

A New Self-Ligating Lingual Bracket with Square Slots

GIUSEPPE SCUZZO, MD, DDS
 KYOTO TAKEMOTO, DDS, PHD
 YUI TAKEMOTO, DDS
 GIACOMO SCUZZO, DDS
 LUCA LOMBARDO, DDS

A major drawback of lingual orthodontics has always been the complexity of ligation. Since single ties cannot guarantee stable ligation, the double-over tie has become more prevalent, especially for Kurz-style brackets.¹ Small lingual brackets such as the STb* have narrow, shallow slots that make it extremely difficult to perform double-over ties while seating the archwire correctly. When horizontal slots are used, loose ligation has a negative impact on the clinician's ability to control rotation and torque.^{2,3} Torque control can also be affected by loss of contact between the wire and the bracket slot during anterior retraction.⁴ On the other hand, most brackets with vertical slots cannot effectively control tipping or tooth height when ligation is loose.

A further drawback of ligation techniques that require seating the archwire deep in the bracket slots, such as the double-over tie, is the friction generated between the wire and ligature.⁵ Passive self-ligating brackets minimize friction while producing light, continuous orthodontic forces that allow the teeth to move more smoothly.^{4,5} Chairtime is reduced, and any negative effects due to the ligation skill of the operator are eliminated.

Slot Dimensions

Until recently, orthodontic manufacturers have focused mainly on bracket design and wire characteristics, with little attention paid to slot dimensions.⁶ Our clinical experience has led us to conclude that the best lingual bracket slot is a passive, square .018" x .018". In this system, assum-

ing that the wire and slot are not rounded at the edges or distorted in any way, both 3rd-order and 2nd-order bracket-slot play will be horizontally

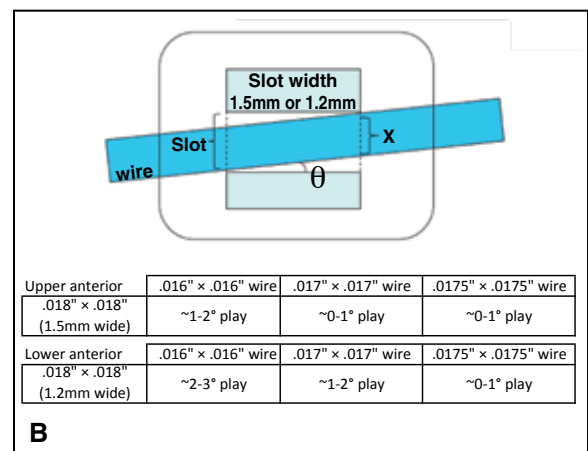
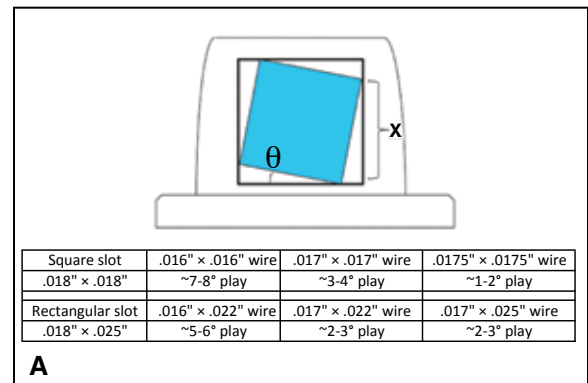


Fig. 1 A. 3rd-order play between square and rectangular slots and different sizes of archwires. **B.** 2nd-order play between STb SL Square Slot lingual brackets* with .018" x .018" square slots and different sizes of archwires.

*Trademark of Ormco Corporation, Orange, CA; www.ormco.com.



Dr. Giuseppe Scuzzo



Dr. K. Takemoto



Dr. Y. Takemoto



Dr. Giacomo Scuzzo



Dr. Lombardo

Drs. Giuseppe Scuzzo and Kyoto Takemoto are Adjunct Professors, Department of Orthodontics, University of Ferrara, Ferrara, Italy, and are in the private practice of orthodontics in Rome, Italy, and Tokyo, Japan, respectively. They are developers of the STb and STb SL Square Slot lingual bracket systems. Dr. Yui Takemoto is a post-graduate resident, Department of Orthodontics, University of Ferrara, and Dr. Giacomo Scuzzo is a graduate student, School of Dentistry, European University of Madrid, Madrid, Spain. Dr. Lombardo is an Adjunct Professor, Department of Orthodontics, University of Ferrara, and is in the private practice of orthodontics at Contrada Nicolizia, 92100 Licata, AG, Italy; e-mail: lulombardo@tiscali.it.

and vertically equal (Fig. 1). That makes a square slot more effective than a rectangular slot in correcting rotations, whether a round or square wire is used (Fig. 2). The square slot avoids the problems in three-dimensional control experienced with both vertical and horizontal rectangular slots. Furthermore, when a vertical square-slot bracket is combined with a sliding door for self-ligation, the archwire is prevented from disengaging during retraction, resulting in minimal loss of torque and better control.

Labial self-ligating brackets are typically .018" x .025" or .022" x .028" (or .022" x .027"). Since excessive horizontal play makes it difficult to rotate teeth with these slot sizes and thin round archwires, wider slots and thicker wires have been proposed.⁷ In lingual orthodontics, of course, increasing the slot width mesiodistally is not a viable solution because of the short interbracket distances, especially in the mandibular anterior region.⁸ Based on our experience, the optimum lingual slot width appears to be 1.5mm in the maxilla and 1.2mm in the mandible; further narrowing of the mandibular slot would adversely

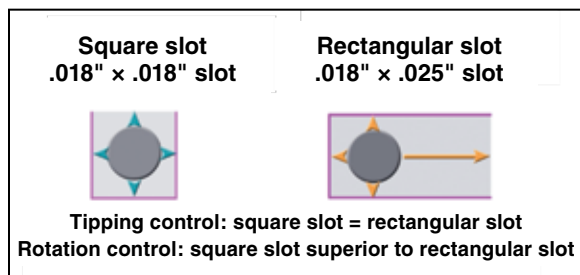


Fig. 2 Rotation control with a round or square wire is more effective with a square slot.

affect control of rotation and tipping (Fig. 3). Assuming the lingual straightwire method is employed,^{9,10} with a gingival offset, the bracket can be as thin as 1.7mm.

Straight-Wire Bracket Design

We have developed a new self-ligating bracket, the STb SL Square Slot,* with these slot dimensions for use with the passive lingual straightwire technique. Gingival offset allows the brackets to be positioned closer to the lingual surfaces of the teeth and a thinner coat of base resin to be used. Bonding more closely to the gingival margin minimizes premature occlusal contacts between the maxillary anterior brackets and mandibular anterior teeth. The brackets have vertical slots and limit the choice of wire cross-section to round or square, thus facilitating archwire insertion.

*Trademark of Ormco Corporation, Orange, CA; www.ormco.com. Available in the United States and Europe in mid-2012.

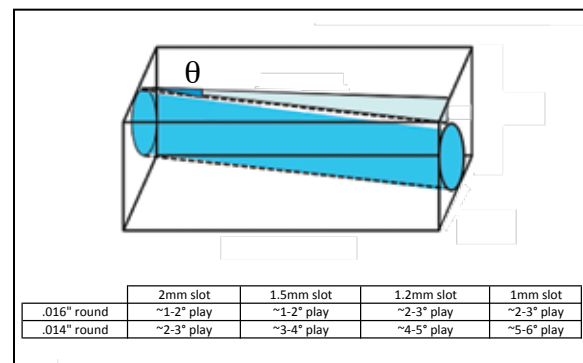


Fig. 3 1st-order play between round wires and slots with different widths.

TABLE 1
CASE 1 CEPHALOMETRIC DATA

	Pretreatment	Post-Treatment
SNA	81.6°	83.3°
SNB	74.9°	76.1°
ANB	6.7°	7.1°
A-Na⊥	4.0mm	-0.4mm
Pg-Na⊥	-3.4mm	-14.1mm
Wits appraisal	2.7mm	4.5mm
FMA	28.3°	32.2°
MP-SN	40.3°	38.6°
Palatal-Md angle	32.4°	29.9°
Palatal-Occlusal Plane	13.9°	11.1°
Md Plane-Occlusal Plane	18.4°	18.8°
U1-APo	6.5mm	5.5mm
L1-APo	2.2mm	0.2mm
U1-Palatal plane	108.2°	103.8°
U1-Occlusal plane	57.9°	65.1°
L1-Occlusal plane	64.3°	70.0°
IMPA	97.2°	91.2°



Fig. 4 STb SL Square Slot lingual brackets for incisors (A), premolars (B), and molars (C).

On the incisor and canine brackets, the sliding doors open to the gingival for passive self-ligation (Fig. 4A). Torque is set at 60° in the maxillary arch and 45° in the mandibular arch. The upper and lower canine brackets have 8° of distal tipping and distal offsets of 5° so that the thickness at the distal end is greater than at the mesial, obviating the need for additional wire bends between the canines and premolars.

Because the clinical crowns of the premolars and molars are shorter, an easy-closing hinge cap is used instead of a sliding door for the posterior brackets. Premolar brackets have a slot width of 1.5mm, and torque prescriptions range from 0° to 11° (Fig. 4B). Maxillary molar brackets feature 10° of torque, a distal offset of 3°, and a slot width of 3.5mm; mandibular molar brackets have 0° of torque and a slot width of 4mm (Fig. 4C).

Case 1

A 30-year-old male presented complaining of an unesthetic dental appearance (Fig. 5, Table 1). Extraoral analysis showed a slightly retrognathic mandibular profile with no asymmetry. Intra-

oral examination revealed severe crowding in the maxillary and mandibular arches and a lack of space for the upper left canine. The molar relationship was Class I on the right side, while Class II molar and canine relationships were present on the left.

The treatment plan was to resolve the Class II molar relationship and derotate the upper right first molar using the M-Pendulum appliance¹ (Fig. 6A). Five months after appliance placement, when

bilateral Class I molar relationships had been achieved (Fig. 6B), STb SL Square Slot lingual brackets were placed using a manual setup and indirect bonding (Fig. 7). The archwire sequence used in both arches was .013" Copper Ni-Ti** for alignment, .016" TMA** for leveling, and .0175" ×

**Registered trademark of Ormco Corporation, Orange, CA; www.ormco.com.

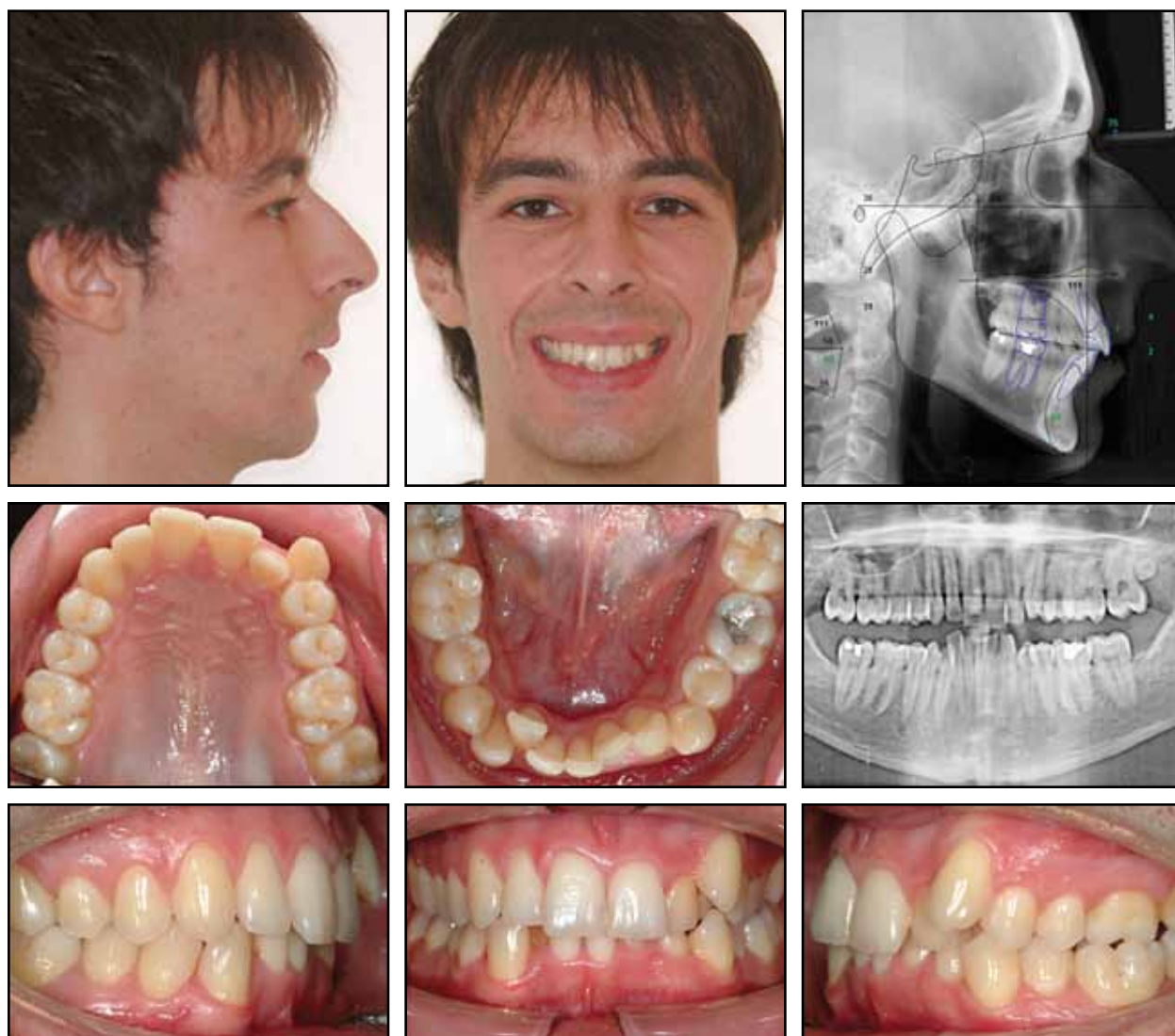


Fig. 5 Case 1. 30-year-old male patient with Class II molar relationship and blocked-out maxillary canine on left side before treatment.

A New Self-Ligating Lingual Bracket with Square Slots

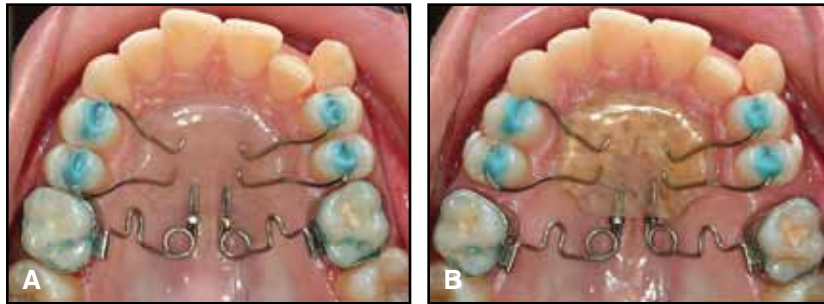


Fig. 6 Case 1. Upper molar distalization using M-Pendulum appliance. A. Immediately after appliance placement. B. After five months of distalization.



Fig. 7 Case 1. Manual setup for indirect bonding of STb SL Square Slot lingual brackets.

.0175" TMA for torque control and detailing (Fig. 8).

After 22 months of active treatment, the patient displayed a Class I molar relationship on both sides, with ideal overbite and overjet (Fig. 9, Table 1). Essix*** retainers were prescribed for both arches. One month after appliance removal, gingival recession at the upper left canine required a soft-tissue graft for root coverage and restoration of gingival morphology. Improvement in the gingival architecture was seen at a follow-up appointment three months later (Fig. 10).

***Registered trademark of Dentsply Raintree Essix, Sarasota, FL; www.essix.com.

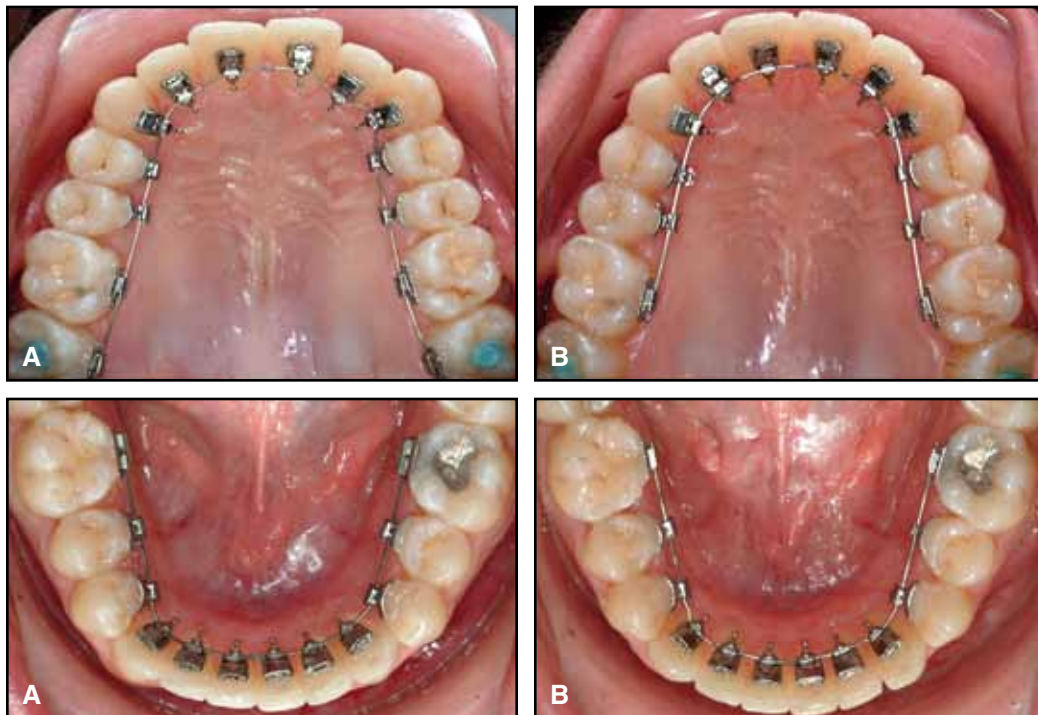


Fig. 8 Case 1. A. After 14 months of treatment. B. After 18 months of treatment.

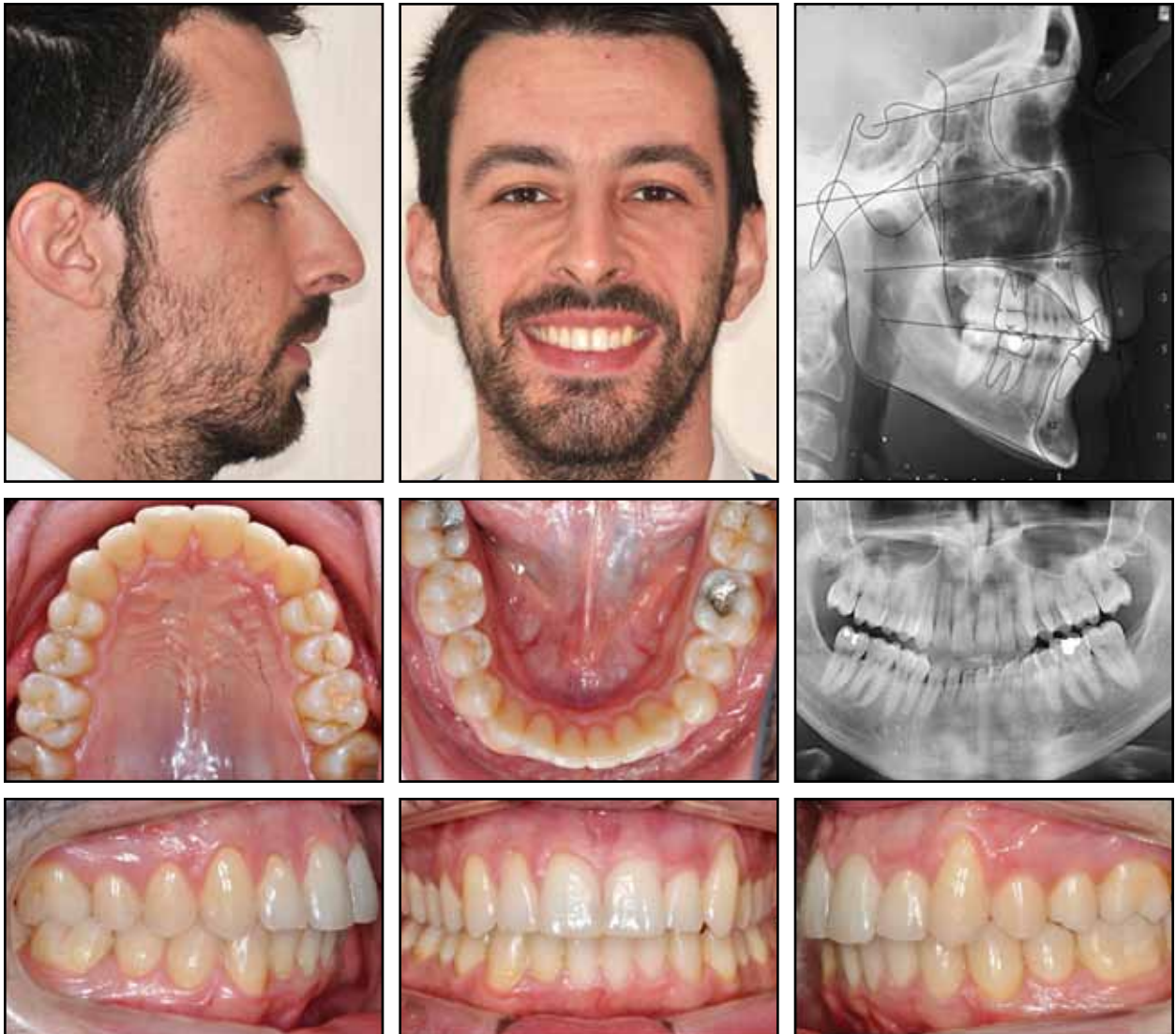


Fig. 9 Case 1. Following appliance removal, after 22 months of treatment.



Fig. 10 Case 1. Patient four months after end of treatment and three months after soft-tissue graft.

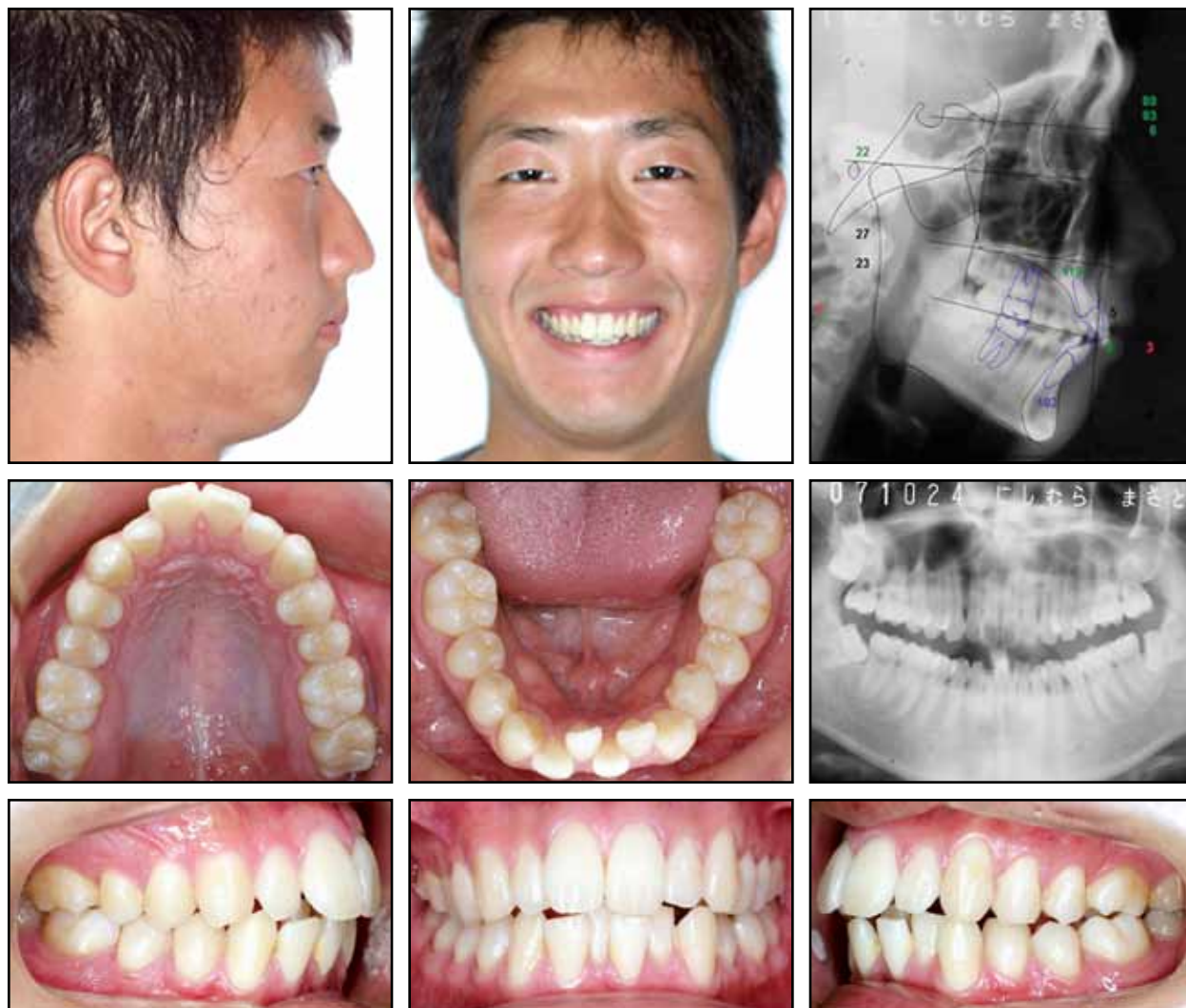


Fig. 11 Case 2. 20-year-old male patient with dental Class II occlusion and anterior open bite before treatment.



Fig. 12 Case 2. Manual setup for indirect bonding of lingual brackets.

TABLE 2
CASE 2 CEPHALOMETRIC DATA

	Pretreatment	Post-Treatment
SNA	85.8°	75.3°
SNB	80.0°	74.0°
ANB	5.8°	1.3°
A-Na⊥	-0.3mm	-8.3mm
Pg-Na⊥	-10.8mm	-16.1mm
Wits appraisal	2.9mm	-1.7mm
FMA	26.2°	28.0°
MP-SN	30.1°	33.5°
Palatal-Md angle	22.4°	22.5°
Palatal-Occlusal Plane	7.3°	9.6°
Md Plane-Occlusal Plane	15.2°	12.9°
U1-APo	6.7mm	7.3mm
L1-APo	4.6mm	5.5mm
U1-Palatal plane	117.5°	108.6mm
U1-Occlusal plane	55.2°	61.8°
L1-Occlusal plane	59.4°	61.1°
IMPA	105.4°	106.1°

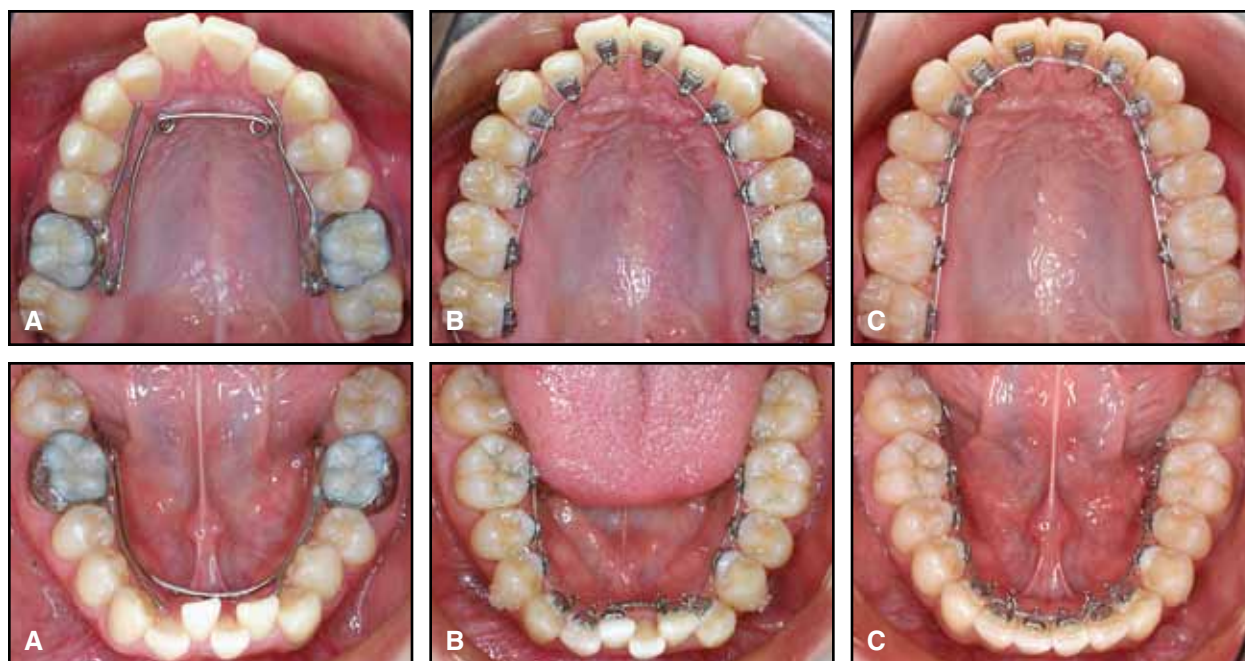


Fig. 13 Case 2. A. Quad-Helix placed in upper arch and Bi-Helix in lower arch. B. Six months later, expanders removed and STb SL Square Slot lingual brackets bonded in both arches. C. After 12 months of treatment.

Case 2

A 20-year-old male presented with the chief complaint of dental crowding (Fig. 11, Table 2). Clinical examination showed a bilateral skeletal Class I relationship, a dental Class II occlusion, and an anterior open bite. The third molars were extracted prior to treatment.

A setup model was fabricated manually for indirect bonding (Fig. 12). To expand the arches, a Quad-Helix† appliance was placed in the maxilla and a Bi-Helix in the mandible (Fig. 13A). Six months later, STb SL Square Slot lingual brackets were bonded (Fig. 13B). The archwire sequence

†Rocky Mountain Orthodontics, Denver, CO; www.rmortho.com.

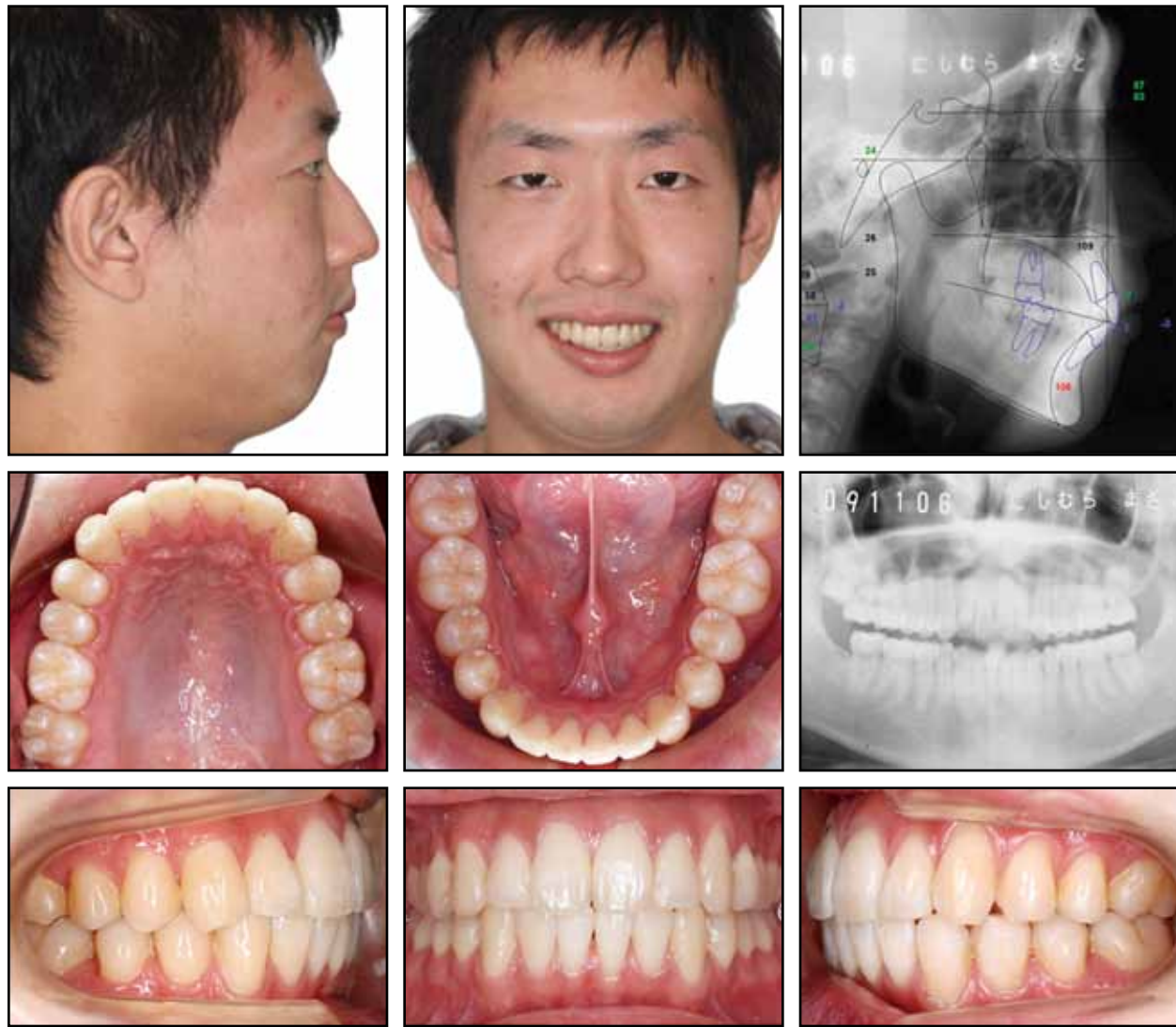


Fig. 14 Case 2. Patient after 14 months of treatment.

in both arches was .013" Copper Ni-Ti for alignment, .016" TMA for leveling, and .0175" x .0175" TMA for torque control and detailing (Fig. 13C).

After 14 months of active treatment, the Class II malocclusion and crowding had been resolved, and the appliances were removed (Fig. 14, Table 2). Essix retainers were then delivered for both arches.

REFERENCES

1. Alexander, C.M.; Alexander, R.G.; Gorman, J.C.; Hilgers, J.J.; Kurz, C.; Scholz, R.P.; Smith, J.R.; and Swartz, M.L.: Lingual orthodontics: A status report, Part 5: Lingual mechanotherapy, *J. Clin. Orthod.* 17:99-115, 1983.
2. Scuzzo, G. and Takemoto, K.: *Invisible Orthodontics: Current Concepts & Solutions in Lingual Orthodontics*, Quintessence,

Chicago, 2003.

3. Siciliani, G. and Terranova, S.: *Ortodonzia Linguale*, Elsevier Masson, Milan, 2001.
4. Geron, S.: Self-ligating brackets in lingual orthodontics, *Semin. Orthod.* 14:64-72, 2008.
5. Harradine, N.W.T.: Self-ligating brackets: Where are we now? *J. Orthod.* 30:262-273, 2003.
6. Rinchuse, D.J.; Rinchuse, D.J.; and Kapur-Wadhwa, R.: Orthodontic appliance design, *Am. J. Orthod.* 131:76-82, 2007.
7. Rinchuse, D.J. and Miles, P.G.: Self-ligating brackets: Present and future, *Am. J. Orthod.* 132:216-222, 2007.
8. Moran, K.I.: Relative wire stiffness due to lingual versus labial interbracket distance, *Am. J. Orthod.* 92:24-32, 1987.
9. Takemoto, K. and Scuzzo, G.: The straight-wire concept in lingual orthodontics, *J. Clin. Orthod.* 35:46-52, 2001.
10. Takemoto, K.; Scuzzo, G.; Lombardo, L.; and Takemoto, Y.: La technique linguale straight wire, *Int. Orthod.* 8:1-19, 2009.
11. Echarri, P.; Scuzzo, G.; and Cirulli, N.: A modified Pendulum appliance for anterior anchorage control, *J. Clin. Orthod.* 37:352-359, 2003.