Differential Anchorage and the Edgewise Appliance

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The problem of anchorage preservation remains universal regardless of the orthodontic technique used. Simple anchorage is provided by teeth that are free to tip in response to force application; stationary anchorage occurs with teeth that can move only bodily. Differential anchorage is the strategic application of stationary anchorage units against simple anchorage units.

Although the lack of mesiodistal control with Angle’s ribbon arch bracket was considered a drawback by many (including Angle himself), the freedom of the teeth to tip actually improved anchorage control by pitting simple against stationary anchorage units (Fig. 1). Unfortunately, there were no efficient means to upright the tipped teeth at that time.

The edgewise bracket eliminated the simple anchorage potential of the anterior teeth. Tweed and others applied differential anchorage concepts with the edgewise appliance by using a series of archwires with tipback bends in the buccal segments—thereby enhancing anterior retraction as well as anchorage preservation (Fig. 2). Tweed modified these tipping mechanics slightly for use in nonextraction treatment.

Begg’s use of a ribbon arch allowed him to produce the tipping mechanics without 2nd-order bends. Final uprighting and torque were accomplished with removable auxiliaries. The end result was a pure expression of differential anchorage, eliminating the need

Fig. 1 Angle used differential anchorage concepts to close extraction spaces, pitting the tipping of cuspids against bodily movement of molars. Heavy forces caused excessive mesial movement of anchor molars. (From Angle, E.H.: Treatment of Malocclusion of the Teeth, 7th ed., S.S. White Dental Manufacturing Co., Philadelphia, 1967.)

Fig. 2 Tweed used tipback bends to facilitate anterior retraction by tipping teeth distally toward extraction sites. A. Before extraction of bicuspids. B. Initiation of retraction, with vertical loops to close spaces. C. Extraction sites closed, note tipping of anterior segments to minimize “tos hold” effect. D. Continuous ideal archwires for root paralleling and final finishing. (From Tweed, C.H.: The application of the principles of the Edgewise Arch in the treatment of malocclusions, Angle Orthod. 11:5-67, 1941. Reprinted by permission.)
for extraoral forces and bite planes.

**Straightwire Mechanics**

With conventional edgewise techniques, two distinct phases of wire bending accomplish different goals:

1. **Major tooth movements.** Special retraction and space closure archwires incorporate 2nd- and 3rd-order bends to reposition teeth while minimizing stationary anchorage strain.
2. **Final finishing.** Entirely different archwires use detailed, artistic bends for finishing.

Today's preangled appliances have a reverse anchorage potential that decreases the efficiency of bodily tooth repositioning by holding teeth, particularly cusps and incisors, in their final axial inclinations during major tooth movements. This "toe hold" effect increases the anchorage potential of the anterior segment or, in nonextraction treatment, an entire arch that might require retraction (Fig. 3).

During Class II nonextraction treatment, the entire maxillary dentition is held forward by the distally inclined roots of the cusps and incisors, complicating the establishment of a Class I occlusion. Class III treatment is similarly affected, with the lower arch held forward by cuspid and incisor inclinations.

Roth advocates the use of tipping mechanics:

"In my opinion the tooth moving mechanisms that are currently available do not effectively and efficiently allow teeth to be translated; therefore some tipping must be resorted to during the course of treatment for the sake of efficiency. . . . After all, the important thing is where the teeth are positioned at the end of treatment, not necessarily how they got there (as long as they got there in an efficient and effective manner)."

Regardless of the bracket used, the natural tendency of the teeth in response to horizontal forces is to tip. With edgewise brackets, this tipping creates couples that deflect the anterior portion of the archwire incisally. The deflection is even greater with straightwire appliances because of their preangled cuspids and pretorqued incisor archwire slots.

In extraction treatment, this archwire deflection results in a reverse curve of Spee in the upper arch and an accentuated curve in the lower arch, which restrict the ability to open a deep anterior overbite without extraoral forces (Fig. 4). The same adverse vertical deflection occurs, although to a lesser extent, during nonextraction treatment wherever an attempt is made to retract either arch.

Attempting to control the vertical deflec-
Differential anchorage and the edgewise appliance

Fig. 5 Tip-Edge bracket surfaces (T) prevent excessive crown tipping during retraction. Opposite surfaces (U) control final mesiodistal angulation of each tooth. Central ridges (CR) control torque when used with rectangular archwire. Wings (R) control rotation as with twin brackets.

tion of the archwire during retraction can make treatment overly complex, requiring functional appliances, multiple archwires, headgears, and/or orthognathic surgery. Many of the archwires used in straightwire techniques are looped, segmented, or otherwise modified to overcome problems that result mainly from the preadjusted bracket slots themselves.

Differential Straight Arch Technique

A new straightwire approach, the Differential Straight Arch Technique, eliminates the complex mechanics of conventional techniques and offers these advantages:

- Uses only four straight, round archwires (six if rectangular archwires are used for finishing)
- Less need for functional appliances, extraoral forces, or orthognathic surgery

Fig. 6 A. Initial appliance with .016" Australian archwires. B. Uprighting and torquing stage with .022" Australian archwires. C. Precision straightwire finishing with Tip-Edge rings and full-size .021" x .027" stainless steel archwires. D. After 18 months of treatment using eight archwires (two required because of breakage).
- Shorter treatment times
- Maximum interbracket distance

This is made possible by the Tip-Edge* bracket's archwire slot, which allows crown tipping only in one predetermined direction (Fig. 5). The system uses differential anchorage for major tooth movements, reserving the straightwire concept for final finishing only (Fig. 6).

*Tip-Edge is a registered trademark of TP Orthodontics, Inc., P.O. Box 73, LaPorte, IN 46350.

In Class II treatment, the Tip-Edge brackets' unidirectional limitation of tooth movement inhibits mesial movement of the mandibular dentition. The crowns of the maxillary teeth can simultaneously tip distally toward a Class I occlusion (Fig. 7).

The reverse occurs in Class III treatment, with mesial movement of the maxillary teeth limited while the mandibular dentition tips distally toward a Class I relationship (Fig. 8). In either case, corrections are accomplished without 2nd- and 3rd-order bends.

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**Fig. 7** In nonextraction Class II treatment, maxillary teeth exhibit simple anchorage, with crowns tipping toward Class I. Mandibular teeth are restricted to bodily movement, producing stationary anchorage. A. Beginning of treatment. B. Initiation of Class II mechanics. C. Final finishing using straightwire prescription.

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**Fig. 8** In nonextraction Class III treatment, maxillary dentition is limited to bodily movement, while crowns of lower teeth tip toward Class I. A. Beginning of treatment. B. Initiation of Class III mechanics. C. Final finishing using straightwire prescription.
Archwire Sequence

The vertical deflection common to conventional edgewise and straightwire appliances is eliminated (Fig. 9). Bite opening is accomplished using stiff, .016" Australian archwires with strong anchor bends mesial to the molar tubes.

Light forces (1-2oz) can quickly tip the six anterior teeth around .016" archwires toward an edge-to-edge relationship. It is imperative that only very light Class II elastics be used; otherwise, the depressive force of the maxillary archwire will be overpowered. Bicuspids are never engaged until the bite is open, so that intrusive forces will be concentrated on the cuspids and incisors.

Once an edge-to-edge relationship is established, cuspal interdigitation of the buccal segments will be minimized, and mandibular

Fig. 9 Cuspid retraction compared on identical jigs. A. With conventional straightwire appliance, couples deflect archwire incisally. B. Tip Edge bracket prevents deflection.
growth or repositioning will more easily correct a Class II malocclusion. Recent research has indicated that this bite plane effect, rather than the stimulation of mandibular growth, is the main mechanism through which functional appliances operate. In extraction cases, .022” archwires are used next to close the extraction spaces (Fig. 10). Because the central ridges of the bracket are off-center mesiodistally, the size of the slot relative to the archwire increases as the tooth tips, thus facilitating the progression from .016” to .022” archwires.

Specially designed springs are used for mesiodistal uprighting, which automatically stops at the axial inclination determined by the archwire slot (Fig. 11). Removable auxiliaries simultaneously accomplish incisor torquing.

Elastomeric Tip-Edge rings are used in conjunction with rectangular archwires to provide three-dimensional control for final finish-

Fig. 10 A. Beginning of treatment with Differential Straight Arch appliance. B. Extraction sites closed and overbite and overjet corrected without extraoral forces or functional appliances.

Fig. 11 Movement of maxillary right cuspid during Differential Straight Arch treatment. A. .016” archwire at start of treatment. B. Completion of cuspid retraction with .022” archwire. C. Final uprighting to angulation prescribed by bracket slot.
Fig. 12. A. Tip-Edge ring with crossbar and lingually directed lugs wedge uprighting surfaces of bracket against archwire. B. Patient in finishing phase with rectangular archwires and Tip-Edge rings. C. Without Tip-Edge rings, “bottoming out” of archwire onto control surfaces is clearly seen.

Fig. 13. A. Patient with Class II, division 1 malocclusion and pronounced overjet. B. Differential Straight Arch appliances. C. After 11 weeks of treatment. Note bite opening, correction of overjet, and Class II buccal relationship produced with only 1.5 oz Class II elastics.
ing (Fig. 12). The crossbar and lugs of the rings wedge the uprighting surfaces of the brackets against the archwire, creating a flexible edgewise bracket slot.

When delivering force to a tooth, interbracket distance is more important than archwire size. It requires up to 13 times more force to deflect an archwire between extra-wide twin brackets than between narrow, single edgewise brackets. The Tip-Edge appliance’s use of 100 percent interbracket distance allows for more rapid progression to larger archwires with less patient discomfort and fewer bond failures.

Conclusion

Many orthodontists consider the tipping mechanics used in the Differential Straight Arch technique to contradict edgewise treatment concepts. With conventional straightwire treatment, however, tipping must be minimized to prevent vertical archwire deflection. The Tip-Edge appliance not only eliminates this archwire distortion, but it also reduces the complex uprighting mechanics of conventional straightwire techniques to a simple uprighting spring.

Differential anchorage produces essentially the same kind of alveolar base correction as with functional appliance therapy, but it provides more precise finishing ability—all in one relatively short phase of treatment (Fig. 13).

Major treatment objectives can now be accomplished more easily, and usually without functional appliances, extraoral forces, looped retraction archwires, or surgery. An apparently minor change in the edgewise archwire slot offers a new world of streamlined, yet controlled, treatment mechanics.

REFERENCES


Kesling and Rocke Orthodontic Group
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Straight-Wire Appliance is a registered trademark of "A" Company, 11436 Sorrento Valley Road, San Diego, CA 92121.

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