Frictionless Mechanics in Orthodontic Space Closure

Introduction

Orthodontic treatment frequently requires the extraction of teeth to alleviate crowding, optimize facial balance and establish desired functional goals. The choice of teeth to extract usually depends on the characteristics of the presenting malocclusion. Severe crowding/protrusion typically warrants the extraction of first bicuspids, whereas milder manifestations allow for the extraction of second bicuspids. A retrospective study by Haque et al., however, failed to find a difference in anchorage loss between the extraction of maxillary first and second bicuspids.1

Space closing mechanics can be broadly classified into:

- Frictional or sliding mechanics, where the teeth slide along the arch wire.
- Frictionless or closing loop mechanics, where the teeth and the arch wire move as a unit.

In general, sliding mechanics offers excellent control of the occlusal plane and root position, with moment-to-force ratios approaching those required for translation predictably generated with full-sized arch wires.2 The .022 slot appliance is uniquely suited to facilitate sliding mechanics owing to the increased clearance between the slot and the working arch wire (19x25 stainless steel).

However, in situations requiring moderate to maximum anchorage control as well as intrusion during retraction, closing loops with differential moment activations may offer a better alternative.3,4 The incorporation of a loop creates discontinuity between the anterior and posterior segments, allowing them to behave more independently when compared to a stiff continuous arch wire.
Case #1

The subject (Fig. 1) presented with a Class I dental relationship over a high-angle Class II skeletal base, with proclined and procumbent incisors (Fig. 2). The lips were protrusive, anterior to E-plane (Fig. 3), with a relative lack of pogonion projection and facial balance. Treatment objectives were to reduce protrusion, improve facial balance and idealize overjet and overbite.

Because the retraction need was greater in the upper arch compared with the lower, upper first and lower second premolars were extracted. The 6s and 7s were banded, and the 5–5 were bonded with .022 MBT brackets (Victory Series, 3M Unitek). Alignment was initiated with .014, .018 and 19x25 NiTi (Figs. 5 and 6).

Space closure was initiated in 19x25 stainless steel on the lower arch (sliding mechanics), and a 19x25 TMA closing loop in a continuous arch wire on the upper (Fig. 7). The upper arch wire was differentially
gabled with $\beta > \alpha$ and horizontally activated about 4–5mm per side. A reverse curve was incorporated in the lower arch wire to maintain bite-opening during space closure.

At the end of upper arch space closure (six months later), the protrusion had been reduced significantly. At this stage, the upper arch was ready for second-order root correction of the canine and premolars, and the third-order root correction of the incisors.

Root correction requires large M:F ratios and good vertical and AP control to minimize side effects and undesirable equilibrium forces. A 19x25 TMA arch wire (with a helix to lower the load deflection rate, and symmetric V-bends) was engaged into the slots (Fig. 8). Root correction was completed in 19x25 SS, followed by sliding mechanics and Class II elastics for final space closure and to idealize the overjet (Fig. 9).

First molar bands were removed and power chain placed 7–7 (toed-in arch wires) to close up band spaces. Occlusal detailing was completed in a 19x25 SS braided upper arch wires with seating elastics to a 19x25 SS lower arch wire (Fig. 10).

The final records (Fig. 11) showed harmonious and well-balanced facial aesthetics. The upper incisors were intruded and retracted about 4–5mm by a combination of translation and controlled tipping, and the curve of Spee on the lower arch was leveled by incisor intrusion (Figs. 12 and 13). The total treatment time was approximately 26 months. Retention included a maxillary wrap around the 7s and a fixed lower 3–3 bonded only to the 3s.
Case #2

The subject (Fig. 14) presented with excess overjet, severely proclined upper and lower incisors (Fig. 15), lip incompetence, a significant curve of Spee with crowding and stepped-up lower 3–3 (Fig. 16), and a reversed smile line.

Treatment objectives were to intrude and retract the upper and lower incisors to establish optimal overjet, overbite and lip competence.

Upper and lower first premolars were extracted to resolve the crowding and protrusion. The lower 6s and 7s were banded, and the rest of the teeth bonded with .022 MBT brackets (Victory Series, 3M Unitek). Maxillary arch alignment was initiated with .014, .018 and 19x25 Niti.

A 17x25 TMA T-loop arch wire, differentially gabled (β > α), was used to intrude and retract the upper 3–3, while separate canine retraction with segmented arch mechanics (17x25 TMA retraction springs) was initiated in the lower arch to unravel the lower crowding (Fig. 17).

Once there was adequate space, the lower incisors were leveled with a one-piece intrusion arch, cinched distal to the 6s and ligated between the 1s and 2s to provide a line of action closer to the center of resistance of the anterior segment (Fig. 18).6

Ten months into treatment, the lower arch had been leveled and the maxillary incisor proclination substantially reduced (Fig. 19). However, the side effects of the mechanics were evident, with the lingually tipped upper 3–3 and the distally tipped and rotated lower 3s. Both phenomena were related to inadequate moment: force ratio during retraction. At this stage, the arches were ready for root correction, followed by correction of the AP relationship with sliding mechanics.

At month 15, both upper and lower arches were in 19x25 SS with good transverse and vertical control of the occlusal plane. Class II elastics were applied from the lower 7s to the upper arch wire hook to protract the lower molars into Class I. First- and second-order bends were applied in the steel wires to fine-tune tooth and root position. The final result at month 23 shows good intercuspation and optimal incisal display (Fig. 21). Both upper and lower incisors were intruded and uprighted during retraction and a slight opening of the mandibular plane was also evident (Fig. 22). Lip competence and facial balance were also significantly improved.
**Conclusion**

A frictionless stage of space-closing mechanics can be beneficial to incorporate in specific cases, especially those presenting with large overjet, protrusion and a deep bite. Finishing in relatively full-sized arch wires allows the practitioner to take advantage of the prescription and deliver a more optimal result. Incorporating the principles of segmented arch mechanics into conventional practice can allow for efficient and effective treatment.

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**References**


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![Fig. 20](image1)

![Fig. 21](image2)

![Fig. 22](image3)