastic traction. D, The narrow Begg bracket permits transversal tipping of incisors, as they are retracted. This distomesial crown and root movement renders the intrusive force from the tip-back in the archwire less effective in counteracting the effects of Class II elastic traction. Therefore, the root apices may be "round tripped" and the incisors extruded.

Controlled tipping

A combination of three factors is responsible for controlled tipping of the maxillary incisors with this technique: Class II elastic traction, an accentuated curve of Spee archwire design, and wide edgewise brackets. Class II elastics deliver a clockwise moment to proclined maxillary incisors. This moment of force induces lingual movement of the maxillary incisor crowns rotating these teeth around an axis approximately in the middle third of the roots. In Division 1 cases the accentuated curve of Spee in the archwire, however, delivers a counterclockwise moment to the incisors that tends to displace apically the axis of rotation. The simultaneous action of these forces creates an axis of rotation nearer the apex of the incisors (Fig. 1A). In the Begg technique a similar effect is obtained on incisors by Class II elastic force and a tip-back in the archwire. However, when the incisor crowns are tipped beyond their normal relationships to the root apices, the counterclockwise moment supplied by the tip-back becomes less effective to counteract the clockwise moment delivered by the Class II traction. In fact, the tip-back effect may even be converted into a clockwise moment. This synergistic action enhances labial movement of the root apex, the center of rotation being transferred toward the incisal edge (Fig. 1B). This sequence of events can be avoided by discontinuing tipping of the incisors when they approach an upright position; but when overjet persists, cessation of tipping at this incisal inclination is incompatible with the basic practice inherent in the Begg technique.

In the amalgamated technique, undesirable clockwise rotation of the maxillary incisors is largely avoided, because the teeth are retracted *only* to their optimal angulation relative to the line nasion-point A. Thereafter, they are translated palatally. In classical Begg treatment free tipping abates only after an edge-to-edge incisor relationship is achieved, but it may continue into the second stage of treatment if extraction spaces persist after elimination of overjet and overbite.

Labial displacement of incisor root apices may occur inadvertently in the amalgamated technique or, for that matter, in any other technique, owing to carelessness.

The wide Siamese edgewise brackets provide control of mesiodistal tooth movement safeguarding against transversal deviations of the apices of the incisor roots (Fig. 1C). Otherwise, the mesiodistal "round tripping" movement must be corrected during finishing (Fig. 1D).

Biologic considerations

Although remodeling of alveolar bone can and does accommodate root movement, the control of this osteophytic response and the extent to which it occurs remain unknown.[2] The detrimental effects of root infringement against the palatal bony cortex have been demonstrated by ten Hoeve and Mulie.[3] Their laminagraphs revealed potentially irreversible changes in the labial cortical plate after perforation by the apices of the incisors during retraction. The roots of the canines can also damage the labial cortex during marked distal tipping of their crowns. These findings caution the clinician to monitor movements of root apices and tooth crowns carefully to prevent pathological insults to the tissues. Root apices should be maintained within the confines of the alveolar trough throughout treatment.

The third stage of the Begg technique is actually a potentially more destructive period of tooth movement than the earlier stages. Following excessive lingual tipping of maxillary and mandibular anterior teeth in Class II, Division 1 extraction treatment with second stage Begg technique, the roots of the canines and second premolars are usually hyperdivergent relative to each other and require extensive uprighting to gain parallelism at the extraction sites. Moreover, the interincisal angle is markedly obtuse and requires considerable lingual torque of the incisor roots for normalization with relatively heavy uprighting and torquing forces. These forces are directed to the labial and interproximal alveolar crests around the teeth with the possibility of causing irreversible damage to these sites. Furthermore, anchorage taxation accompanies lingual root torque and root uprighting via the torquing and uprighting springs of third stage mechanics. This anchorage drain often leads to a combination of labial crown movement of anterior teeth and mesial migration of posterior teeth. Therefore, increased procumbency of incisors often results, as root uprighting occurs at the extraction sites and the interincisal angle is normalized in spite of the efforts made to balance these uprighting forces. The resulting bimaxillary protrusion tendency occurs especially in the absence of extraoral anchorage support, rarely employed in classical Begg treatment. The clinician, in an effort to anticipate this anchorage loss, often attempts to overretract anterior teeth, a questionable procedure in view of the destructive tissue changes mentioned above.

A possible explanation of anchorage loss in the third stage is related to the tissue changes accompanying tooth movement of the initial stages. Labial movement of the root apices of maxillary incisors during the early stages of Begg mechanics induces superfluous preosseous matrix deposition in the wake of this movement. Subsequent lingual root torquing of incisors in the third stage is impeded by this uncalcified and newly calcified tissue which apparently has greater resistance to osteoclasis. Consequently, the incisors frequently extrude and the crowns move labially in response to the torquing auxiliary, since the desired lingual root torque is resisted.

In the bimaxillary protrusion case where a flattening of a convex facial profile is desired, the facial changes sought are often attained at the end of the second stage, but they may be lost as a result of third stage uprighting and torquing. Unless serial cephalometric analyses are studied, the operator may not fully appreciate the magnitude of the "round tripping" to which the maxillary incisors are subjected. Moreover, without radiographic studies utilizing techniques such as laminagraphy, the clinician may not be aware of the insults to the periodontium by these redundant tooth movements.

An example of possible anchorage dissipation in third stage Begg mechanics is demonstrated in Figure 2. At the end of the first two stages the *left* tracings reveal favorable bimaxillary protrusion reduction. The right tracings compare the end of second stage treatment with late third stage and reveal considerable anchorage loss in the form of incisor procumbency. Pre- and posttreatment superposition (middle) shows the net results of maxillary incisor movement throughout treatment. Uprighting and torquing supported by Class II elastics can cause this type of anchorage loss, which is another example of "round tripping."

Case Reports

Five case reports have been selected to clarify treatment with our technique. Specifics of appliance construction will be provided, whenever pertinent, to explain treatment procedures, but reference is made to an earlier paper for basic information of this method. All cases presented were treated by postdoctoral students under the direction of the author.

The malocclusion of a 12 year-old female (D.H.) involved correction of 11 mm overjet and slight malalignment of the incisors in both arches (Fig. 3). Overbite was within normal limits (30%). The maxillary first premolars and the mandibular right second premolar were extracted, as well as the mandibular left second deciduous molar because of agenesis of the mandibular left second premolar. After appliance construction .014" archwires were placed with an accentuated curve of Spee in the maxillary arch and a reverse curve in the mandibular arch to initiate leveling. Light Class II elastics (2 oz.) were worn full-time. After one month the .014" wires were changed to .016" diameter of the same design. The

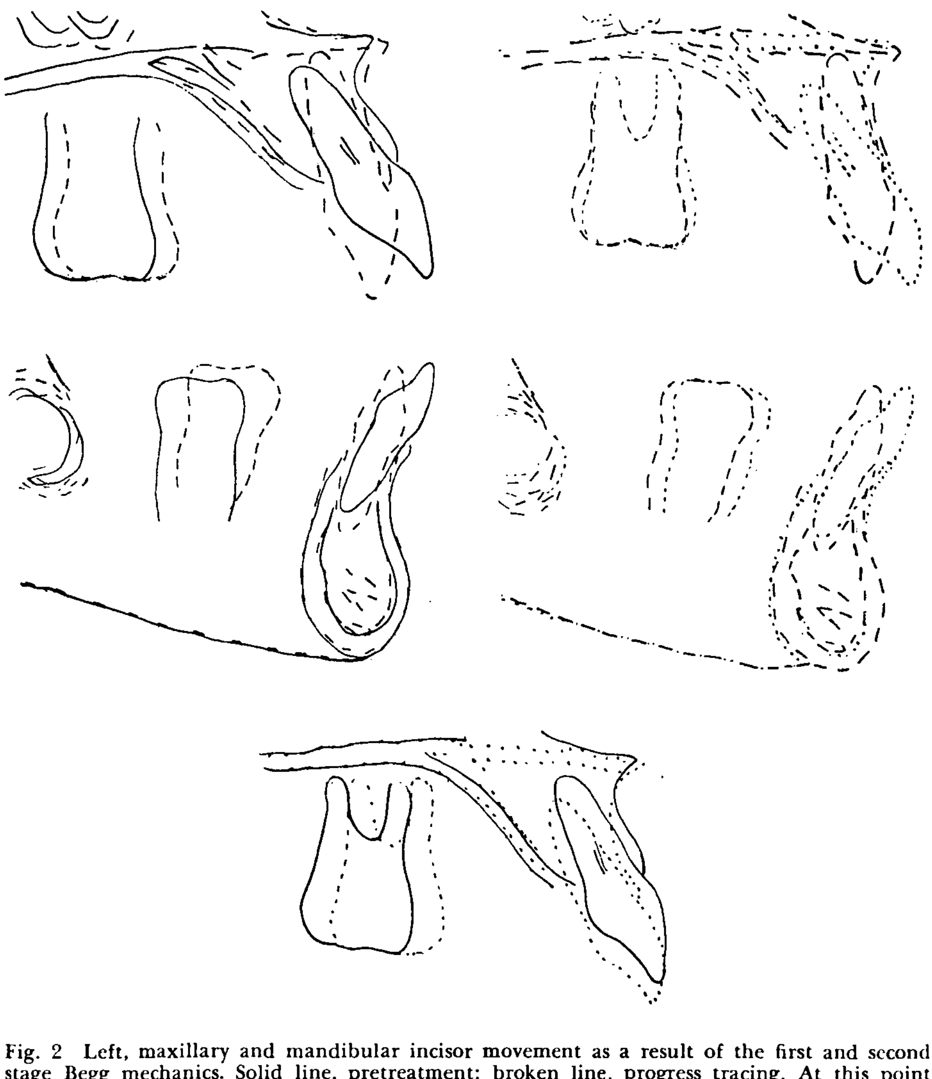

Fig. 2 Left, maxillary and mandibular incisor movement as a result of the first and second stage Begg mechanics. Solid line, pretreatment; broken line, progress tracing. At this point in treatment, incisor procumbency has been reduced favorably. Right tracings depict the return of incisor procumbency and some incisor extrusion resulting from third stage Begg mechanics. Broken line, end of second stage; dotted line, posttreatment. Middle, shows the net maxillary incisor movement throughout treatment. Solid line, pretreatment; dotted line, posttreatment. Note the distance the incisor root apex had to move during treatment for very little net effect and undesirable extrusion of these incisors.

Class II elastic force was increased to 3-4 ounces. In the absence of mandibular second premolars this amount of elastic traction delivered to an .014″ archwire might rotate the mandibular first molars in mesiolingual direction, and therefore heavier (.016″) wires were used soon after initiation of active treatment. Furthermore, an additional force was applied to the maxillary canines with power thread for their retraction, while the Class II elastics were continued to reduce the overjet (Fig. 3E). In general, canine retraction proceeds quite well without adding more traction. This procedure is used mainly to unravel crowding of maxillary incisors, while simultaneously reducing overjet. As an alternative, multiple looped archwires may be used successfully.

After a two-month treatment period, the overjet was reduced considerably; the molar relationship and overbite were improved. Root paralleling was initiated because of archwire engagement in angulated brackets. Expansion was placed in the mandibular wire at the molars to offset their tendency to "roll in" lingually in response to the Class II elastic force (Fig. 3F).

When the maxillary incisors had reached a desirable axial inclination relative to the nasion-point A line overjet persisted and space remained in the maxillary arch. The maxillary archwire was replaced with an .016″ × .022″ rectangular wire with Warren torquing springs (Fig. 3G and H). At this point Class I elastic ligatures were tied in the four quadrants and Class II elastics continued. Bodily retraction of the maxillary incisors eliminates tedious finishing procedures.

The mandibular archwire can be changed to an .018″ round wire or to an .016″ × .022″ rectangular wire at this stage of treatment. At every visit the archwire was firmly hand-tied into the brackets to continue root uprighting. When overjet and overbite have been normalized, and spaces still persist in either or both arches, Class I power thread elastics are placed from the molars to the rings bent into the archwire one millimeter distal to the lateral incisors. If additional mesial movement of the mandibular molars is indicated, Class II elastics must be continued. When all spaces are closed in both arches, positioning of incisor roots with favorable angulation relative to each other should have been achieved with the light rectangular archwires and the Warren springs. When additional torque of the maxillary incisors is necessary, an .018″ × .022″ archwire with auxiliaries is inserted for this purpose. Patient D.H. was treated in 14 months with a total of four archwires in each dental arch.

In a 12 year-old male patient (F.M.) considerable crowding of max-

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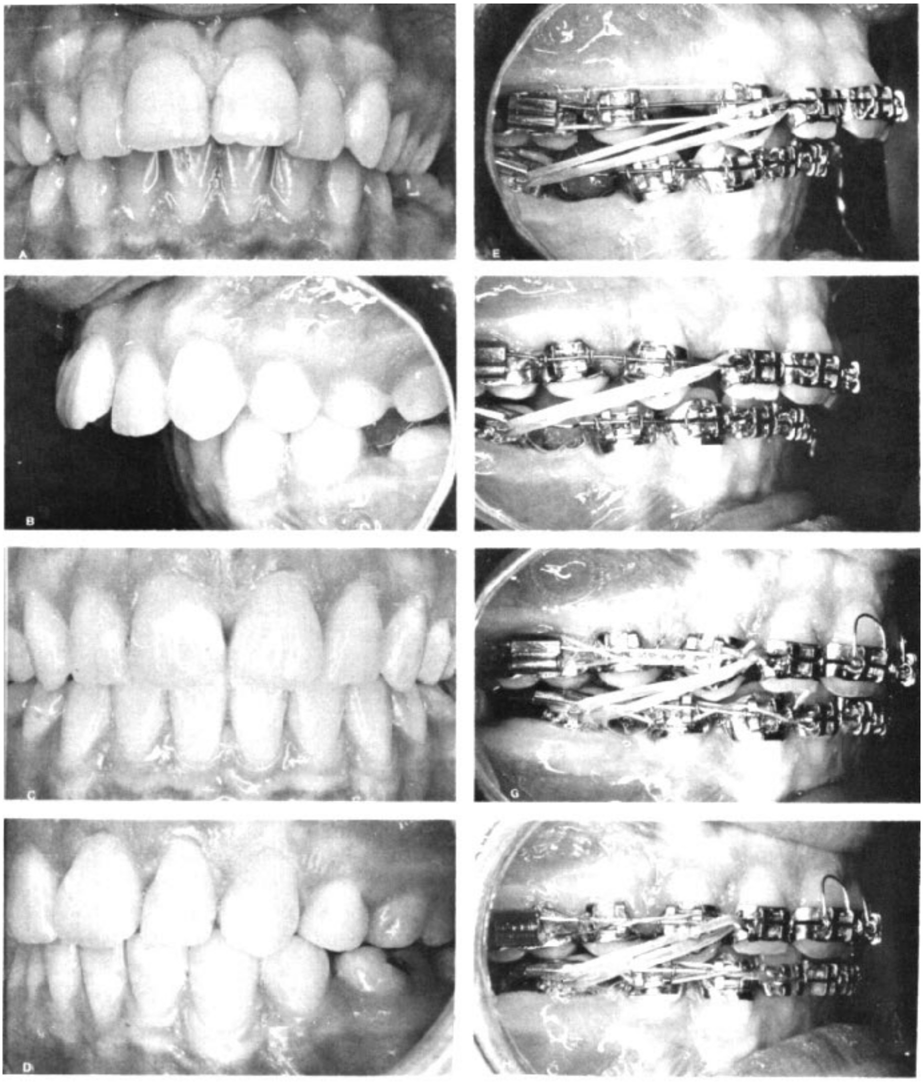
Fig. 3 A and B, pretreatment photos of patient D.H., Class II, Division 1 malocclusion with 14-mm overjet. The maxillary first and mandibular right second premolars and mandibular left second deciduous molar were extracted for treatment. C and D, posttreatment photos. E, .016″ archwires. Retraction of the maxillary canines was initiated with elastic ligature tied from canine to molar to facilitate overjet reduction with Class II elastics (3 oz.). F, .016″ archwires with Class II elastics. Note reduction of overjet and correction of canine and molar relationships. G and H, .016″ × .022″ archwires with Warren auxiliaries for maxillary incisor root control. Class I elastic ligatures and Class II elastics continue space closure and improve intercuspation. Left, pretreatment facial photographs. Right, posttreatment facial photographs. The total treatment time was 14 months.



illary anterior teeth, a midline deviation, and a palatal crossbite of the maxillary right molars and premolars were encountered in a Class II type malocclusion. Maxillary first and mandibular second premolars were extracted (Fig. 4). This boy was treated in approximately the same length of time as patient D.H. The midline deviation corrected spontaneously owing to the differential forces applied by the Class II elastics with a longer Class II elastic span on the left side to induce movement of the maxillary midline to that side. A cross elastic was utilized on the right side to correct the crossbite. Owing to bracket angulation, uprighting auxiliaries are superfluous with this technique, since the roots at the extraction sites are never more hyperdivergent to each other than prior to treatment.

The Class II, Division 1 malocclusion of an 11 year-old boy (D.M.) was characterized by an 8 mm overjet, impinging overbite and moderately severe bimaxillary crowding. Four first premolars were extracted. A cervical headgear was used for anchorage support and for achieving slight distalization of maxillary molars. The series of photographs in Figure 5 is self-explanatory and represents 12 months of treatment.

Patient P.D. was a 12 year-old girl who had a "borderline" Class II, Division 1 type malocclusion with 10 mm overjet, impinging overbite, and end-to-end canine relationship, neutroclusion of molars, and multiple spaces in the maxillary anterior segment (Fig. 6). A total of three archwires (.014", .016", and 0.16" × .022" with Warren springs) in each arch was utilized during seven months of active treatment to demonstrate the sequence of treatment, as well as facial changes.

Patient N.C. was a 10-year, 6 month-old female with a Class II, Division 1 malocclusion, impinging overbite, and 10 mm overjet (Fig. 7). Maxillary first premolars and mandibular second premolars were extracted to facilitate correction. Initial archwires (.014") with 2 oz. of Class II elastic traction were used for one month, followed by .016" wires and Class II elastics for one month, .018" wires for one month, continuing Class II elastics, .016" × .022" archwires with Warren torquing springs for the maxillary incisors, and a combination of Class II and Class I elastic traction for three to four months. Subsequently, the four second molars were banded to correct rotations and "T" loop auxiliaries soldered to the base arch were utilized for this purpose. Debanding was done 13 months after initial archwires were inserted. Figure 7 depicts the highlights of treatment and demonstrates facial changes that include bodily retraction and relative intrusion of maxillary incisors, while maintaining the mandibular incisor sagittal position. Bite opening was attained by a combination of the following factors: incisor intrusion, molar and premolar extrusion, and growth. Detailed cephalometric appraisal of results obtained with this technique was included in a previous paper.[1]

Patients are seen every 4 to 5 weeks throughout treatment in most instances. Yet patients may be examined more frequently for appliance adjustment to safeguard against damage from loose bands, broken elastics, ligatures, bonded brackets, and distorted archwires. One measure of the efficiency of a technique is the actual chair time expended during active treatment. From initial archwire insertion to retention, most malocclusions require approximately three hours ac-

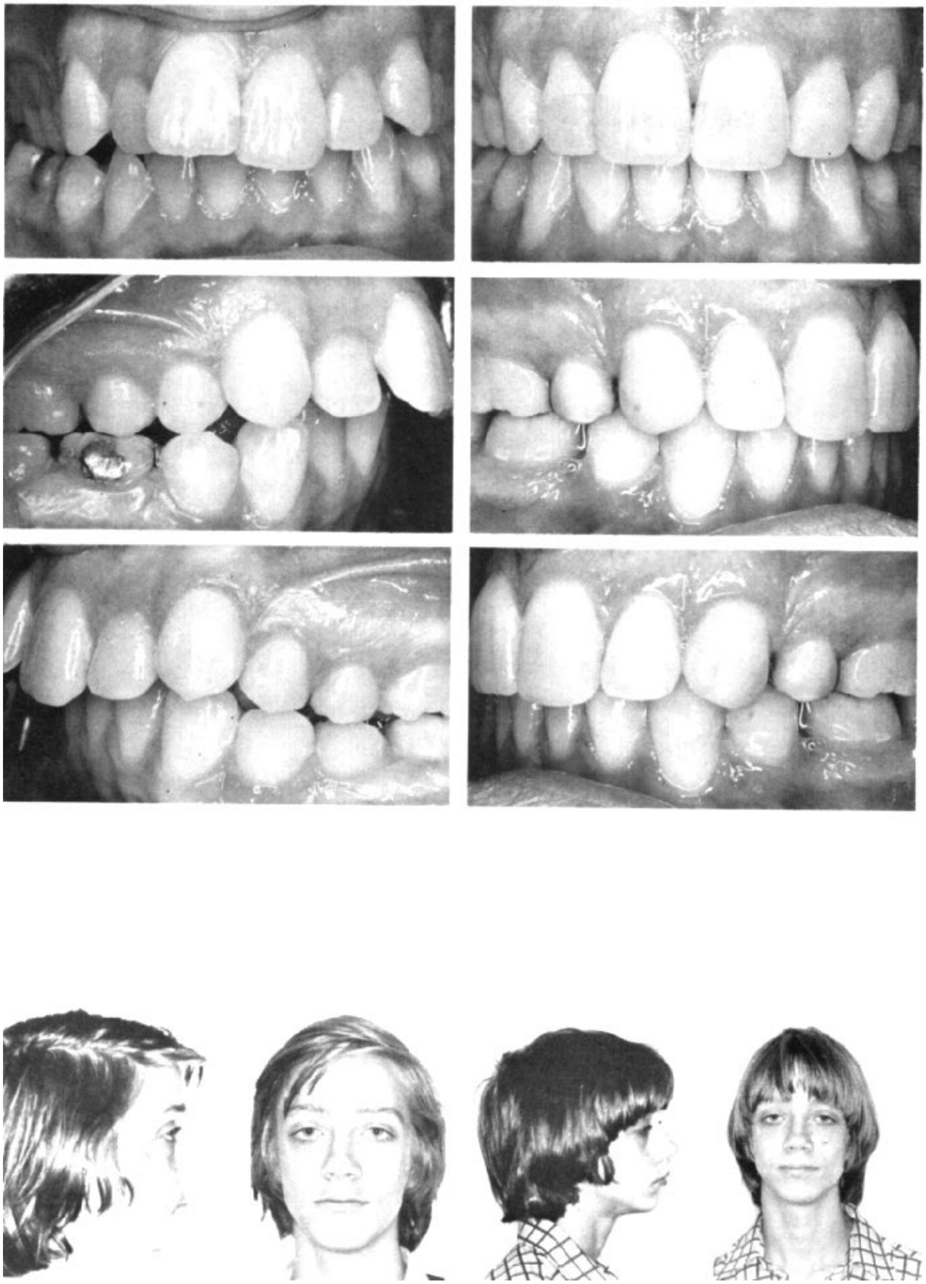


Fig. 4 Left, pretreatment records of patient F.M., Class II, Division 1 malocclusion with 9 mm overjet, moderate bimaxillary crowding, palatal crossbite on the right side and midline deviation. Maxillary first premolars and mandibular second premolars were extracted to attain correction. Right, posttreatment records. Treatment time was 14 months.

Fig. 5 A and B, pretreatment records of patient D.M. Class II, Division 1 type malocclusion with moderate-to-severe bimaxillary crowding, impinging overbite, and 8 mm overjet. The four first premolars were extracted as an adjunct to orthodontic treatment. C, .014" initial archwires with elastic ligatures to initiate canine retraction and permit incisor alignment. D, .016" archwires with elastic ligatures to continue canine retraction. Class I and Class II elastics reduce the overjet, open the bite and correct the molar relationship. E, .018" archwires. F, .016" × .022" archwires with Warren torquing auxiliaries for translation of maxillary incisors and final space closure. A cervical headgear was utilized to conserve anchorage. Twelve months of treatment were required for correction of this malocclusion. G and H, posttreatment photos. Left, pretreatment facial photographs; posttreatment, right.

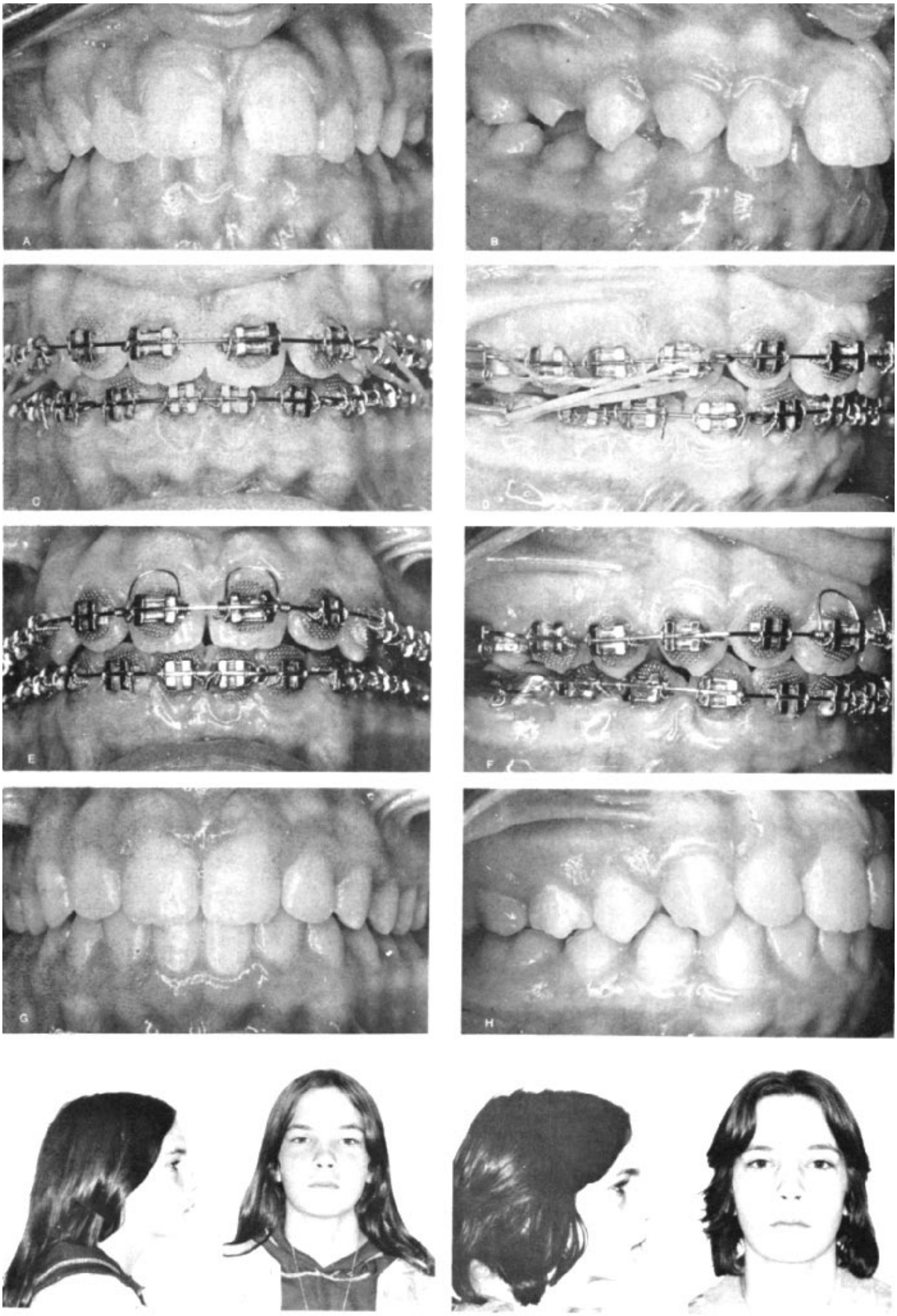


Fig. 6 A and B, pretreatment photos of patient P.D. with Class II, Division 1 type malocclusion, impinging overbite, 10 mm overjet and multiple spaces between the maxillary anterior teeth. C through F, illustrate the result of seven months of treatment time with three archwires (.014", .016" and .016" × .022"). G and H posttreatment records. Left, pretreatment facial photographs; right, posttreatment photographs.

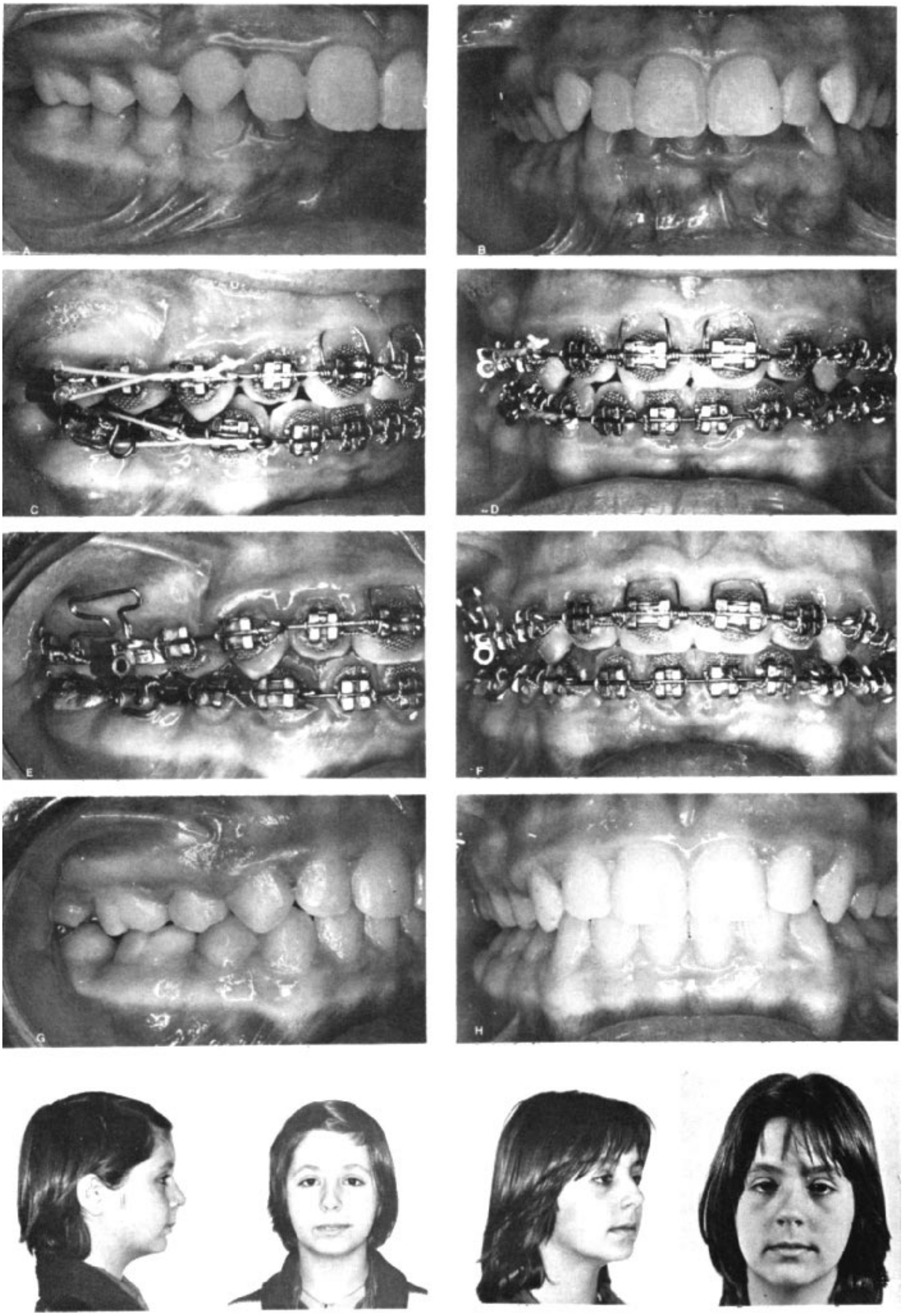


Fig. 7 A and B, pretreatment records, of patient N.C., Class II, Division I malocclusion with impinging overbite and 10 mm overjet. Maxillary first premolars and mandibular second premolars were extracted to permit orthodontic correction. C through F, illustrate overbite and overjet correction within 5 months of treatment. .016" × .022" "T" loop auxiliary is shown aligning the maxillary second molars. Posttreatment records, G and H. Left, pretreatment facial photographs; right, posttreatment photographs. Total treatment was 13 months.

tual treatment time. Complex and severe malocclusions obviously require a greater time expenditure.

Discussion

Many clinicians schooled in the classic edgewise technique, who converted to the Begg differential force technique because of the limitations of the "old" edgewise mechanism, have been reassessing their decisions. Although many shortcomings of the earlier edgewise technique were ameliorated, the third stage of the Begg technique demanded arduous and tedious finishing procedures. The inability to circumvent lengthy and complex finishing requirements, as well as adverse tissue changes induced by excessive tipping of teeth, have led to a resurgence of interest in the edgewise appliance. Moreover, modern edgewise methods have evolved considerably through the use of lighter forces, customized brackets and innovations in archwire design that have brought dramatic changes. In spite of these improvements, orthodontists often continue to succumb to appliance fads. For example, the straight-wire appliance[4] with its preangulated, pretorqued, prethicknessed bracketing is attracting clinicians seeking the elusive "ultimate appliance." In this technique the controlled tooth movement achieved by the amalgamated method and other light wire methods is replaced by excessively rigid control. The practice to assign a predetermined position to each tooth predisposes the patient to an automated nonphysiologic treatment procedure and to stereotyped results. The straight-wire appliance, a method purportedly based upon "nature's nonorthodontic normals," ignores the potential for natural settling of the occlusion that is encouraged by light-wire techniques. Nonetheless, the author noted with interest the straight-wire practice of allowing "controlled settling" with round wires after correction of the malocclusion with heavy rectangular archwires.

Aside from these misgivings about the general concept of the straight-wire method, the introduction of variable thickness brackets and pretorqued slots are innovations of questionable merit. First-order bends in archwires are necessary to individualize arch form and standardized variable thickness brackets lack this versatility. Dependence upon the action of a rectangular archwire that completely fills a pretorqued slot to obtain root torque is inefficient. Moreover, while the rectangular wire is forcefully distorted into the pretorqued slots to induce lingual root torque of maxillary incisors, the canines must often be "round tripped" due to an unfavorable archwire-slot angulation relationship, as the wire is tied into their pretorqued brackets. Initially, the forces to the canines may induce labial root torque, and only after considerable lingual root torque of maxillary incisors has been attained does the action on the canine revert to lingual root torque.

The use of an undersized archwire with auxiliaries, such as Warren springs that apply a second moment to the tooth at a more gingival level, is more efficient and versatile in obtaining root torque than torque incorporated into the archwire. Also, lingual root torque to incisors with Warren springs does not affect the adjacent canines because the light rectangular archwire is free to rotate within the larger edgewise bracket.

Furthermore, the undersized edgewise archwire is free to slide through the premolar and molar attachments as the incisors are retracted bodily. This effective movement of the teeth would be severely limited if the archwire fully filled the bracket slot to provide the classic mechanism for bodily incisor movement, because the archwire would be tightly engaged in the molar and premolar attachments. The degree of friction in this instance is considerably greater than in the amalgamated technique, and therefore considerable anchorage taxation will be experienced.

The advantages of the .022″ × .028″ wide Siamese edgewise bracket over the popular .018″ × .025″ narrow width single edgewise bracket were discussed in an earlier paper.[1] Since excellent results are obtained with the amalgamated technique employing the simpler wide Siamese edgewise bracket, a combination bracket, such as the Fogel and Magill bracket with its Begg and edgewise slots, is not needed.

The ten Hoeve-Mulie findings have already resulted in efforts to achieve incisor intrusion early in the Begg treatment. The very nature of the Begg technique, however, with its reliance on free tipping and Class II elastics makes maxillary incisor intrusion and limitation of mandibular molar extrusion difficult at best, unless adjuncts, such as high-pull headgears, are used for incisor intrusion.

Perspective

A tenet basic to all healing sciences is *prima non noce*. The extent to which malocclusion detracts from oral health is an unresolved issue. Dentists and epidemiologists disagree on the exact relationship between overjet, overbite, crowding and other dentoalveolar and basal arch dysplasias to periodontal health.[5] Despite the prevalence of malocclusions of varying severity, many individuals possess dentitions that function well during their lifespans. Unless the orthodontist can correct a malocclusion with reasonable assurance that the longevity of the dentition will not be compromised by his mechanotherapy, the benefits of excellent intercuspation in neutroclusion could be overshadowed by periodontal disaster. Thus, the end does not justify the means, unless the correction of malocclusion is attained without adverse tooth movement as a prerequisite to limit irreversible tissue changes.

Dr. Begg's contribution to orthodontics is renowned and respected. His concepts of stone age man's dentition and differential forces have truly revolutionized the treatment planning and the practices of progressive orthodontists. The valuable introduction of early and rapid overbite and overjet correction in the Class II case by pitting maxillary anterior arch segments against mandibular posterior units and intrusive forces against extrusive forces is based on sound biomechanical principles. These innovations have undeniably improved edgewise practice over the past 20 years. That these advances must be inextricably related to the Begg bracket, however, is fallacious. The inability to control root-apex position in the Begg technique, as currently practiced, is partially related to an inherent limitation of the bracket itself. Excessive freedom for tooth tipping labiolingually and mesiodistally results in inefficient tooth movements during the early stages of Begg treatment and necessitates redundant, lengthy and arduous finishing procedures. The basic Begg concept of complete elimination of overjet by continuous free tipping of anterior teeth without regard to axial inclinations should be reassessed.

The amalgamated technique presented in this paper was founded on observations derived from the author's experiences in research, teaching, and practice. The study and use of various orthodontic methods and experimentation with bone physiology provided an impetus to develop a mechanically and biologically improved treatment regimen.

This method is in a dynamic state and modifications, such as bracket positioning, archwire design, and differential force management, are continuing to achieve the most physiologic tooth movements attainable. No pretense is made that this goal has been reached. On the contrary, the amalgamated technique, as practiced today, will be modified as new experiences dictate. In the final analysis, what more is the edgewise, twin wire, labiolingual, Begg, or any technique than the thoughtful implementation of mechanical procedures that have evolved from investigative and practical experiences. The ultimate system will be an amalgamation of ideas and methods, an acceptable compromise. In evaluating mechanotherapy, "understanding the advantages and limitations of the ultimate choice is far more important than the choice itself."[7]

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