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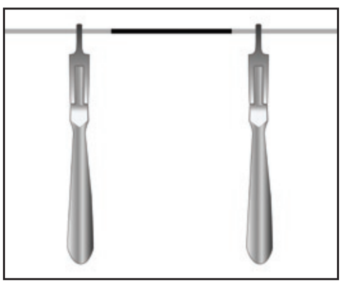
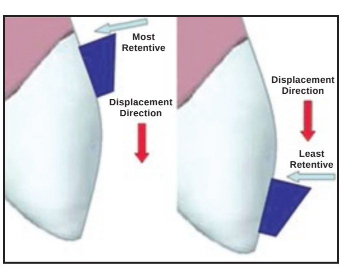
The Cover

The "surgery first" approach of Dr. Nagasaka and colleagues is illustrated on this month's cover.



90 Reprogramming Memory

106 Crossbite Correction



113 Aligner Attachments

DEPARTMENTS

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THE EDITOR'S CORNER

Surgery-First Orthognathics

Some of the most challenging, and yet rewarding, cases that orthodontists face are those in which the only way to achieve a suitable outcome is through a combination of orthodontic treatment and orthognathic surgery. In such a case, the discrepancy between the maxilla and the mandible is so great that it cannot be overcome through mechanical approaches such as headgear, function regulators, or mandibular propulsor appliances. Efforts to treat the malocclusion through a "camouflage" approach involving selective extractions and overretraction or -protraction of the anterior dentition generally result in a compromised profile. The occlusion may be acceptable, but the patient's appearance will leave much to be desired. In my practice, once or twice a year, an adult patient comes to me seeking profile improvement after having been treated for a severe Class II or Class III as an adolescent. The only remedy is a presurgical phase of orthodontics in which the main goal is to undo the camouflage treatment that was intentionally performed 10-15 years earlier. Such a case is extraordinarily difficult, and the extent of the surgery required is significantly greater than if the case had been treated surgically in the first place. An augmentation genioplasty or similar procedure is often needed to provide the patient with an acceptable profile.

Generally speaking, a case is treated by camouflage techniques rather than surgical-orthodontics because the patient does not want surgery. The reasons for this are obvious and understandable. Nobody really *wants* to undergo a potentially life-threatening surgery under general anesthesia, followed by a painful recovery period that could last several months. And with more and more insurance companies declining to cover orthognathic surgery, many patients simply cannot afford the procedures. Orthodontists are genuinely caring doctors who want to help their patients as best they can. Saying "no" when a patient asks to be treated without surgery can be extremely difficult. Over the years, however, I have learned that if surgery is really indicated, either it should be done or the case should not be treated. It took me quite a while, but I finally learned to say "no" to even the most persistent patients. As a result, I have been treating an increasing number of cases surgically compared to my early years in practice. It can still be troublesome, and potentially dangerous, when a patient initially agrees to a presurgical phase of orthodontics, then backs out as the date of the surgery approaches. At that point, a suitable outcome is almost impossible to achieve. I've committed the better part of two years to decompensating the dentition and setting up the occlusion, and the resulting tooth positions are usually far from where they would have been if the original treatment plan had been nonsurgical.

Traditional surgical-orthodontic treatment has involved a presurgical orthodontic phase in which the teeth are positioned appropriately relative to their own arches. Crowding can be addressed through extractions or reproximation as indicated. Vertically, the teeth are leveled to a flat occlusal plane, again relative to their own arches; it is not uncommon for presurgical cases to have two occlusal planes, one maxillary and one mandibular. Malrotations and malalignments are addressed so that when the surgeon corrects the underlying skeletal base, the resulting occlusion facilitates proper positioning of the jaws, and the surgeon can use that occlusion as an index prior to intermaxillary fixation. Following surgery, only minor orthodontic finishing is needed to idealize the occlusion and esthetic appearance.

Many cases have been treated successfully with this approach, but when a patient refuses surgery after all the preparations have been made, the results can be catastrophic. The orthodontist is left in a precarious position: do we stop treatment and remove the braces even though the final occlusion is wrong, or do we try to move the teeth back to their original positions? Under the first choice, the patient has straight teeth, but an entirely unacceptable occlusion and function. With the second option, the patient will need another two or three years of "round-tripping", which more often than not results in external apical root resorption. How do we overcome this dilemma?

The "surgery first" approach has been proposed by a number of orthodontists and oral surgeons over the years—in fact, there was a heated debate over the sequence of treatment in the early years of orthognathic surgery. The vast majority of orthognathic teams have settled on the orthodontics-first approach, primarily because of the ability to achieve a close approximation of the final occlusion in the presurgical phase. There is no good solution for the patient who backs out of surgery at the last minute. But that situation may be about to change.

In this issue of JCO, Drs. Nagasaka, Sugawara, Kawamura, and Nanda present a convincing surgery-first method that has been made possible by the development of temporary anchorage devices. Careful model surgery and fabrication of intra- and post-operative occlusal splints based on these models eliminate the need for direct dental indexing. The results shown by these authors demonstrate entirely acceptable occlusal and esthetic outcomes, while completely eliminating the possibility of a patient refusing surgery following presurgical orthodontic preparation. The authors document a number of other decisive advantages of the surgery-first approach. The technique they present may well represent a paradigm shift in surgical-orthodontic treatment.

RGK

Reprogramming the Memory of Superelastic Nickel Titanium Archwires

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FRANZ GÜNTER SANDER, DMD
FRANZ MARTIN SANDER, DMD, PD

Superelastic nickel titanium archwires can be used effectively in many orthodontic patients.[1-6] The major disadvantage of these wires is their inability to be adjusted during the course of treatment. In 1990, Sander introduced a pulsed-heat-induction method for reprogramming the memory of superelastic nickel titanium wires for specific clinical purposes.[7] This is now easily accomplished at the chair with a commercially available device, the Memory-Maker* (Fig. 1). In a previous article (JCO, October 2008), we described the theory behind the reprogramming. This article shows two common clinical applications.

Bending Nickel Titanium Wires with the Memory-Maker

The Memory-Maker can be used to customize nickel titanium archwires and arch segments for individual patients.[2,3,6] Before bending the

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Fig. 1 Memory-Maker with two electrically connected pliers and rectangular foot switch.

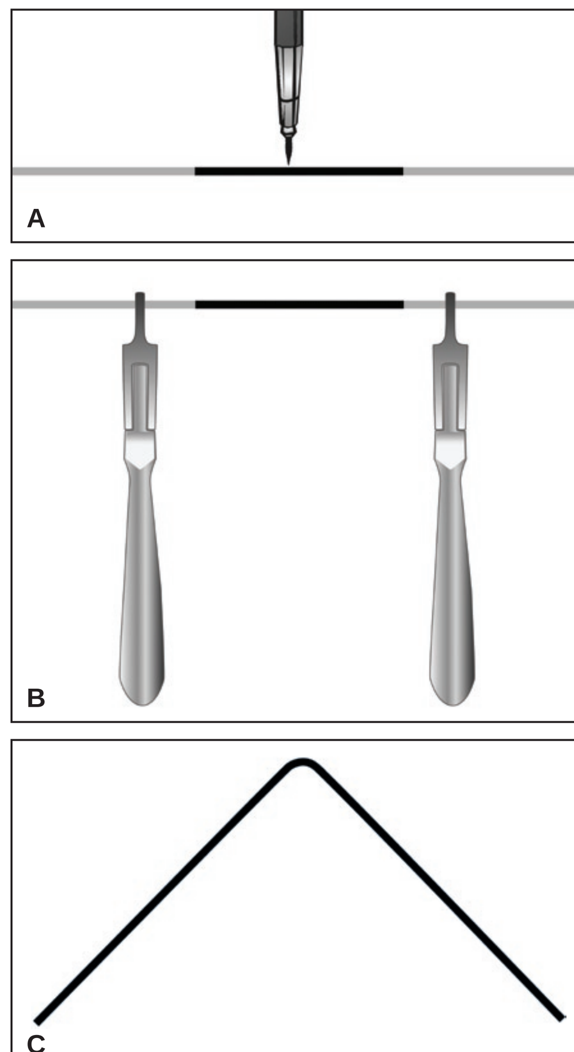

Fig. 2 Placing right-angle bend in .018" × .018" superelastic nickel titanium wire. A. Site of bend identified with waterproof marker. B. Wire grasped with orthodontic pliers connected to Memory-Maker. C. Bent wire.

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actual wire with the Memory-Maker, a similar piece of test wire should be used to adjust the current and frequency of the device. The first step is to indicate the area to be bent with a waterproof marker (Fig. 2A). Next, the wire is grasped with the pliers attached to the electrodes of the Memory-Maker (Fig. 2B). The pliers should be placed in the same locations on the test wire as will be needed for the required bend in the actual wire. To make a right-angle bend, the wire is held with the pliers about 10mm apart, equidistant from the marked area. A pulsed electric current with a frequency of about 1-3Hz is applied until a small amount of smoke appears from the waterproof ink, and the wire turns a golden color as it is heated to 360-500°C. If the wire is overheated and annealed, its color will change to blue or black, and it will lose its superelastic properties. After placing the desired bend in the archwire, pulsed electric current is applied and a recoil force is generated in the opposite direction of the bend. To program the memory in the desired configuration, this recoil must be resisted by repositioning the bend and applying more pulsed current until the desired temperature is reached (Fig. 2C).

Case 1: Segmental Mechanics for Maxillary Canine Rotation and Torque

In routine rotation cases, a small-diameter nickel titanium wire can be deflected into the bracket slot and secured with a firm or asymmetrical figure-8 ligature.[1] In cases of severe horizontal and vertical displacement, however, the

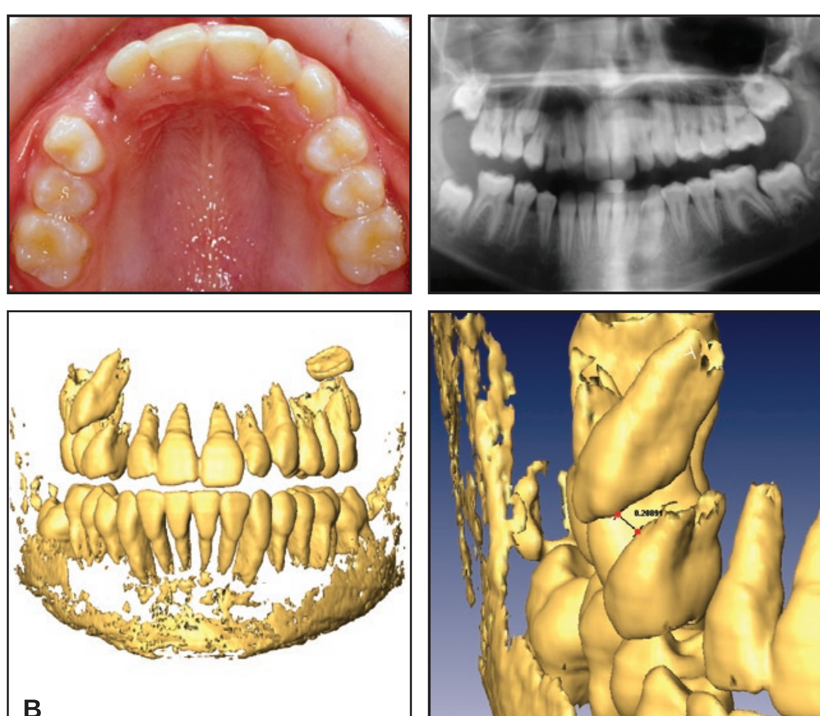

Fig. 3 Case 1. A. 15-year-old female patient with impacted maxillary right canine encroaching on buccal root of first premolar before treatment. B. Cone-beam computed tomographic radiographs showing transposition of canine, with 2mm between canine and first premolar.

Fig. 4 Case 1. A. Horizontal traction applied from power arm on archwire. B. After canine rotation of nearly 90°, elastomeric ligature attached to archwire to move canine mesially and occlusally.

archwire may not be flexible enough to accomplish the rotation efficiently, or it may cause undesirable side effects. Teeth that are impacted or ectopically erupted usually require substantial rotation and torque for proper alignment. Customized nickel titanium auxiliary segments can perform such complex tooth movements effectively without overloading adjacent teeth.

Fig. 5 Case 1. Vertical-slot bracket bonded to exposed canine.

A 15-year-old female presented with an impacted maxillary right canine that was displaced distally, encroaching on the buccal root of the right first premolar (Fig. 3). The canine was surgically exposed, and an eyelet was bonded to its buccal surface. Space for the canine was opened with a coil spring, and mesial traction was applied with an elastomeric ligature from a power arm distal to the maxillary right lateral incisor (Fig. 4A). This rotated the canine so that the smallest diameter of its root could pass by the first premolar root. After the canine penetrated the mucosa, it was moved mesially and occlusally with an elastomeric ligature (Fig. 4B).

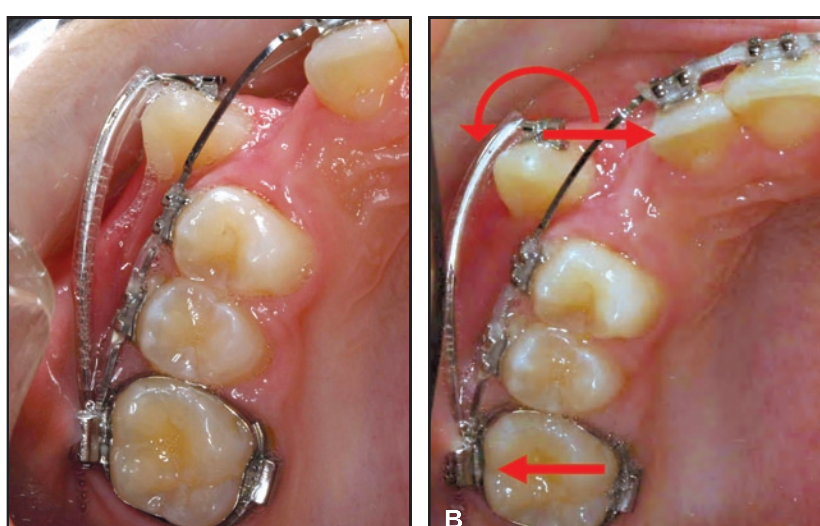

Fig. 6 Case 1. A. Nickel titanium .018" × .018" cantilever wire bent by Memory-Maker, forming segmental arch from canine to first molar. B. Derotation and palatal movement of canine, accompanied by buccal molar movement.

A bracket with an .018" × .018" vertical tube was then bonded to the buccal surface of the canine (Fig. 5), and a superelastic derotation spring was bent with the Memory-Maker from a segment of .018" × .018" nickel titanium wire. The end of the spring with a right-angle bend was inserted into the vertical tube of the maxillary canine bracket, and the cantilever portion, covered with a clear plastic sleeve, was pushed palatally and inserted into the buccal tube of the maxillary first molar (Fig. 6A). The resulting moment rotated the canine distally, thus moving it into the prepared space while the molar was moved buccally (Fig. 6B).

The rotation was achieved in four months, with canine extrusion controlled by contact with the archwire. An occlusal step bend was placed in the nickel titanium archwire with the Memory-Maker, and an .014" nickel titanium wire was secured labially, piggyback style, to align the canine (Fig. 7). Differential palatal root torque for the right maxillary canine was then programmed into the rectangular archwire with the Memory-Maker (Fig. 8A), and the maxillary dentition was detailed as needed (Fig. 8B). At debonding, an almost ideal alignment of the maxillary arch had been achieved (Fig. 9).

Fig. 7 Case 1. Alignment of canine using piggyback technique.

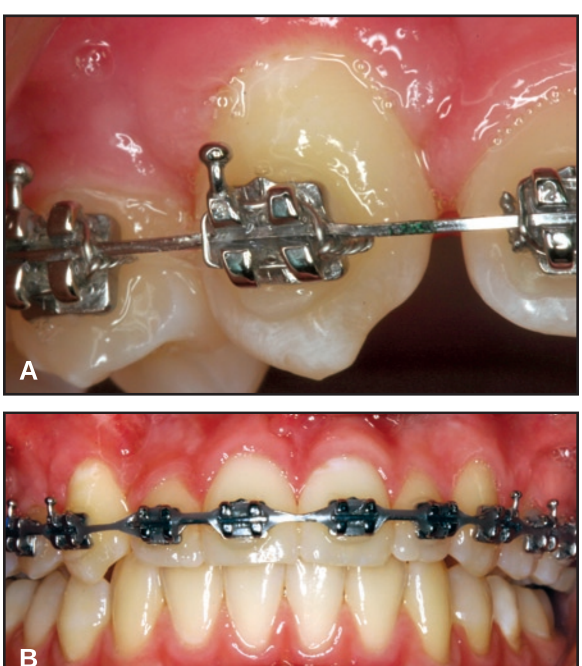

Fig. 8 Case 1. A. Torque adjustment made in rectangular nickel titanium archwire to prevent root resorption. B. Properly torqued canine.

Case 2: Labial Root Torque of a Palatally Displaced Incisor

Palatally displaced maxillary incisors require considerable labial root torque to align once the crossbite has been corrected. It is a challenge to deliver a sufficient moment with a desirable range of activation using a stainless steel or TMA** archwire. Because an .016" × .022" archwire in an .022" bracket has about 22° of freedom before engagement, it is difficult to measure the torque delivered to the tooth, even with an activa-

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Fig. 9 Case 1. Final treatment result, showing almost ideal alignment of maxillary arch.

tion chart (Fig. 10). Overactivation of a stainless steel or TMA archwire makes insertion problematic and may lead to bracket debonding or patient discomfort.

A superelastic nickel titanium archwire has superior properties because of its low modulus of elasticity. Using the Memory-Maker, a differential torsion activation of 45-90° can be placed in an .016" × .022" nickel titanium archwire, providing a wide range of activation for efficient correction of a palatally displaced maxillary lateral incisor with an .022" bracket.[4]

A 13-year-old female presented with maxillary arch constriction and crowding and palatal displacement of the maxillary left lateral incisor (Fig. 11). To gain space, the maxillary arch was rapidly expanded with a jackscrew (Fig. 12). Initial alignment was carried out with an .016" nickel titanium segmental wire (Fig. 13). Space for the blocked-out lateral incisor was then opened with a nickel titanium compressed-coil spring (Fig. 14).

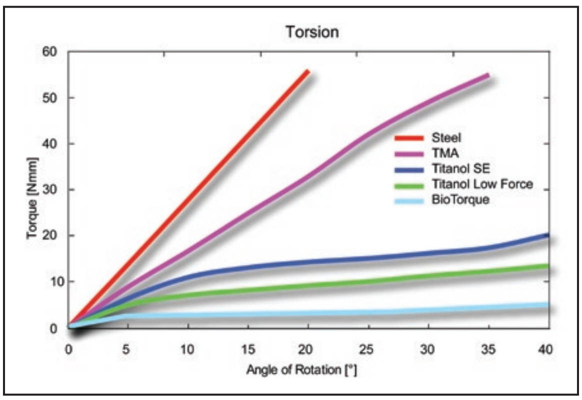

Fig. 10 Single-tooth torsion with five .016" × .022" wires: stainless steel, TMA, Titanol* Superelastic (SE), Titanol Low-Force, and BioTorque.***

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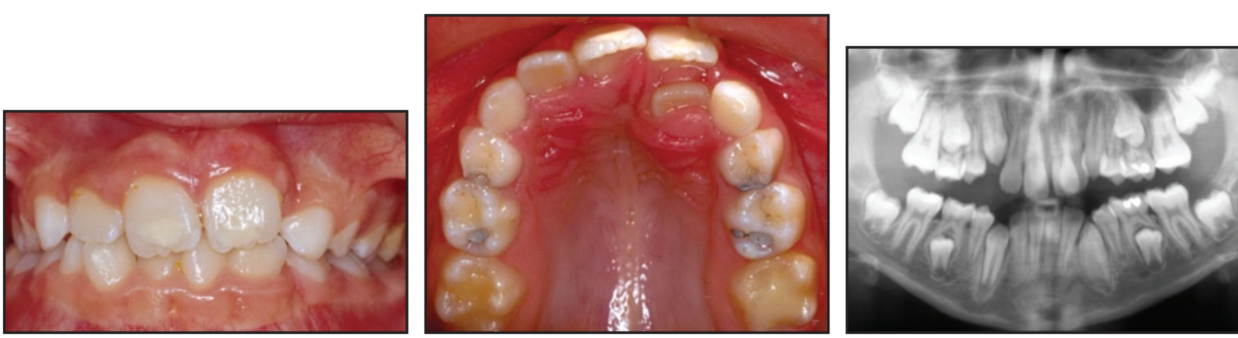

Fig. 11 Case 2. 13-year old female patient with maxillary arch constriction and crowding and palatal displacement of maxillary left lateral incisor before treatment.

Fig. 12 Case 2. Patient after 18 days of rapid palatal expansion at .5mm per day, with acrylic coverage of buccal segments.

A bracket was bonded upside-down to the displaced incisor, changing the bracket torque from +7° to –7°. An .012" BioStarter* nickel titanium archwire was used for initial alignment of the maxillary arch (Fig. 15). Labial root torque was then applied to the lateral incisor with a straight .017" × .025" stainless steel archwire until the tooth position could not be improved further, due to the interbracket play of more than 15° (Fig. 16). The lateral incisor bracket was rebonded in the prescribed position, and the Memory-Maker was used to place about 20° of labial root torque in the appropriate segment of an .017" × .025" Bio-Torque* nickel titanium archwire (Fig. 17). This wire produced the desired torque in three months. The total treatment time was 18 months (Fig. 18).

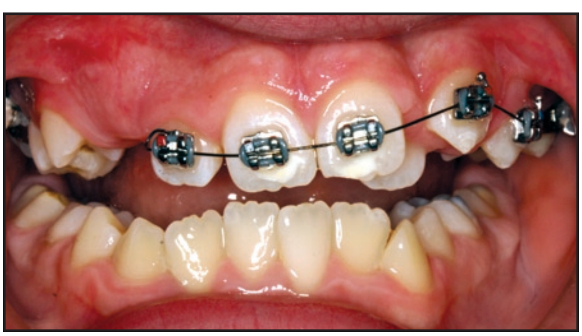

Fig. 13 Case 2. Initial alignment with .016" nickel titanium segmental archwire.

Fig. 14 Case 2. Space gained for maxillary left lateral incisor with superelastic compressed-coil spring.

Fig. 15 Case 2. Alignment of maxillary arch with .012" BioStarter* nickel titanium archwire.

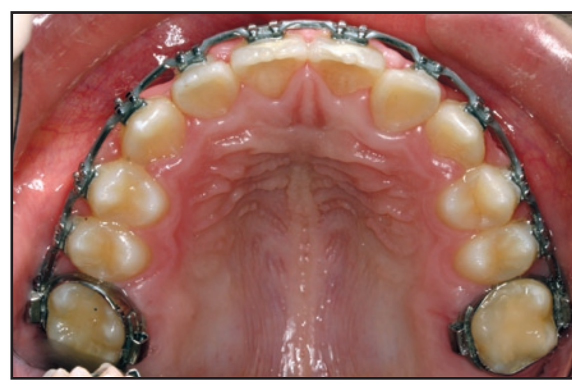

Fig. 16 Case 2. Inadequate labial root torque of maxillary left lateral incisor with rectangular stainless steel archwire.

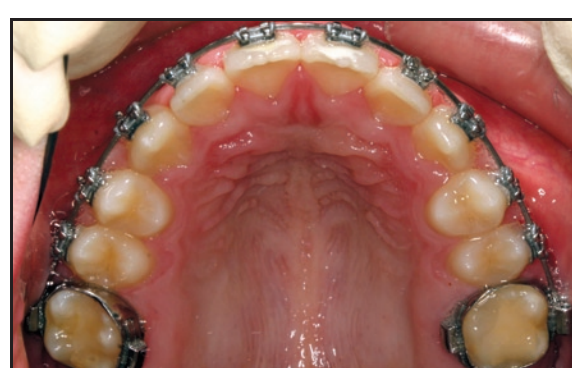

Fig. 17 Case 2. Labial root torque placed in maxillary left lateral incisor segment of BioTorque* nickel titanium archwire using Memory-Maker.

Fig. 18 Case 2. Treatment results after 18 months of fixed appliances.

Conclusion

The Memory-Maker permanently changes the conformation of superelastic nickel titanium wires without destroying their superelastic properties, allowing them to be used for a wide variety of specific clinical applications that are not easily addressed with preformed commercial archwires. The wires can be reprogrammed repeatedly as long as they are not overheated. Customized auxiliaries can be constructed and segments of nickel titanium archwires adjusted to achieve desired movements of individual teeth. Exploiting the superelastic properties of nickel titanium wires can help achieve optimal outcomes while reducing costs and treatment times.

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CASE REPORT

"Surgery First" Skeletal Class III Correction Using the Skeletal Anchorage System

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Surgical-orthodontic treatment traditionally involves presurgical orthodontic preparation, including dental alignment, incisor decompensation, and arch coordination. In skeletal Class III patients, however, presurgical incisor decompensation will exacerbate an anterior crossbite and prognathic lip profile, and can increase the total treatment time with no significant benefit for the patient.[1]

We have adopted a new approach to such treatment: surgery first, followed by orthodontic alignment. This approach was made possible by the development of the Skeletal Anchorage System (SAS), which uses titanium miniplates as temporary anchorage devices and enables predictable three-dimensional movement of the entire dentition in nongrowing patients.[2-4]

The present article describes the treatment of a skeletal Class III patient with a combination of surgery and SAS orthodontic treatment.

Diagnosis and Treatment Plan

A 17-year-old female presented with the chief complaint of a prognathic profile. Initial examination revealed an excessive interlabial gap, mandibular excess, a Class III skeletal relationship, an edge-to-edge bite, maxillary incisor proclination, moderate maxillary crowding, and extreme buccoversion of the maxillary second molars (Fig. 1, Table 1). These problems, particularly the mandibular excess, indicated the need for orthognathic surgery.

After we presented the various surgical-orthodontic options, the patient elected the "surgery first" approach. We also decided


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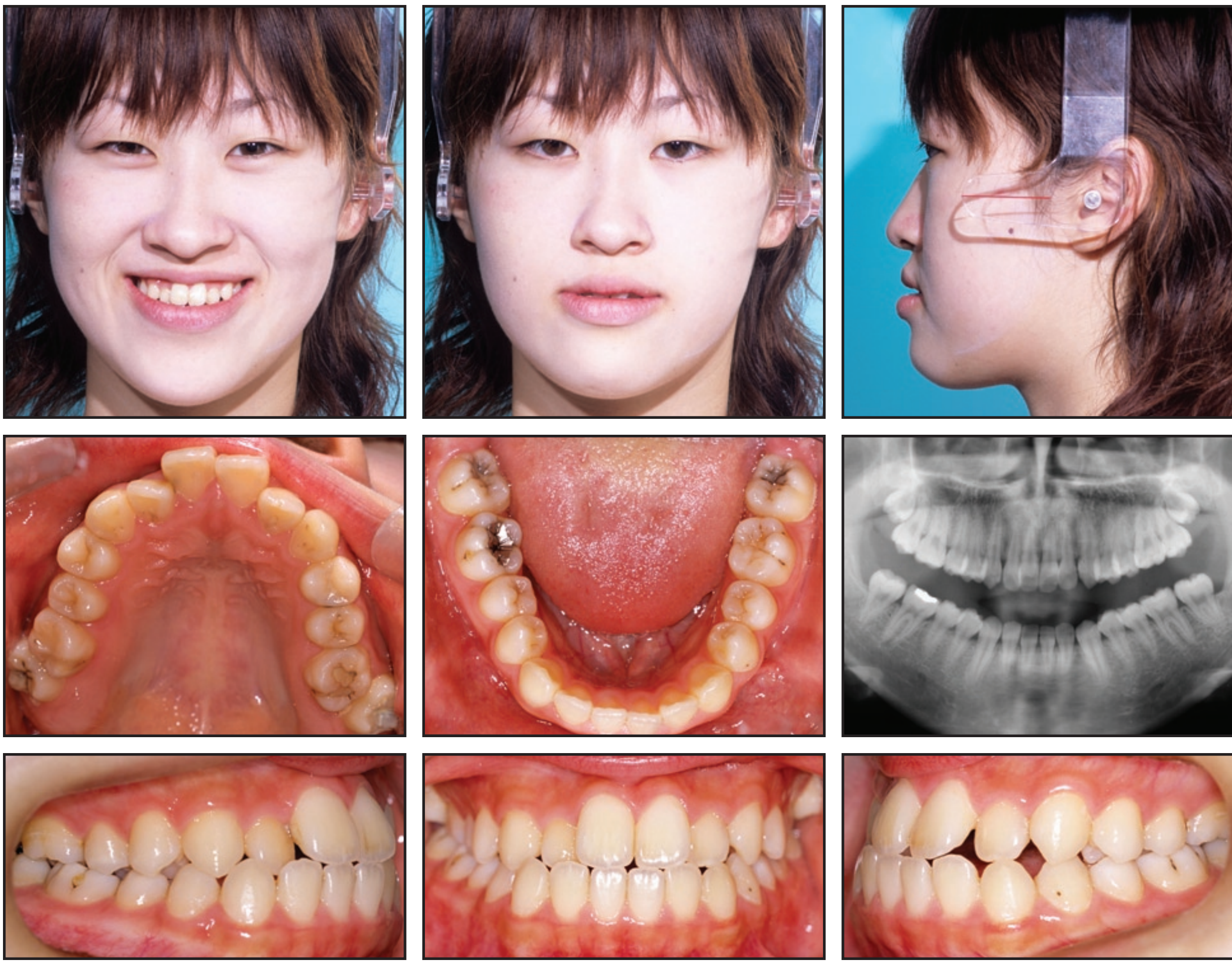


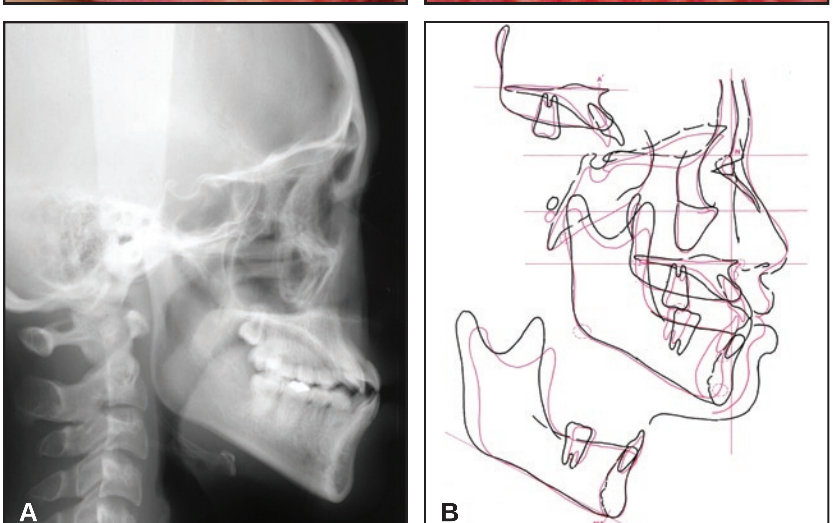


Fig. 1 A. 17-year-old female patient with mandibular excess, Class III skeletal relationship, edge-to-edge bite, and crossbite before treatment. B. Initial cephalometric analysis comparing craniofacial morphology of patient with norms for Japanese female adults.

TABLE 1
CEPHALOMETRIC DATA

	Norm	Pretreatment	Post-Treatment
NS	66.1mm	67.3mm	67.3mm
N-ANS	53.4mm	56.3mm	57.3mm
ANS-Me	69.7mm	72.9mm	71.3mm
N-Me	121.1mm	128.5mm	127.3mm
S′-Ptm′	18.4mm	19.3mm	18.6mm
A′-Ptm′	46.7mm	49.7mm	50.4mm
Is-Is′	30.8mm	27.0mm	28.7mm
Mo-Ms	23.4mm	25.3mm	22.6mm
Gn-Cd	115.2mm	127.3mm	121.2mm
Po’-Go	74.6mm	84.1mm	78.1mm
Cd-Go	60.3mm	61.7mm	60.9mm
Ii-Ii′	43.0mm	47.3mm	46.7mm
Mo-Mi	32.6mm	35.2mm	34.3mm
CdGn-CdA		40.9mm	35.5mm
Wits appraisal		–8.2mm	–4.6mm
Y-axis	65.4°	57.9°	58.9°
FH-SN	6.2°	8.5°	9.7°
SNA	82.3°	83.9°	83.9°
SNB	78.9°	86.4°	82.8°
ANB	3.4°	–2.5°	1.1°
Mandibular plane to SN	40.2°	32.6°	33.8°
Ramus plane to SN	89.0°	91.1°	89.8°
Gonial angle	131.0°	121.6°	124.0°
U1-SN	104.5°	122.9°	113.2°
L1 to mandibular plane	96.3°	89.6°	88.6°
Interincisal angle	124.1°	114.8°	124.4°
Occlusal plane to SN	20.2°	10.3°	14.7°

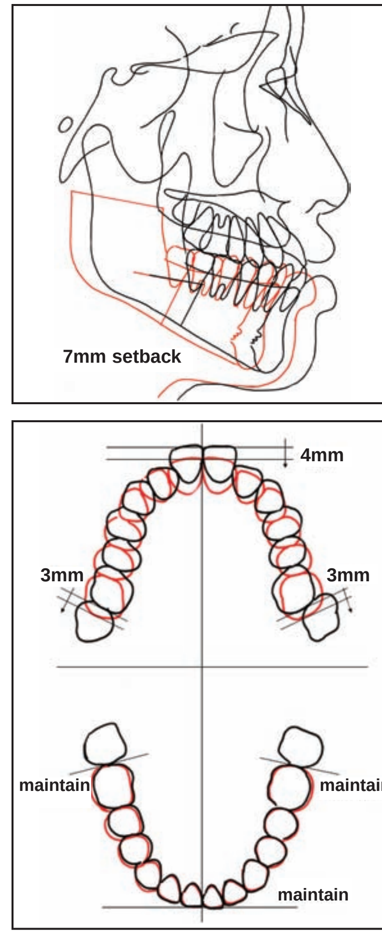


Fig. 2 Cephalometric and occlusogram predictions of treatment results immediately after orthognathic surgery and after orthodontic treatment, respectively, with target positions shown in red.

to extract the maxillary second molars to correct the crossbite and facilitate distalization of the maxillary posterior teeth, allowing the third molars to replace the second molars.

Cephalometric and occlusogram predictions were used for treatment planning (Fig. 2). The cephalometric analysis and Wits appraisal indicated the need for about 7mm of mandibular setback. The mandibular incisors were appropriately inclined, but the maxillary incisors were significantly proclined. Therefore, we planned to retrocline the maxillary incisors by about 4mm after moving the maxillary posterior teeth distally by 3-4mm.

Treatment Progress

Before orthognathic surgery, .022" preadjusted brackets were bonded to all the teeth except the maxillary second molars, and passive rectangular .018" × .025" stainless steel archwires were inserted. Model surgery was performed according to

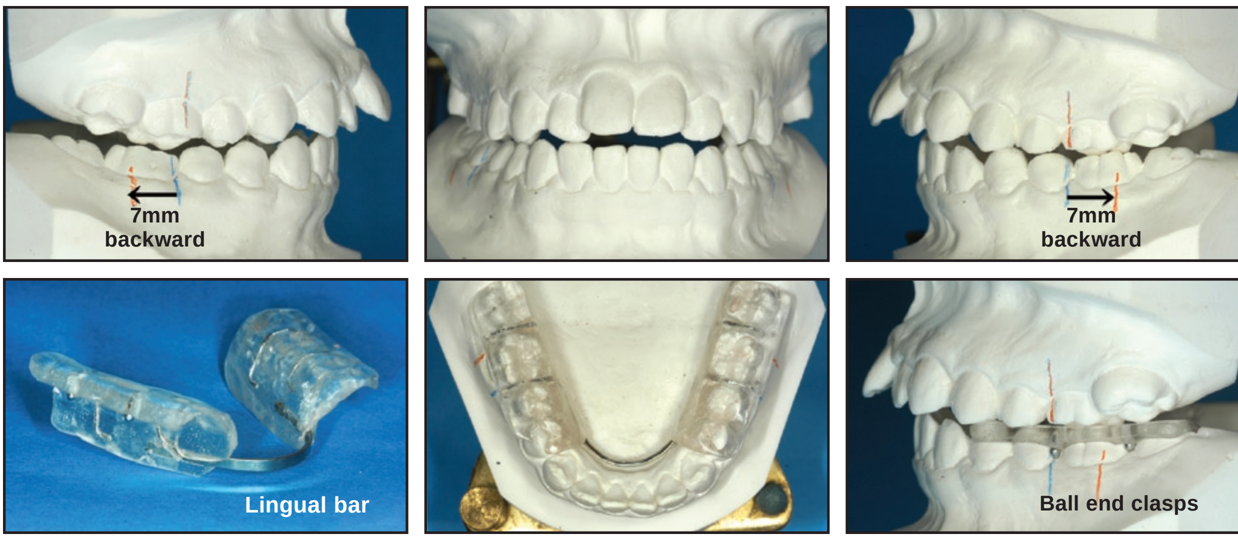


Fig. 3 Model surgery and surgical splint showing bilateral 7mm mandibular setback.

the cephalometric prediction. A surgical splint with a lingual bar and ball end clasps was fabricated to cover the posterior occlusal surfaces and ensure optimal positioning and stabilization of the mandibular model (Fig. 3).

Bilateral sagittal split ramus osteotomy was then performed to achieve the required mandibular setback. Titanium miniplates were used for rigid internal fixation. After the surgical splint was set in the mandibular arch, four intermaxillary fixation screws* were inserted in the anterior alveolar regions to prevent unwanted incisor extrusion. Simultaneously, the maxillary second molars were extracted, and Y-type orthodontic titanium miniplates** were implanted at the zygomatic buttresses, using titanium monocortical screws (2mm in diameter, 5mm long), to distalize the maxillary posterior teeth and thereby decompensate the maxillary incisors. Immediately after surgery, the patient demonstrated a Class II profile and a Class II occlusal relationship with open bite (Fig. 4). The intermaxillary fixation screws were replaced with vertical elastics.

Postsurgical orthodontic treatment was initiated one month after surgery. The maxillary posterior teeth were leveled with a nickel titanium archwire and simultaneously distalized using SAS mechanics, with the passive rectangular wire left in place in the anterior segment. The surgical splint was modified to a removable mandibular occlusal splint, which was used to stabilize the jaw position and masticatory function.

Once these goals had been achieved, one and a half months after surgery, leveling and alignment of the mandibular arch were begun without the splint (Fig. 5A). When sufficient space was available, the maxillary arch was leveled and aligned, and the maxillary anterior teeth were retracted (Fig. 5B-E). Coordination of the maxillary and mandibular arches was followed by finishing and detailing (Fig. 5F).

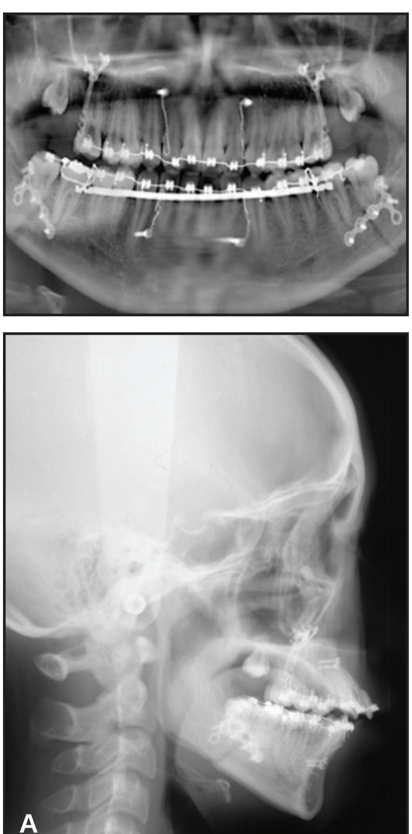
After a total treatment time of 12 months, all brackets were debonded, and the titanium miniplates and screws were removed under local anesthesia. A wraparound retainer was placed in the maxillary arch, and a lingual retainer was bonded in the mandibular anterior segment.

*Dual-Top, trademark of JEIL Medical Corp., #702, Kolon Science Valley 2nd 822, Guro-Dong, Guro-Ku, Seoul, South Korea; www.jeilmed.co.kr.

**SMAP OrthoAnchor, trademark of Dentsply-Sankin Corp., 14-9 Yushima 3-Chome, Bunkyo-ku, Tokyo, Japan; www.dentsply-sankin.com.

Treatment Results

Post-treatment records showed complete resolution of all the patient's orthodontic problems, resulting in a balanced pro-



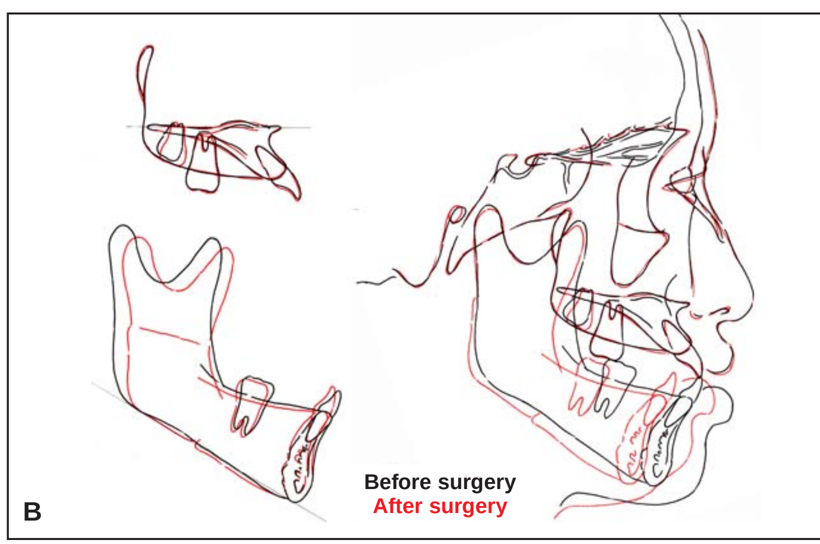


Fig. 4 A. Patient immediately after surgery, showing Class II occlusion with open bite and proper mandibular position maintained with surgical splint. B. Superimposition of preoperative (without surgical splint) and postoperative (with surgical splint) cephalometric tracings. Mandibular body length decreased approximately 8mm, with slight mandibular clockwise rotation.

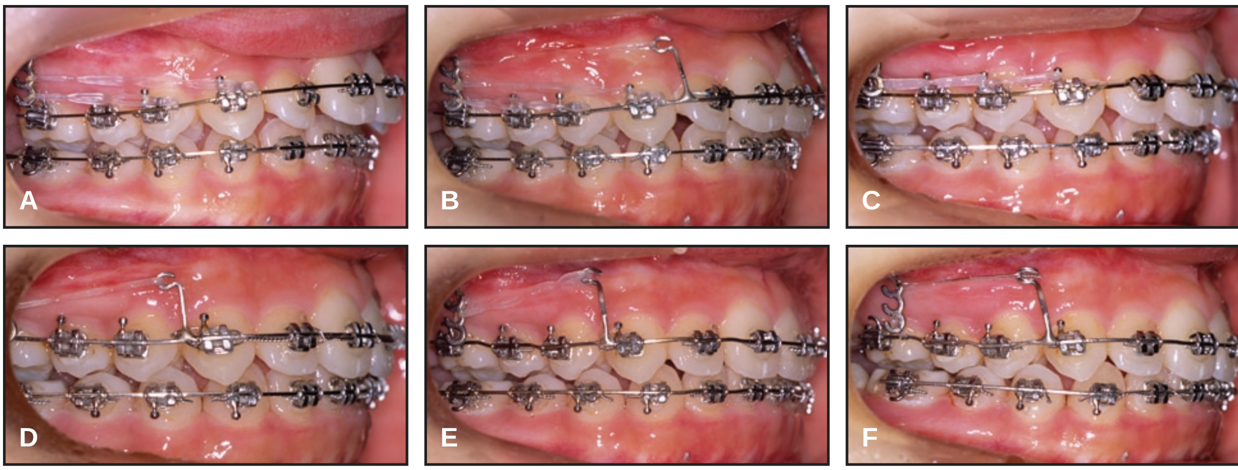


Fig. 5 Changes in canine and molar relationships during postsurgical orthodontic treatment, using the SAS. A. At one and a half months after surgery. B. At four months. C. At six months. D. At seven and a half months. E. At eight months. F. At 10 months.

file with a good occlusal relationship (Fig. 6). The maxillary third molars were erupting into the spaces formerly occupied by the second molars. Cephalometric analysis showed the patient's posttreatment profile to be nearly identical to the norm for Japanese female adults (Table 1). Superimposition of pre- and post-treatment cephalometric tracings showed achievement of all treatment goals. The patient was delighted with the treatment outcome.

Retention records obtained three years after debonding showed generally stable results, with a slight deviation of the lower dental midline (Fig. 7).

Discussion

Skeletal Class III malocclusion goes hand in hand with dentoalveolar compensation, typically involving proclination of the maxillary incisors and retroclination of the mandibular incisors. Therefore, when surgery is performed first, a Class III malocclusion always becomes a Class II relationship immediately after mandibular setback, requiring Class II orthodontic mechanics after surgery (Fig. 8).

Because SAS mechanics can predictably distalize the maxillary molars and protract the mandibular molars in nongrowing patients, it is not difficult to correct Class II malocclusions without premolar extractions.[5] The SAS mechanics can also be used to correct open bite, anterior crowding, dental asymmetry, or excessive arch spacing.[6-8] We now use the "surgery first" approach routinely for Class III correction requiring orthognathic surgery.

A surgical splint is essential to guide repositioning of the mandible, because the postsurgical Class II malocclusion is generally quite unstable. After surgery, the modified, removable splint helps stabilize the jaw and bring the patient into the final occlusion with aid of training elastics.

The "surgery first" approach has several biological and psychosocial advantages over traditional surgical-orthodontic treatment:

- Patient satisfaction is virtually guaranteed, because the patient sees a major improvement in the profile at the beginning of treatment. This rapid improvement makes the patient more willing to accept the Class II profile resulting from orthognathic surgery.
- The Class III profile and anterior crossbite are not exacerbated by incisor decompensation. Concerns about worsening the profile in presurgical treatment sometimes cause Class III patients to forgo orthognathic surgery.
- If a surgical error or skeletal relapse occurs, compensation can be made with SAS mechanics. In conventional treatment, because the decompensation is completed before surgery, it is difficult or impossible to recover from surgi-

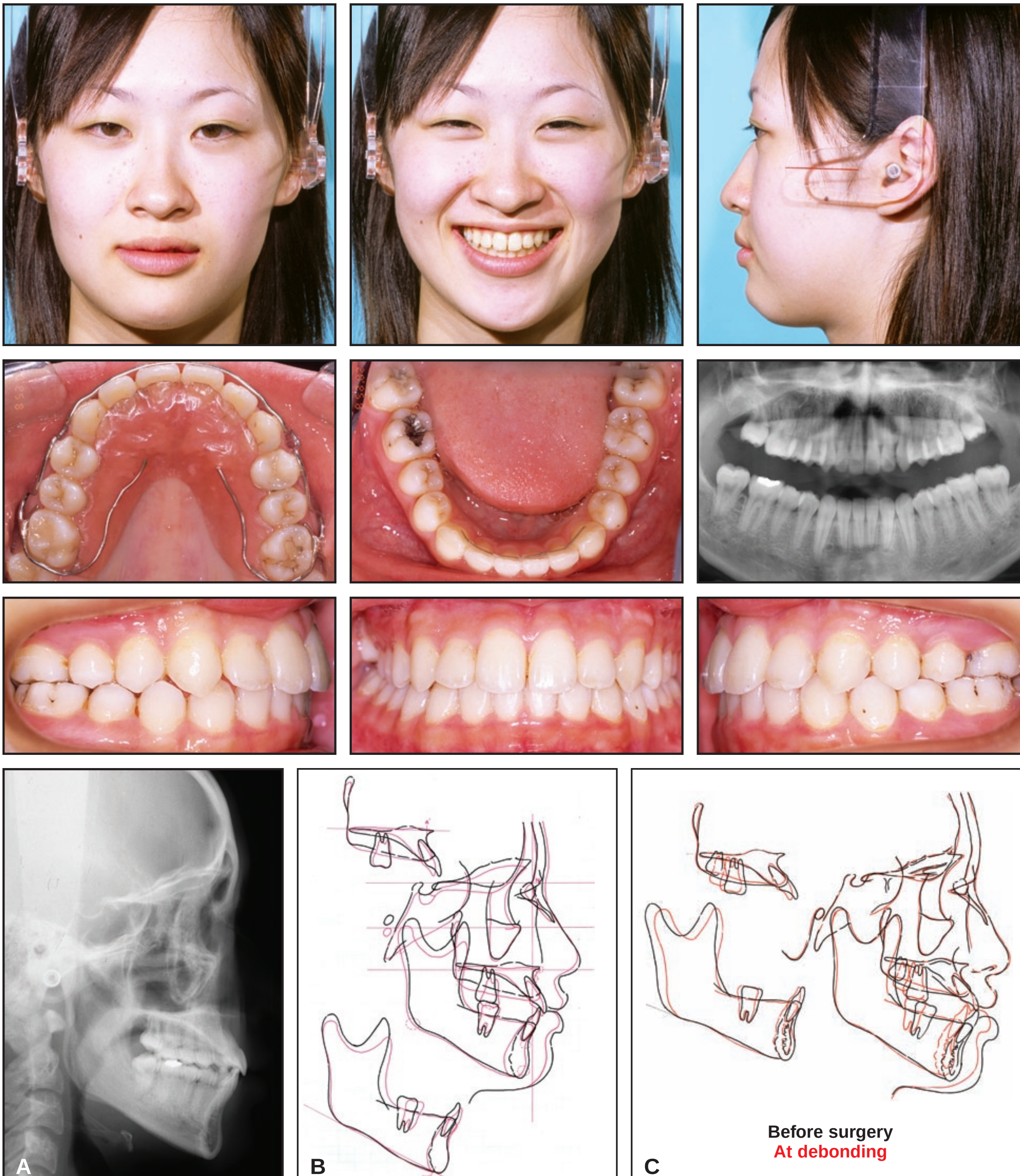


Fig. 6 A. Patient at debonding, 12 months after surgery, with maxillary wraparound retainer and mandibular lingual bonded retainer in place and all titanium miniplates and screws removed. Note eruption of maxillary third molars in proper positions. B. Post-treatment cephalometric analysis, showing dentofacial proportions nearly identical to norms for Japanese female adults. C. Superimposition of pre- and post-treatment cephalometric tracings, showing maxillary molars significantly distalized and maxillary incisors successfully decompensated.

Fig. 7 Patient three years after debonding.

cal error during postsurgical orthodontic treatment.

• The total treatment time is usually much shorter. The 12 months required to treat the case shown here is significantly less than the average time for presurgical orthodontic treatment alone.[9-11] Wilcko and colleagues reported that corticotomy could enhance tooth movement by increasing bone turnover and decreasing bone density.[12] Similarly, bone turnover after orthognathic surgery significantly accelerates orthodontic tooth movement.

• Decompensation can be performed effectively and efficiently. Because a Class III malocclusion becomes a Class II relationship after mandibular setback, the resulting improvement in the tone of the upper lip and tongue increases the force on the incisors of both arches, improving the efficiency of incisor decompensation. This phenomenon may also be a factor in reducing total treatment time.

On the other hand, the "surgery first" approach also has some disadvantages that must be taken into consideration:

• The occlusion cannot be used as a guide for establishing treatment goals, unlike traditional surgical-orthodontic treatment, in which decompensation of the incisors and coordination of the dental arches are performed before surgery. The skeletal disharmony must be accurately assessed to establish an effective treatment plan. The Wits appraisal[13] and craniofacial drawing standards (CDS) analysis[14] can be used to establish individualized treatment goals (Fig. 1B).

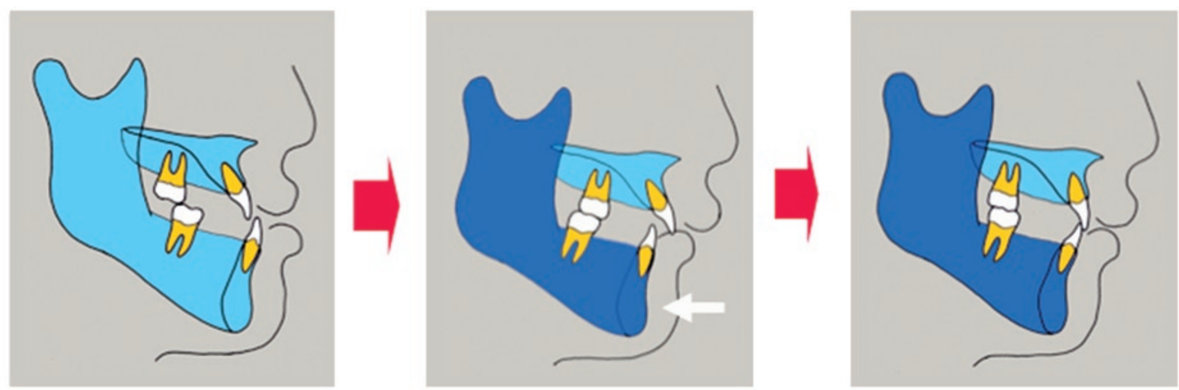


Fig. 8 "Surgery first" mandibular setback for skeletal Class III correction.

• Without presurgical orthodontics, it is difficult to obtain a stable occlusion immediately after surgery. Therefore, the patient must wear an occlusal splint while eating.
• The orthodontist must be experienced and skilled with the SAS technique, which is essential to achieving predictable three-dimensional molar movement.

Conclusion

The "surgery first" approach, combined with SAS mechanics, provides significant benefits to skeletal Class III patients compared with traditional surgical-orthodontic treatment. Among its advantages are rapid profile improvement, more efficient and effective decompensation, and greatly reduced treatment time. We believe these advantages substantially outweigh any disadvantages, and that this new treatment approach may become a standard clinical option in the near future.

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Correction of Posterior Crossbite with a Nickel Titanium Appliance and Indirect Skeletal Anchorage

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SUN HYUNG PARK, DDS, MSD, PHD
YOUN SIC CHUN, DDS, MSD, PHD

The "dragon helix" appliance was developed for correction of crossbite through simultaneous intrusion and palatal tipping of the affected teeth using indirect skeletal anchorage.[1] The original version of the appliance consisted of two arms and a coil spring made from .016" × .022" stainless steel wire. Although it was effective, this appliance was time-consuming to fabricate; moreover, its bulky spring often caused patient discomfort because of gingival impingement and food impaction.

To address these problems, we modified the dragon helix appliance by eliminating the coil spring and changing the material from stainless steel to nickel titanium wire. The modified crossbite corrector takes less time to fabricate and causes less patient discomfort than the original version. It allows the application of light, continuous forces for effective intrusion of extruded molars.

Fabrication and Insertion

A setup model should be used to construct the crossbite corrector (Fig. 1). In a case of crossbite involving an overerupted maxillary molar, the setup model should incorporate a 20-30% overcorrection of the molar to provide enough space for the mandibular molar to be uprighted without interference.

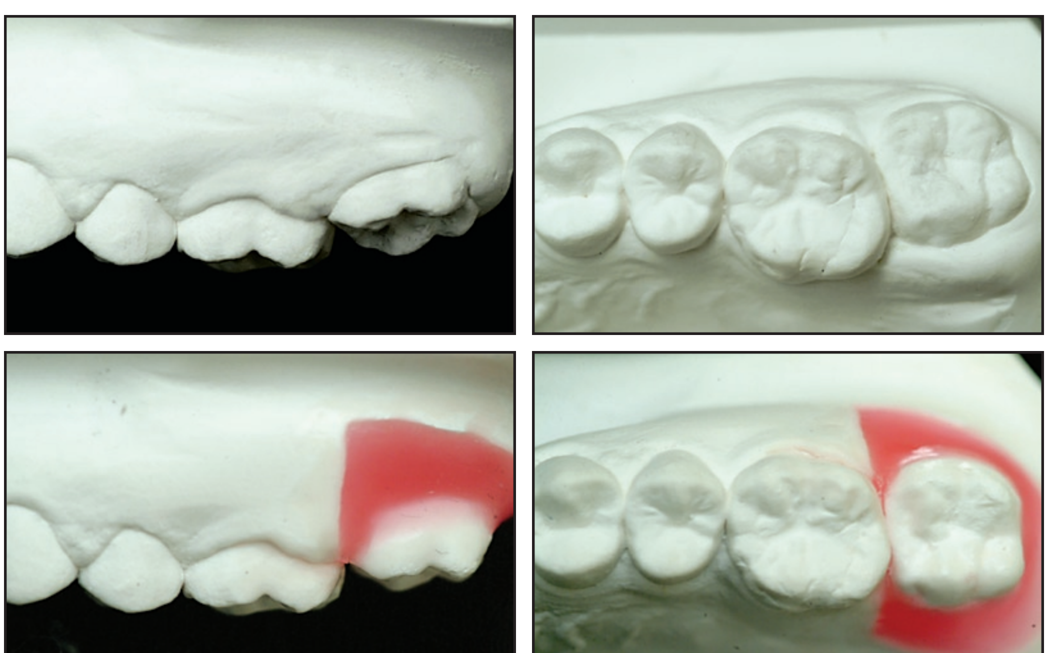

Fig. 1 Fabrication of setup model. Maxillary second molar overcorrected by 20-30% to provide space for uprighting mandibular molar without interference.

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Dr. Chun

The appliance is fabricated from a segment of .018" × .025" nickel titanium wire. The bends in the wire are made using a three-pronged nickel titanium plier* and the Bender Soarer II** (Fig. 2A). First, the wire is bent gingivally against the distobuccal cusp of the maxillary first molar (the anchor tooth). The wire is then marked for the second bend, which is made distally at a distance from the first bend equal to the height of the maxillary second molar (the target tooth). The third bend is made occlusally at the buccal groove of the maxillary second molar. The fourth and final bend brings the end of the wire over the occlusal surface of the maxillary second molar.

To ensure easy and accurate bonding, a composite base molded to the patient's tooth is fabricated for each arm of the crossbite corrector (Fig. 2B). First, a separating medium is applied to the setup model. A conventional composite adhesive is applied to bond the wire ends to the occlusal surface of the target tooth and the buccal surface of the anchor tooth. After the composite bases are separated from the setup model, the bonding surfaces are sandblasted to enhance their mechanical retention.

A conventional composite is then used to bond the arms of the crossbite corrector to the patient's teeth. We recommend bonding the appliance first to the occlusal surface of the maxillary second molar and then to the buccal surface of the maxillary first molar. The tooth impressions in the

*Hu-Friedy, 3232 N. Rockwell St., Chicago, IL 60618; www.hu-friedy.com.

**Tomy, Inc., 818, Shinmachi, Ohkuma-machi, Futaba-gun, Fukushima-ken, 979-1305, Japan; www.tomyinc.co.jp.

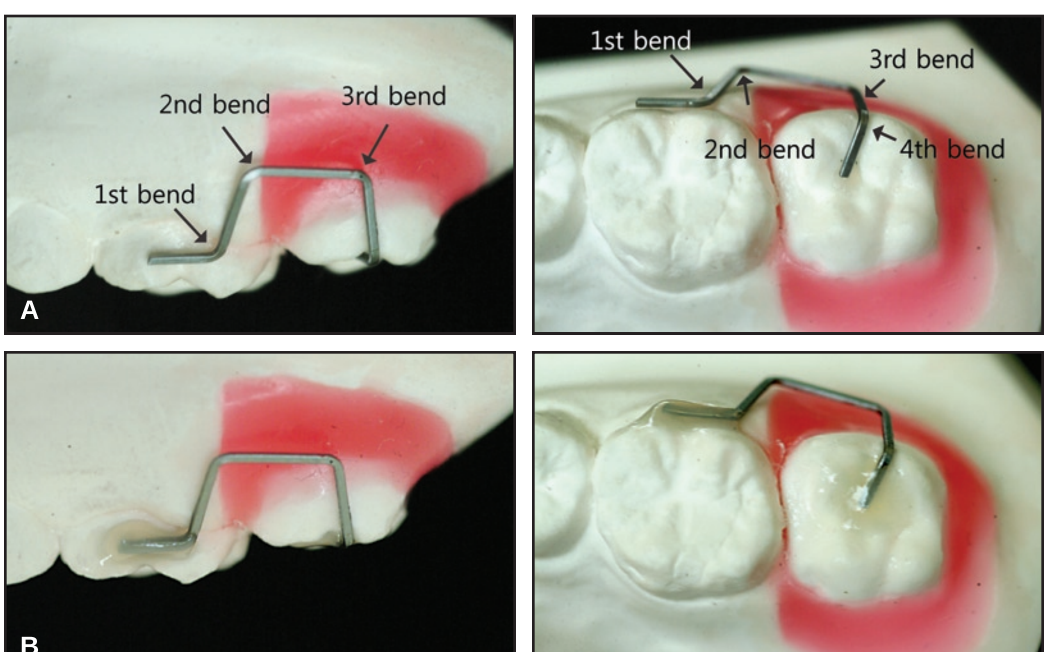

Fig. 2 A. Bends made in nickel titanium wire. B. Fabrication of composite bases.

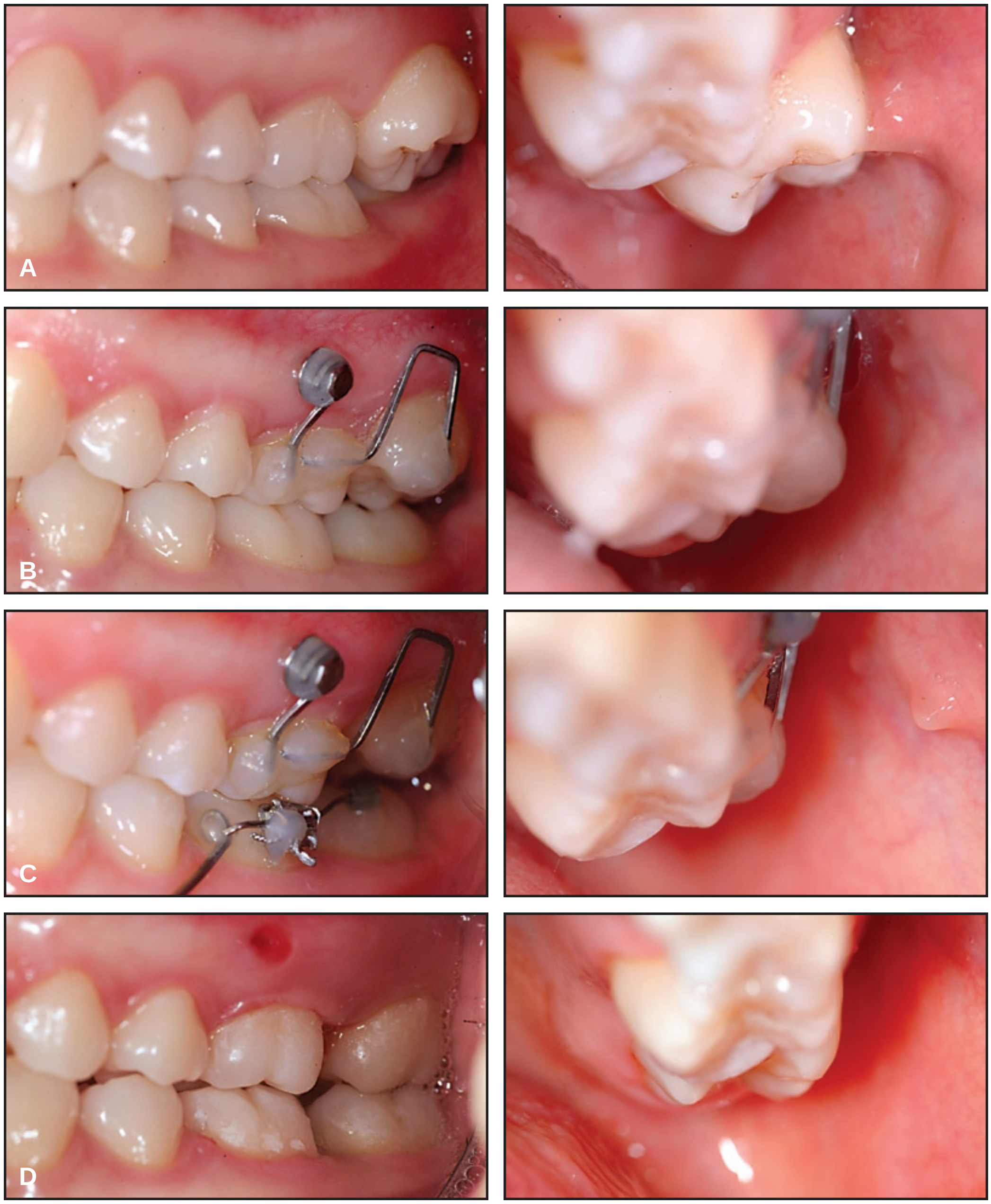

Fig. 3 A. 20-year-old female patient with complete posterior crossbite of left second molars before treatment. B. Intrusion and palatal tipping of left second molar three months after placement of crossbite corrector in maxillary arch. C. Space created for uprighting of mandibular molar four months after placement of maxillary crossbite corrector. D. After 16 months of maxillary arch treatment.

preformed composite bases allow accurate positioning, and because the appliance was fabricated passively on the overcorrected setup model, it is activated as soon as it is placed in the mouth. Reactivation is not necessary until the second molar has been moved to the target position.

Case Report

A 20-year-old female presented with the chief complaint of complete crossbite of the left second molars (Fig. 3A). Initial examination revealed a convex facial profile with lip protrusion and mild anterior crowding in both arches, as well

Fig. 4 A. Mandibular second molar uprighting initiated four months after placement of maxillary crossbite corrector. B. After seven months of mandibular molar uprighting, first molar bracket repositioned and second molar tube replaced with bracket for finishing. C. After nine months of mandibular arch treatment.

as Class II canine and molar relationships. No significant transverse skeletal deviation was observed. Although the patient was diagnosed as having a Class II, division 1 malocclusion, she elected to have only the crossbite corrected.

For indirect skeletal anchorage, a 1.6mm × 8mm miniscrew*** was placed between the maxillary left second premolar and first molar under local anesthesia. The screw was connected to the mesiobuccal surface of the maxillary first molar with .019" × .025" stainless steel wire. The crossbite corrector was then bonded to the maxillary left first and second molars. Three months later, significant intrusion and palatal tipping of the left second molar were observed (Fig. 3B). After another month, the interocclusal clearance was sufficient to begin uprighting the mandibular left second molar (Fig. 3C). Treatment of the maxillary arch took a total of 16 months (Fig. 3D).

A second screw was placed between the mandibular left premolars and connected to the mesiobuccal surface of the mandibular left first molar with .019" × .025" stainless steel wire. Since the mandibular second molar was not intruded and there was already enough clearance for conventional appliances, there was no need to use the crossbite corrector on this tooth. A bracket was bonded to the first molar, and a tube was bonded to the buccal surface of the second molar (Fig. 4A). A nickel titanium wire was placed and activated to tip the second molar buccally. After seven months, mandibular uprighting was complete. The mandibular first molar bracket was repositioned, and a second molar bracket was placed for more detailed leveling and alignment (Fig. 4B). Mandibular arch treatment lasted nine months (Fig. 4C). The total duration of treatment was 16 months (Fig. 5).

***OSAS self-drilling screw, Part No. 1D16109, EPOCH Medical, Seoul, South Korea; www.osas.co.kr.

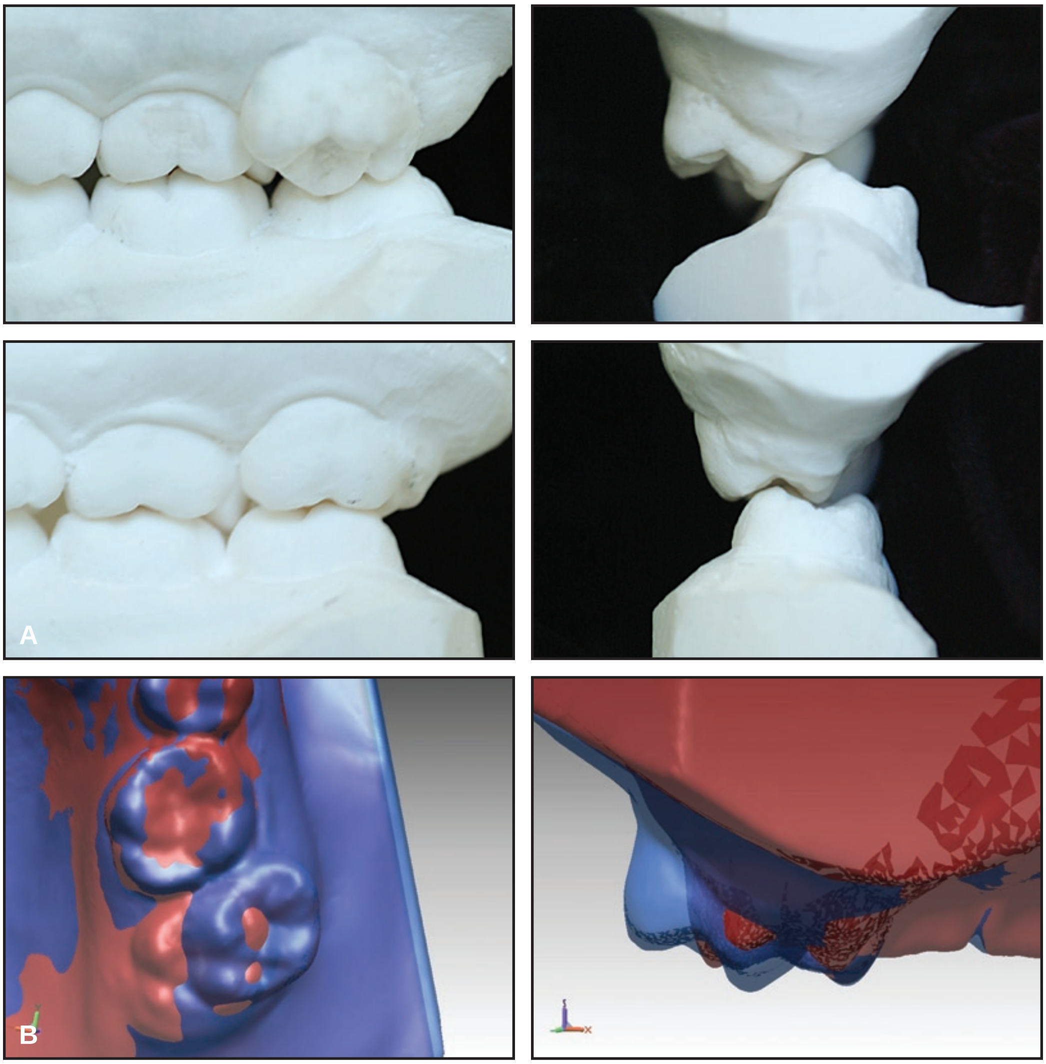

Fig. 5 A. Comparison of pre- and post-treatment dental casts. B. Three-dimensional superimposition of pre- and post-treatment maxillary dental casts.

Discussion

The small, nickel titanium crossbite corrector allows effective tooth movement with less gingival impingement and patient discomfort than was found with the original dragon helix device. Indirect skeletal anchorage with a single miniscrew provides sufficient stability, comparable to that of an ankylosed tooth.[2,3] The screw can be placed wherever there is adequate interradicular space. Other orthodontic treatment can be performed simultaneously with no loss of anchorage.

Use of the modified crossbite corrector with indirect skeletal anchorage requires special attention to several issues. First, because the mechanics involved rely on absolute anchorage, the miniscrew must be checked frequently for mobility. Second, accurate positioning of the crossbite corrector is essential for proper direction of force. Third, as with other systems for intrusive tooth movement, periodontal pocket depth must be regularly monitored. The importance of good oral hygiene should be emphasized to the patient to minimize the risk of periodontal problems.

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TECHNIQUE CLINIC

Esthetic Modification of a Hawley Retainer Using a Translucent Labial Bow

In a few years, the Hawley retainer will be 100 years old. Although it has served the profession well, in the current era of "invisible" orthodontics, some patients find its labial metal bow to be esthetically unacceptable. This problem can now be solved by replacing the anterior section of the bow with a translucent retainer wire. The Astics Translucent Retainer* (the name is derived from the word "aesthetics") is both efficient and unobtrusive, meeting the needs of both clinician and patient.

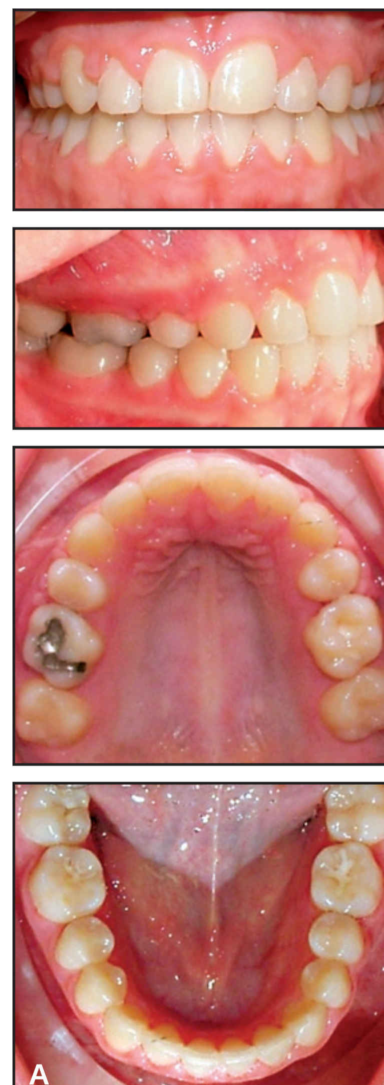
Clinical Example

A 14-year-old female presented with a Class II malocclusion, a blocked-out maxillary canine, a deviated maxillary midline, an acceptable overbite and overjet, and a good mandibular archform. After extraction of the maxillary first premolars, orthodontic treatment resulted in satisfactory Class II molar and Class I canine relationships (A). The planned retention regimen called for conventional Hawley retainers in both arches, worn full-time for three months and then only at night. When the patient was shown examples of the retainer, however, she objected, complaining that the metal bows were even more obtrusive than the fixed appliances that had just been removed (B).

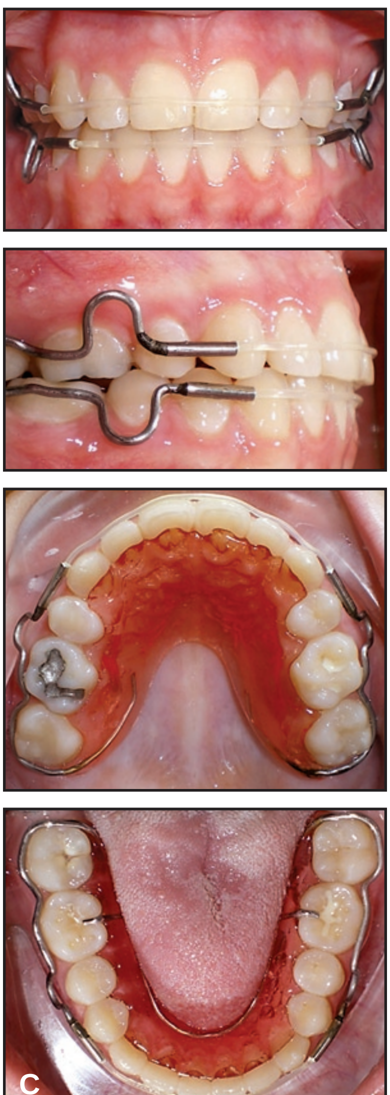
To address her concerns, we ordered Astics retainers for both arches. The patient was happy with their appearance. After a year of supervised retention, following the original plan, the plastic bows showed no discoloration or distortion (C), and the appliances retained their full functional integrity, preserving the stability of the treatment results (D).

Discussion

A disadvantage of using Astics retainers is that they must be fabricated and repaired by a manufacturer-approved laboratory, at a slightly higher cost than that of standard Hawley retainers. Moreover, unlike the metal bow of a Hawley retainer, the Astics plastic bow cannot be modified after fabrication to change the forces exerted on individual teeth, although the bow can be tightened using the metal vertical adjustment loops. In newer versions of the appliance, the adjustment loops are placed more distally than in previous versions, making them invisible in all patients except those with extremely large buccal segments, and even then only at the corners of the mouth in full smiling.



*Trademark of BioMers Products, Suite 459, 2314 Pine Ridge Road, Naples, FL 34109; www.biomersbraces.com.



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Retention of Thermoformed Aligners with Attachments of Various Shapes and Positions

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Removable clear aligners such as Invisalign,* Red, White and Blue,** and Simpli5** are increasingly being used for orthodontic tooth movement. Although each of these systems has been used successfully, a common problem is retention of the appliance on the teeth. Aligner retention can be affected by various factors, including tooth morphology and position, the degree of malocclusion, the aligner material, and wear on the appliance.

Various types of attachments have been developed to improve retention with these systems.[1,2] Custom-formed composite attachments, bonded to the teeth before placement of the aligner, can facilitate tooth movements such as intrusion and extrusion,[3] rotation, and torquing. This allows more patients to be treated with removable aligner systems, including those requiring extractions[4,5] or surgery.[6]

Our clinical experience has suggested that variations in attachment size, shape, and position can greatly influence aligner retention and efficacy. The present study was conducted to evaluate the retention provided by attachments of various shapes and positions through measurement of the aligners' resistance to vertical dislodgement.

Materials and Methods

Three different attachment shapes were evaluated in the study:
Group 1: Horizontal beveled attachments with the bevels directed occlusally.
Group 2: Horizontal beveled attachments with the bevels directed gingivally.
Group 3: Vertical rectangular attachments.

Each of these groups was divided into three subgroups according to the occlusogingival position of the attachment on the tooth:
Position A: 2mm from the gingival margin.
Position B: Centered.
Position C: 2mm from the occlusal surface.

The same maxillary typodont*** was used to create impressions with 10 different maxillary right first premolars, including one tooth without an attachment that served as a control. Using all possible combinations of attachment shapes and

*Registered trademark of Align Technology, Inc., 881 Martin Ave., Santa Clara, CA 95050; www.aligntech.com.

**Trademark of Allesee Orthodontic Appliances, P.O. Box 725, Sturtevant, WI 53177; www.aoalab.com.

***Part No. D85SDP-200, Kilgore International, Inc., 36 W. Pearl St., Coldwater, MI 49036; www.kilgoreinternational.com.

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Dr. Jones

Dr. Mah

Dr. O'Toole

TABLE 1
AVERAGE MAXIMUM DISPLACEMENT FORCE (NEWTONS ± S.D.)

	Position A	Position B	Position C	Control
				1.40 ± 0.59
Group 1	12.95 ± 6.84	12.00 ± 4.96	2.56 ± 0.94	
Group 2	9.60 ± 2.77	11.11 ± 3.60	4.10 ± 1.51	
Group 3	17.08 ± 6.90	13.66 ± 3.41	2.88 ± 1.17	

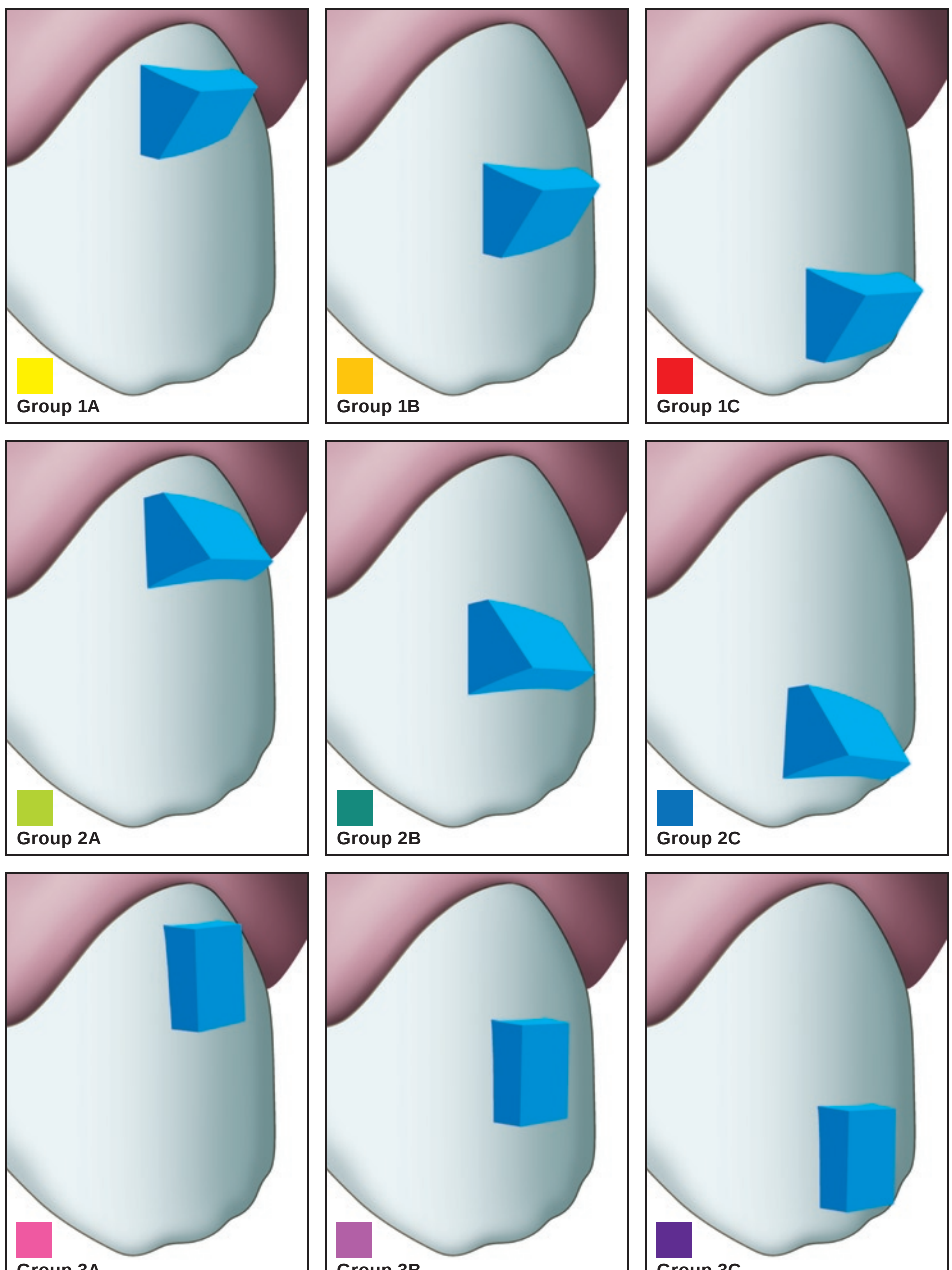

Fig. 1 Nine combinations of attachment design and position.

positions, the nine experimental teeth were set up as follows (Fig. 1):
Group 1A: Horizontal beveled attachment with the bevel directed occlusally, positioned 2mm from the gingival margin.
Group 1B: Horizontal beveled attachment with the bevel directed occlusally, centered occluso-gingivally.
Group 1C: Horizontal beveled attachment with the bevel directed occlusally, positioned 2mm from the occlusal surface.
Group 2A: Horizontal beveled attachment with the bevel directed gingivally, positioned 2mm from the gingival margin.
Group 2B: Horizontal beveled attachment with the bevel directed gingivally, centered occluso-gingivally.
Group 2C: Horizontal beveled attachment with the bevel directed gingivally, positioned 2mm from the occlusal surface.
Group 3A: Vertical rectangular attachment positioned 2mm from the gingival margin.
Group 3B: Vertical rectangular attachment centered occlusogingivally.

Fig. 2 Maxillary right first premolar and corresponding aligner secured to testing machine, and vertical force applied to dislodge aligner from tooth.

Group 3C: Vertical rectangular attachment positioned 2mm from the occlusal surface.

A polyvinyl siloxane impression was taken of the typodont with each of the 10 different maxillary right first premolars in place, and the 10 impressions were sent to a laboratory** for fabrication of the aligners. The laboratory used Excalibur stone† to create casts from the impressions and a Ministar‡ pressure-molding machine to mold Forestadent Track A††† aligner material to the stone casts. At least two Simpli5 aligners were made for each of the casts and trimmed to the gingival margin of the typodont.

The 10 sets of aligners were tested as follows: The maxillary right first premolar and the corresponding aligner were secured to a United testing machine‡‡ (Fig. 2). Vertical displacement forces were applied perpendicular to the occlusal plane at a rate of .04"/minute. Tensile forces were recorded on a continuous analog scale.

This procedure was repeated six times, for a total of seven displacements for each of the aligners, and the average maximum displacement force for each aligner group was calculated. Statistical analysis was performed to determine whether there were significant differences among the groups, with the level of significance set at $p < .05$.

Results

The greatest average maximum displacement force (Table 1) was recorded for Group 3A (vertical rectangular attachment positioned 2mm from the gingival margin), followed by Group 3B (vertical rectangular attachment centered occlusogingivally) and Group 1A (horizontal beveled attachment with bevel directed occlusally, positioned

**Allesee Orthodontic Appliances, P.O. Box 725, Sturtevant, WI 53177; www.aoalab.com.

†Garreco, Inc., P.O. Box 1258, Heber Springs, AR 72543; www.garreco.com.

‡Scheu Dental Technology, Am Burgberg 20, 58642 Iserlohn, Germany; www.scheu-dental.com.

†††Registered trademark of Forestadent, Westliche Karl-Friedrich-Str. 151, 75172 Pforzheim, Germany; www.forestadent.com.

‡‡United Calibration Corp., 5802 Engineer Drive, Huntington Beach, CA 92649; www.tensiletest.com.

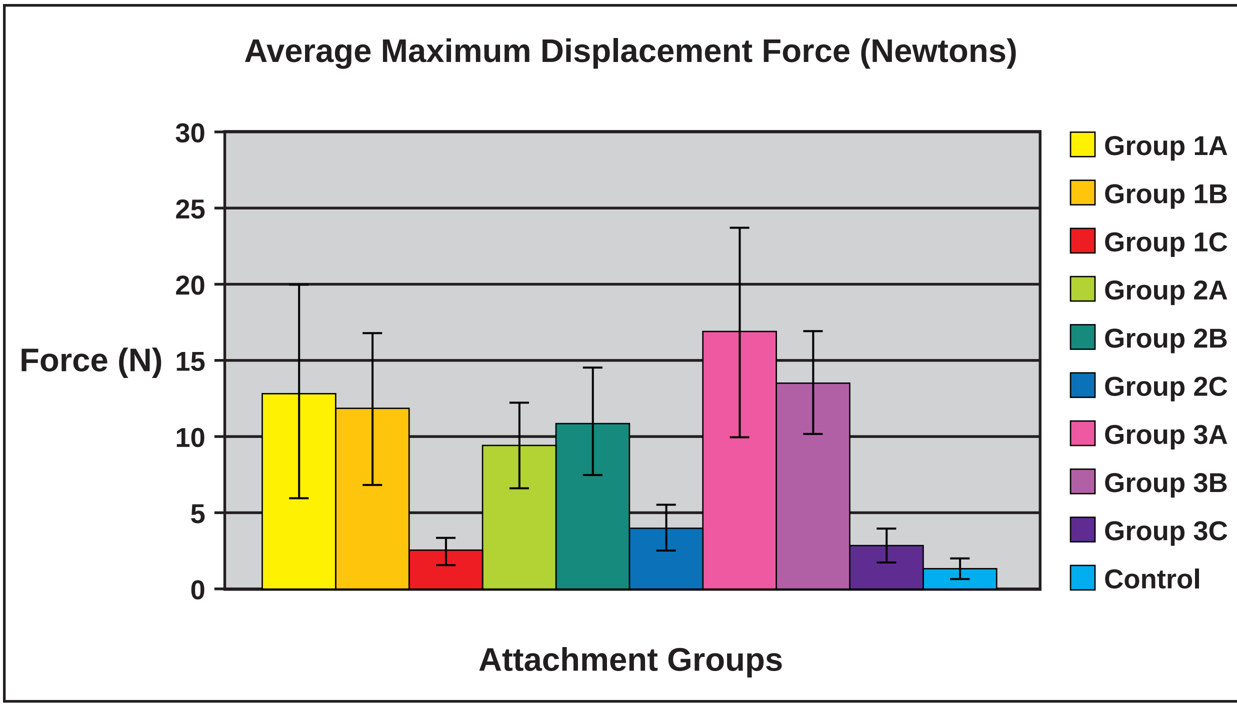

Fig. 3 Average maximum displacement force by attachment type.

2mm from the gingival margin).

Overall, the vertical rectangular attachment (Group 3) showed the greatest average maximum displacement force (Fig. 3), followed by the horizontal beveled attachment with the bevel directed occlusally (Group 1). For all attachment designs except the horizontal beveled attachment with the bevel directed gingivally, the most retentive position was 2mm from the gingival margin (Position A), followed by the centered position (Position B) and 2mm from the occlusal surface (Position C). These differences were all statistically significant ($p < .05$). For the horizontal beveled attachment with the bevel directed gingivally, the centered position (Position B) was most retentive, followed by 2mm from the gingival margin (Position A) and 2mm from the occlusal surface (Position C). All of the attachment types showed much greater resistance to displacement than the control group.

Discussion

Conventional wisdom has suggested that horizontal attachments positioned closer to the occlusal surfaces will be more retentive because the aligners are less flexible in this region.[2] As the thermoforming process drapes the material over the dental model and draws it over the sides, the material thins in the gingival regions, resulting in less stiffness in these areas. Our results suggest, however, that this phenomenon does not significantly affect appliance retention. In fact, aligner retention improved with more gingival placement of the attachments, probably due to the increased degree of undercut on the gingival aspect of the attachment as it follows the curvature of the tooth surface (Fig. 4).

Further clinical research is required to determine the acceptable range of force for various types of tooth movement with removable aligners, as well as to determine the best range of force values to optimize both appliance retention and ease of insertion and removal. If all the tested configurations turn out to be adequate for these purposes, other variables such as esthetics, ease of attachment

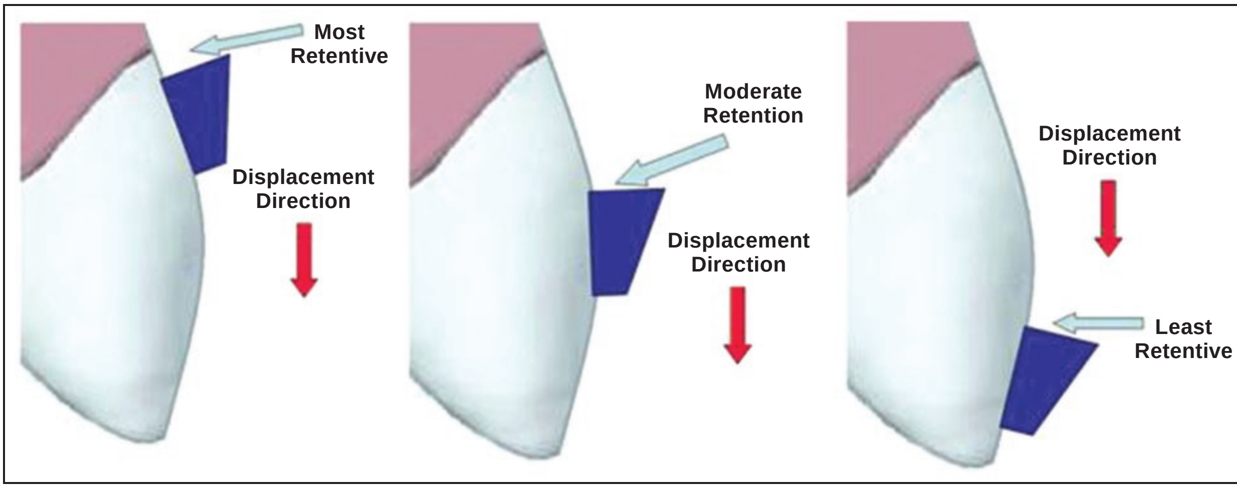

Fig. 4 Maximum retention provided by positioning attachments more gingivally.

placement, and accessibility for oral hygiene may become more important factors in attachment design and placement. In addition, clinical studies are needed to improve our understanding of retentive forces with respect to appliance efficacy, various types of tooth movement, and patient comfort during placement and removal. Durability of the attachments was not addressed in this study, but may have clinical significance, since aligners are inserted and removed frequently. In addition, other forces not measured, such as torsional forces, may be involved in aligner retention.

Conclusion

A thorough understanding of the retentive properties of various types of attachments is essential when planning tooth movement using removable aligners. For certain tooth movements such as extrusion, maximal retentive force is needed. According to the results of our study, this can be achieved by placing the attachment more gingivally, by choosing an attachment that does not have a gingivally directed bevel, or both. In cases where maximal retention is not needed, other types of attachments may be used to facilitate appliance removal.

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PEARLS

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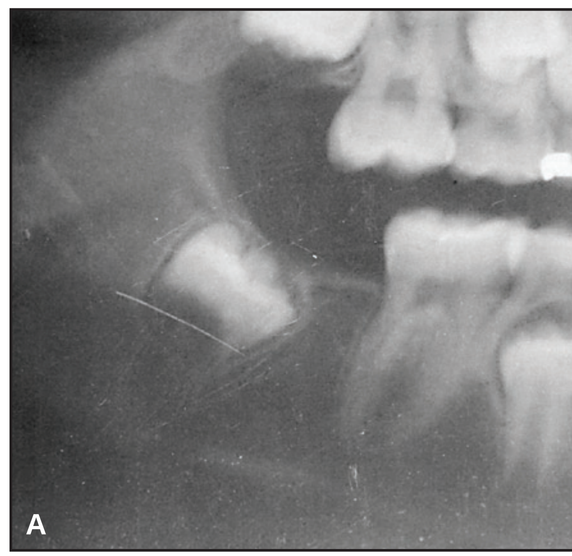
A Lesson Learned

An 11-year-old female presented for orthodontic treatment. The records were unremarkable save for one thing: the panoramic x-ray showed an extraordinarily wide span from the distal of the mandibular right first molar to the mesial of the mandibular right second molar (A). It wasn't until the mandibular left second molar had almost fully erupted about a year later, with no sign of the mandibular right second molar, that a red flag was raised.

A progress panorex then displayed what appeared to be an odontoma (B), which was confirmed by biopsy. The x-ray also showed that the mandibular right second molar had fully formed, but had drifted so far distally that it had begun erupting superiorly into the ascending ramus. The crown of the tooth was surrounded by what appeared to be a dentigerous cyst.

The surgeon determined that the best course of action was to remove the wayward second molar, the surrounding cyst, and the odontoma. All went well, and healing was rapid and uneventful.

My lesson learned: take progress films on all eruption aberrancies observed in the initial records, no matter how insignificant they may seem.



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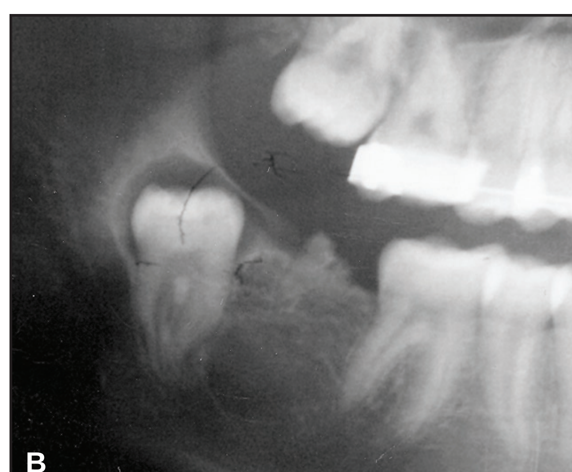

B

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