Superelastic Nickel Titanium Spring Clips for the SPEED Appliance

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The nickel titanium SPEED SE* bracket (Fig. 1) is much more efficient and user-friendly than its stainless steel predecessor for several reasons. First, the more accessible labial window is easier to locate with the tip of the opening instrument. Second, pulling occlusally on the labial arm is more mechanically advantageous than pushing the gingival end of the longer lingual arm. Third, the nickel titanium spring clip can easily withstand excessive opening force. Finally, the almost invariably light force required makes opening SPEED SE brackets a more comfortable procedure for both patient and operator.

The ideal opening instrument is one with a slender but rigid tip, just long enough to seat against the angulated internal guide slot when fully inserted in the bracket (Fig. 2). This allows the operator to feel when the opening window is properly engaged, even when a direct line of sight is not possible, as is sometimes the case in the upper molar regions.

When the instrument tip is fully inserted against the internal glide slot, the spring clip opens (Fig. 3A,B). Using a ligature director, the archwire is then pushed into full contact with the lingual wall of the slot (Fig. 3C). The spring clip needs only a nudge from a finger to propel itself into the fully closed position, where it can interact with the wire while holding it secure (Fig. 3D). When a smaller archwire is used (Fig. 3E), the spring clip automatically adjusts for the bracket-archwire relationship (Fig. 3F).

Although the SPEED appliance functions most efficiently without elastomeric ligatures, the upper incisor brackets will accept them when a child wants to have "colored braces" (Fig. 4). The patient should understand that they are pure-

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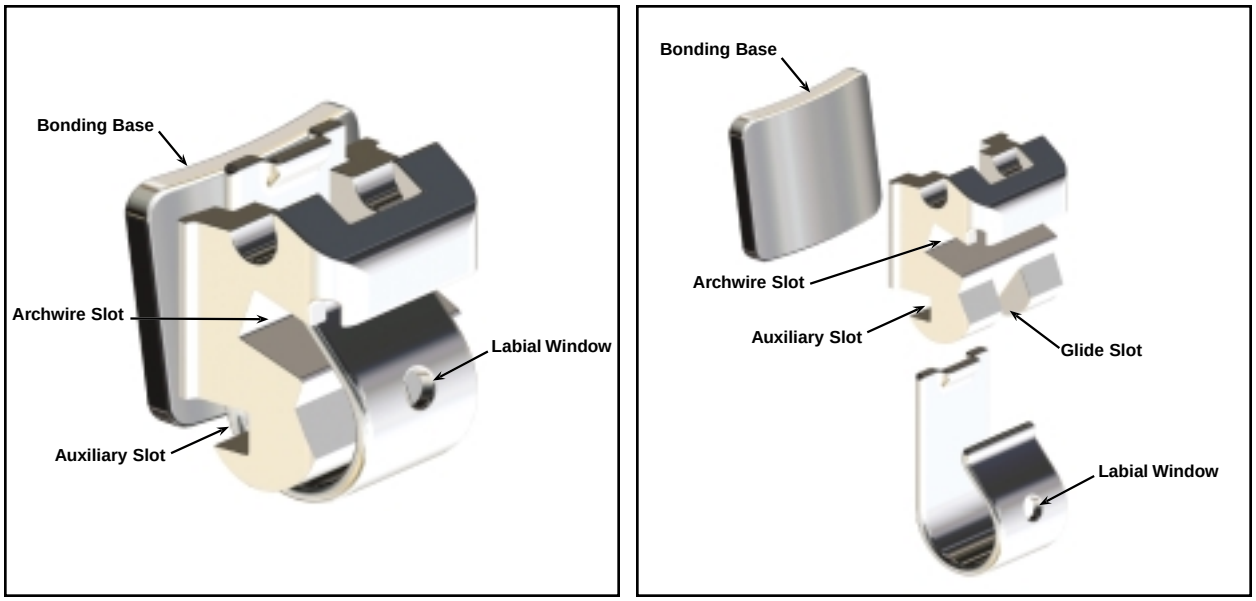

Fig. 1 Upper left central incisor SPEED SE bracket.

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ly decorative and may slow treatment somewhat.

Testing vs. Original Stainless Steel Spring Clip

Opening the spring requires a force of only 300 ± 30g applied to the labial window, compared to a force of 800 ± 200g applied to the lingual arm of the original stainless steel spring

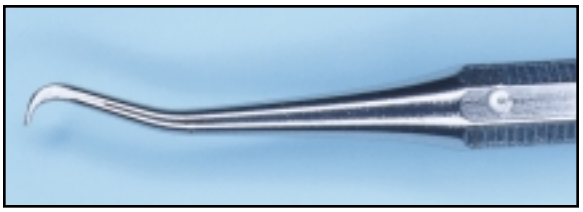

Fig. 2 Ideal opening instrument has slender, rigid tip, just long enough to seat against internal guide slot when fully inserted.

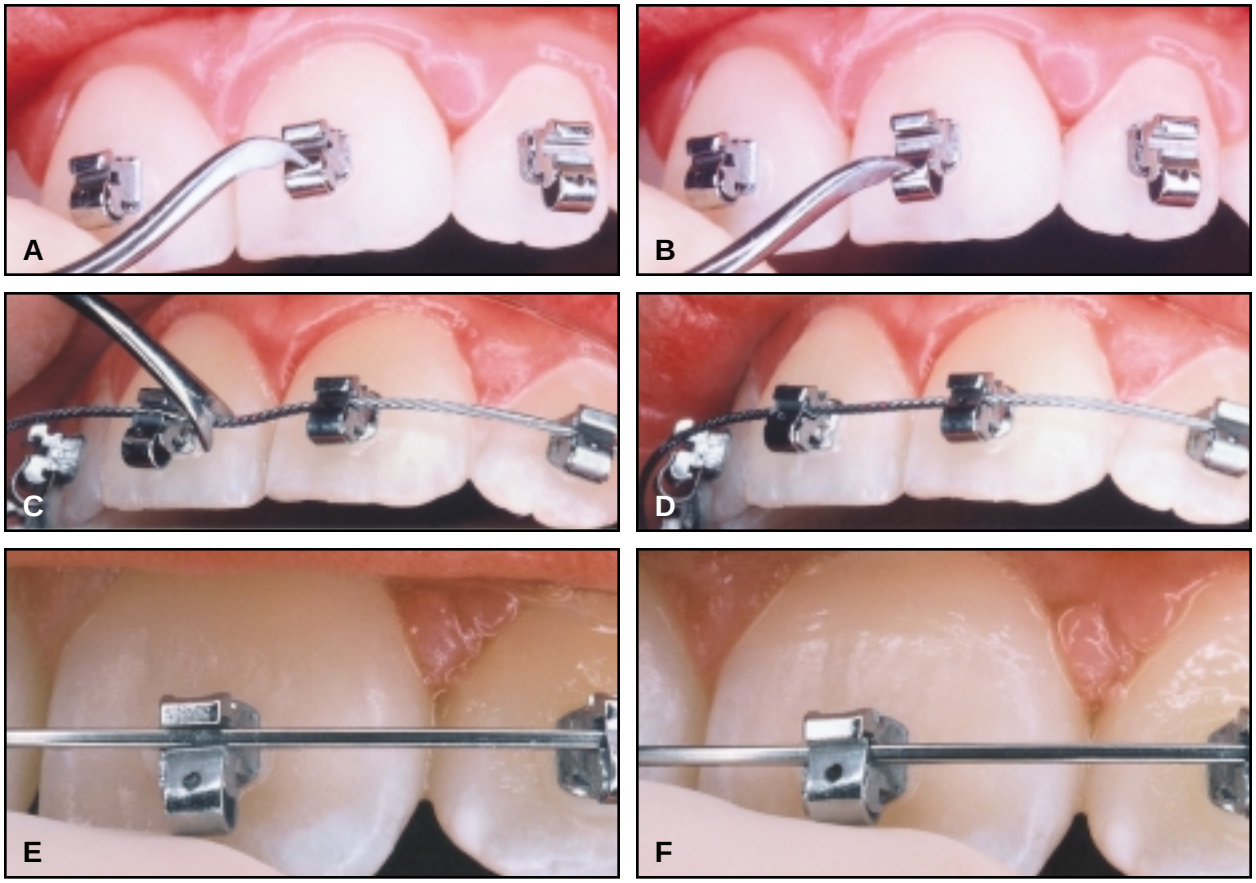

Fig. 3 A. Instrument tip fully inserted into opening window of upper lateral incisor bracket. B. Spring clip in open position. C. Ligature director used to push Supercable* into full contact with lingual wall of bracket slot. D. Spring clip in fully closed position. E. Smaller, .021" × .025" nickel titanium archwire does not completely fill bracket slot. F. Labial arm of spring clip is skewed slightly left to correct bracket-archwire relationship.

Fig. 4 Patient with light blue elastomeric ligatures matching color of her blouse.

clip. Even with excessive opening force, the nickel titanium spring clip returns to its normal open position. Our measurements have shown that the built-in spring force does not diminish in such cases, as would occur with a stainless steel spring clip.

A prototype SPEED SE bracket was clamped in a vice while holding an .020" superelastic nickel titanium wire in its slot (Fig. 5A). Even when a force sufficient to permanently bend the wire was applied with a plier, the wire could not be extracted, nor was the spring clip damaged (Fig. 5B).

The same bracket was then placed on an .021" "D" stainless steel wire clamped in a vice, with a straight .016" × .016" wire in the auxiliary tube as a rotation indicator (Fig. 5C). The SE spring clip did not lose its attitude control capability; the bracket proved capable of fully rotat-

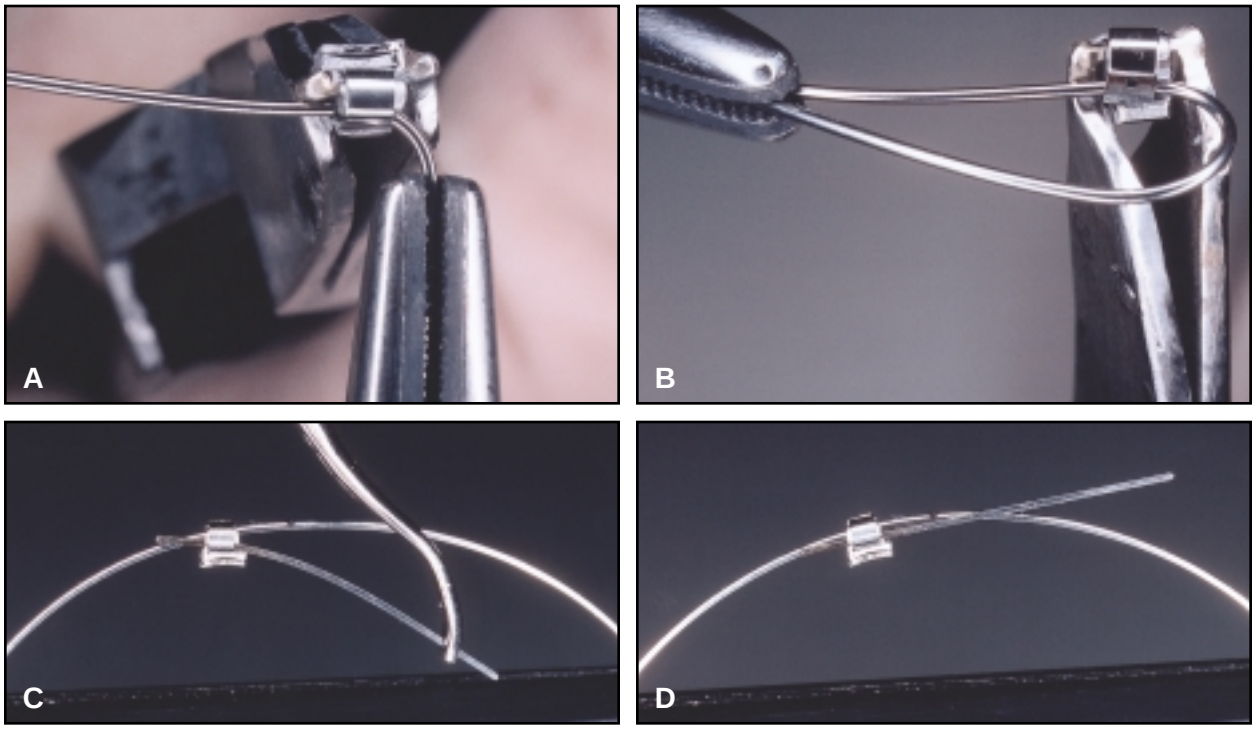

Fig. 5 A. SPEED SE bracket clamped into vice while holding .020" nickel titanium wire. B. Force sufficient to permanently bend wire could not dislodge wire or damage spring clip. C. Same bracket holding .021" "D" stainless steel wire in slot and straight .016" × .016" indicator wire in auxiliary tube. D. Bracket still rotated back into programmed relationship with stiff stainless steel wire.

ing itself back into its programmed relationship with the stiff stainless steel wire (Fig. 5D).

Temperature Effect

I have found that at body temperature, SPEED SE brackets perform virtually identically to SPEED brackets with stainless steel spring clips. They will apply substantially less force when cooled, however, and more force when heated by food and drink of differing temperatures. This effect of superelastic nickel titanium[1] appears to be beneficial in the early stages of treatment (Fig. 6), when both the springs and the Supercable archwire stiffen in response to increased temperature and then relax upon cooling. The surges of force appear to enhance the mechanical interaction of these components while moving the tooth roots in the desired direction into the enlarging bony sockets. The subsequent relaxation of the springs upon cooling to body temperature lowers the appliance-induced stresses within the periodontal ligament to less than the capillary blood pressure, as long as the appropriate-size Supercable is used.

According to Proffit, "The optimum force level for orthodontic movement is the lightest force and resulting pressure that produces a near-maximum response."[2] I believe the long-pitch, seven-stranded Supercable, in combination with the narrow SE brackets, permits the orthodontist to approach this ideal, where compressive stresses can be created within the periodontium that are sufficient to initiate and sustain the orthodontic cellular response without reaching levels that may cause ischemia and hyalinization.

Conclusion

Although I began experimenting with labial opening holes in SPEED bracket spring clips as early as 1979, they were unsuccessful until it became feasible to make the spring clips from nickel titanium. The new SPEED SE bracket combines all the advantages of the original bracket with the additional features of a superelastic nickel titanium spring clip:

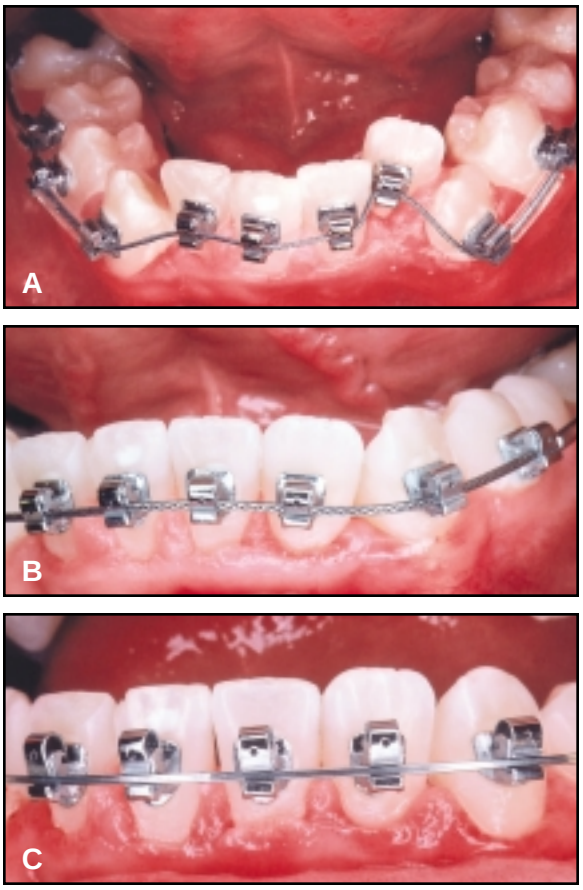

Fig. 6 A. Crowding case with initial .018" Supercable engaged by all mandibular SPEED SE brackets. Left lateral incisor spring is deflected labially and distally, but escape barrier built into bracket body prevents it from releasing archwire. Despite severe malalignment, Supercable is free to slide distally through canine and bicuspid brackets, and will soon begin to do so in incisor brackets. B. Tooth movement less than three months later, with Supercable replaced by eight-stranded .021" × .025" superelastic nickel titanium archwire. C. After 13 months of treatment, third archwire (.021" × .025" solid nickel titanium) is seated passively in bracket slots. Nearly complete expression of built-in torque occurred while mandibular dentition was bearing 3.5oz of Class II elastic force on each side.

- Ease of opening
- Avoidance of permanent deformation
- Relatively constant force application
- Temperature effect

REFERENCES

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2. Prof fit, W.R.: *Contemporary Orthodontics*, Mosby, St. Louis, 1986, p. 307.