Lingual Straightwire Treatment with the Orapix System

DIDIER FILLION, DDS

Because of the necessity to incorporate numerous in-out bends to compensate for differences in tooth thickness, Fujita described his original lingual concept in 1979 as the "mushroom archwire".[1] To reduce the number of bends, mainly in the anterior area, several laboratory techniques—including the CLASS,*[2] BEST,[3] and Hiro[4] systems—have positioned the incisor brackets at the same distance from the labial surfaces as the canine brackets. The result is a shorter interbracket distance, which makes it more difficult to exert three-dimensional control of the incisors. Moreover, the in-out bends between the canines and premolars are still required.

Scuzzo and Takemoto demonstrated that lingual straight wires can be used if the brackets are repositioned gingivally, since the difference in thickness of the canines and premolars decreases with the bonding height, but their method requires a physical model setup.[5,6] We have developed an alternative straightwire technique, using the Orapix digital system** to fabricate lingual appliances from a virtual setup.[7,8]

Building the Setup

Models are shipped to the Orapix center, where they are scanned with the proprietary Orapix three-dimensional scanner. Each virtual arch is then segmented into individual dental units (Fig. 1). After the treatment plan is determined based on the doctor's prescription, a labial curve is selected from among standardized curves and superimposed on the occlusal view of the patient's mandibular arch. The standardized curve can be customized according to the treatment objectives. A curve with a similar form is selected for the maxillary arch, and the two curves are positioned by the software in relation to the desired occlusion (Fig. 2).

The selected orientation prescription, which includes inclination, angulation, and height, determines the position of each tooth in the virtual setup. A variety of prescriptions can be prepared for different treatment plans and saved in the program.

The teeth are first placed automatically in relation to the labial curves and oriented according to the selected prescription, then adjusted to fit the desired final treatment result. A collision test is

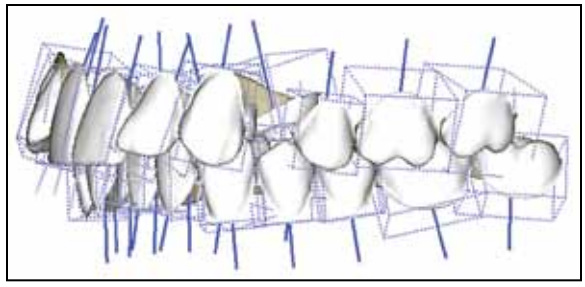

Fig. 1 Segmentation of virtual arch.

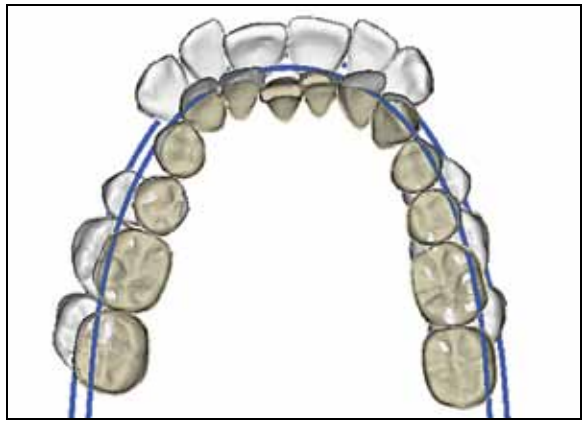

Fig. 2 Mandibular labial curve selected from standardized set; similar maxillary and mandibular labial curves positioned on patient's dentition.

*Specialty Appliances, Cumming, GA; www.specialtyappliances.com.

**Orapix Co., Ltd., Seoul, Korea; www.orapix.com

Dr. Fillion is Director, Lingual Post-Graduate Course, Paris V University, Paris, France; an Adjunct Clinical Professor, New York University, New York, NY; a Visiting Professor, Ferrara University, Italy; and in the private practice of lingual orthodontics at 22 rue Cortambert, 75116 Paris, France; e-mail: smile@drfillion.com. He contributed to the development of the Orapix system for lingual orthodontics.

performed to adjust the contact points according to anatomical, abrasive, and prosthetic considerations. The teeth can be reoriented in three dimensions with simple mouse clicks (Fig. 3A). After the contact points are adjusted (Figs. 3B,C), the virtual setup is finalized (Fig. 4).

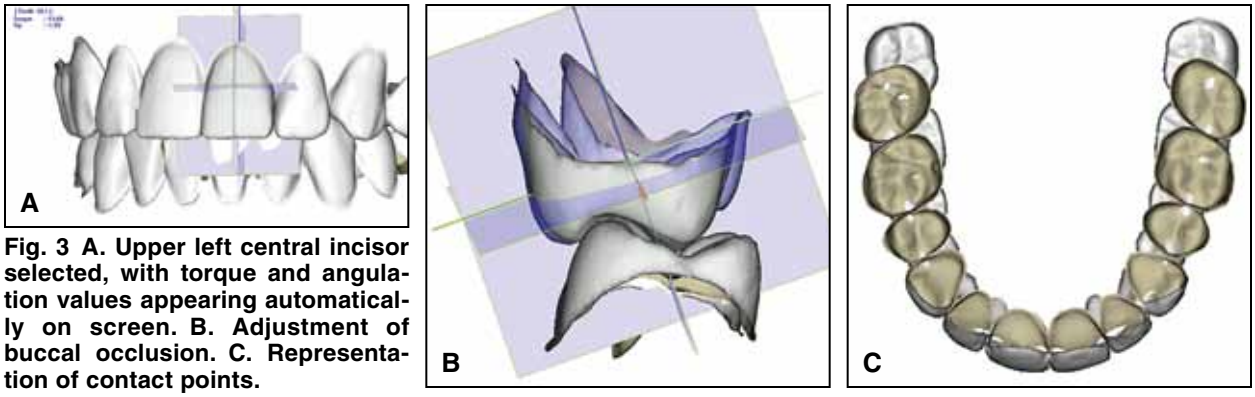

Fig. 3 A. Upper left central incisor selected, with torque and angulation values appearing automatically on screen. B. Adjustment of buccal occlusion. C. Representation of contact points.

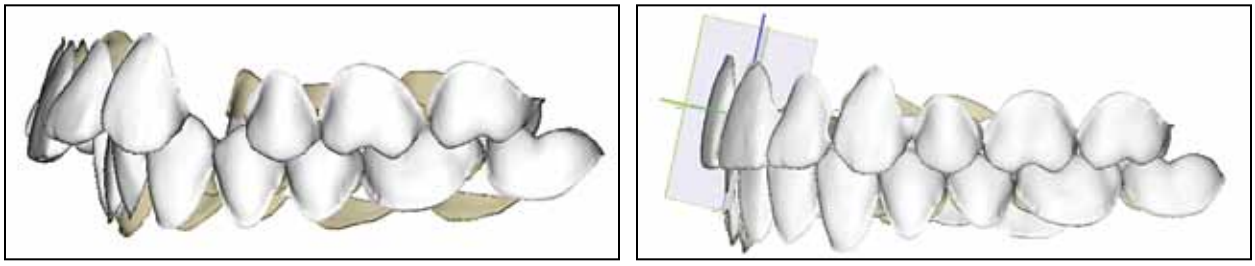

Fig. 4 Initial malocclusion and ideal virtual setup.

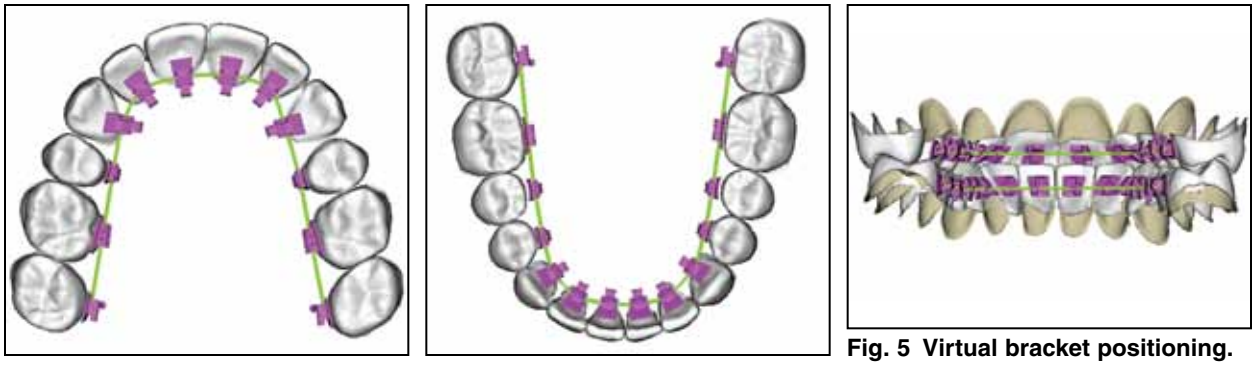

Fig. 5 Virtual bracket positioning.

Virtual Bracket Positioning

Virtual brackets are selected from the software library and initially placed by the software on a plane parallel to the occlusal plane. Bracket positioning with the Orapix system has two objectives: to place the brackets as close as possible to the enamel, and to permit the use of straight wires.

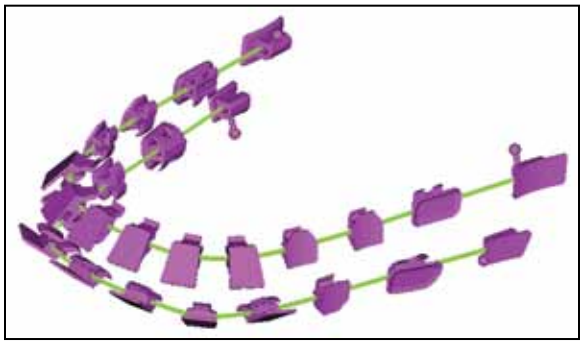

Fig. 6 Virtual lingual straight wires passing through centers of bracket slots.

The virtual brackets are first moved vertically to the ideal slot heights, which are .5-1mm more gingival than in the mushroom archwire technique. Next, the central incisor brackets are moved horizontally toward the lingual surfaces until contact occurs. To eliminate the bends between canines and premolars, the upper canine brackets must be rotated 10-15° and placed at a slight distance from the virtual tooth surfaces (mean = .6mm, Fig. 5).

Archwire Design

Once bracket positioning is complete, the software shows the virtual straight wire passing through the center of each slot (Fig. 6). Because the upper incisor brackets are closer to the lingual surfaces, the anterior part of the maxillary straight wire is flatter than that of the mandibular wire.

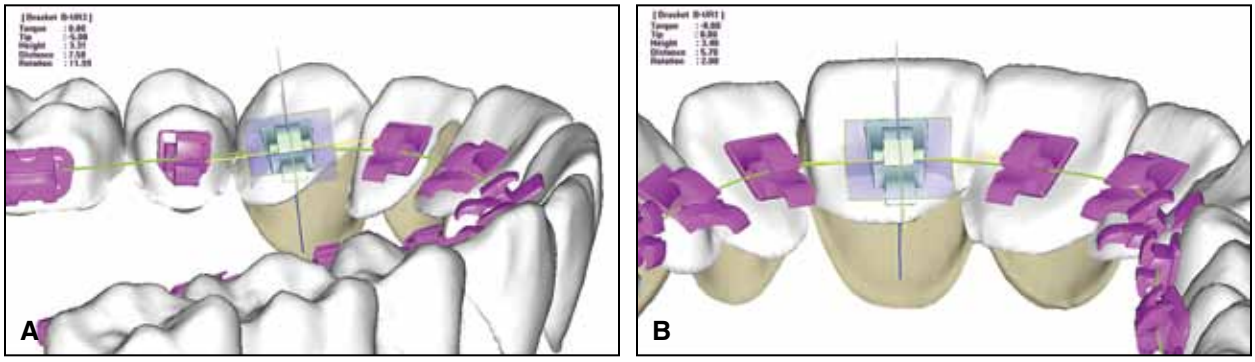

Fig. 7 A. Overcorrection of angulation for first-premolar extraction case. B. Extra torque added to prescription by changing inclination of bracket slot.

Fig. 8 A. Two-part bonding jig connecting bracket and tooth. B. Jig used to position bracket on plaster cast. C. KommonBase system for indirect bonding, with resin pads extended over lingual surfaces of anterior teeth.

In other systems, overcorrections are made by modifying the positions of the teeth on the wax setup. With the Orapix system, overcorrections are incorporated into the virtual setup by adjusting the virtual bracket positions for angulation (Fig. 7A), inclination (Fig. 7B), height, and rotation.

Indirect Bonding Procedure

After the orthodontist has approved the final setup and bracket positions, transfer jigs are created on-screen, then fabricated in acrylic using CAD/CAM technology. One piece of the jig adapts to the buccal and occlusal aspects of the tooth, and the second piece, fitting perfectly into the bracket slot, slides along the tooth piece to place the bracket precisely on the lingual surface (Fig. 8A).

The physical brackets are bonded to the plaster cast with the jigs, filling the gaps between the bracket bases and the lingual surfaces with composite resin. After polymerization (Fig. 8B), the two parts of each jig are removed. Using the KommonBase system developed by Komori,[9] the customized resin pads are enlarged to extend over most of the lingual surfaces of the incisors and canines and toward the occlusal surfaces of the premolars and molars (Fig. 8C). To avoid gingival contact, the resin should not be extended toward the gingivae.

The brackets can be bonded all at once using a silicone transfer tray, or individually by adding temporary flowable-composite positioning extensions to the labial and occlusal surfaces of each bracket's resin pad for accurate and stable positioning. After bonding, these composite extensions are cut away with a carbide bur. The original plaster casts are returned to the doctor so that any debonded brackets can be rebonded with the jigs and the resin-extension technique.

We have seen an extremely low failure rate using the KommonBase bonding technique and resin-reinforced glass-ionomer cement. The large resin pad fits the tooth anatomy precisely and provides a substantial surface area that significantly increases bond strength.

The following premolar-extraction cases were treated with the Orapix system.

Case 1

A 28-year-old female presented with a crossbite of the upper right canine and a 3mm midline discrepancy (Fig. 9, Table 1). Both upper first premolars had been removed during previous orthodontic treatment, which had not been finished, leaving interdental spacing in the upper arch. A Class III canine relationship was noted on the left side. The profile was harmonious, except for a slightly protrusive lower lip.

A treatment plan involving extraction of the lower second premolars was chosen to limit retrusive movement of the lower incisors. On the virtual setup, the lower incisors were placed with an inclination of 0° to the occlusal plane (Fig. 10).

First-generation STb*** brackets were bonded in the upper arch, then two months later in the lower arch (Fig. 11). Occlusal build-ups were cemented to the upper first molars for crossbite correction. The lower second premolars were extracted after bracket placement.

The archwire sequence was as follows:

- .012" and .016" nickel titanium for leveling and alignment
- .0175" × .0175" TMA*** for torque control
- Lower combination wire (.018" × .025" in the anterior, .018" round in the buccal segments) with sliding mechanics for space closure (Fig. 12)
- .0175" × .0175" TMA for detailing

After 22 months of active treatment, the final occlusion was close to the ideal setup, with the upper right canine and lower incisors properly inclined (Fig. 13).

Case 2

A 22-year-old female presented with the chief complaint of severe protrusion in both arches (Fig. 14, Table 2). The dental arches were aligned, and Class I molar and canine relationships were observed.

The treatment plan was to extract the maxillary and mandibular first premolars and to use palatal miniscrews (Absoanchor†) for maximum

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

†Dentos, Daegu, Korea; www.dentos.co.kr.

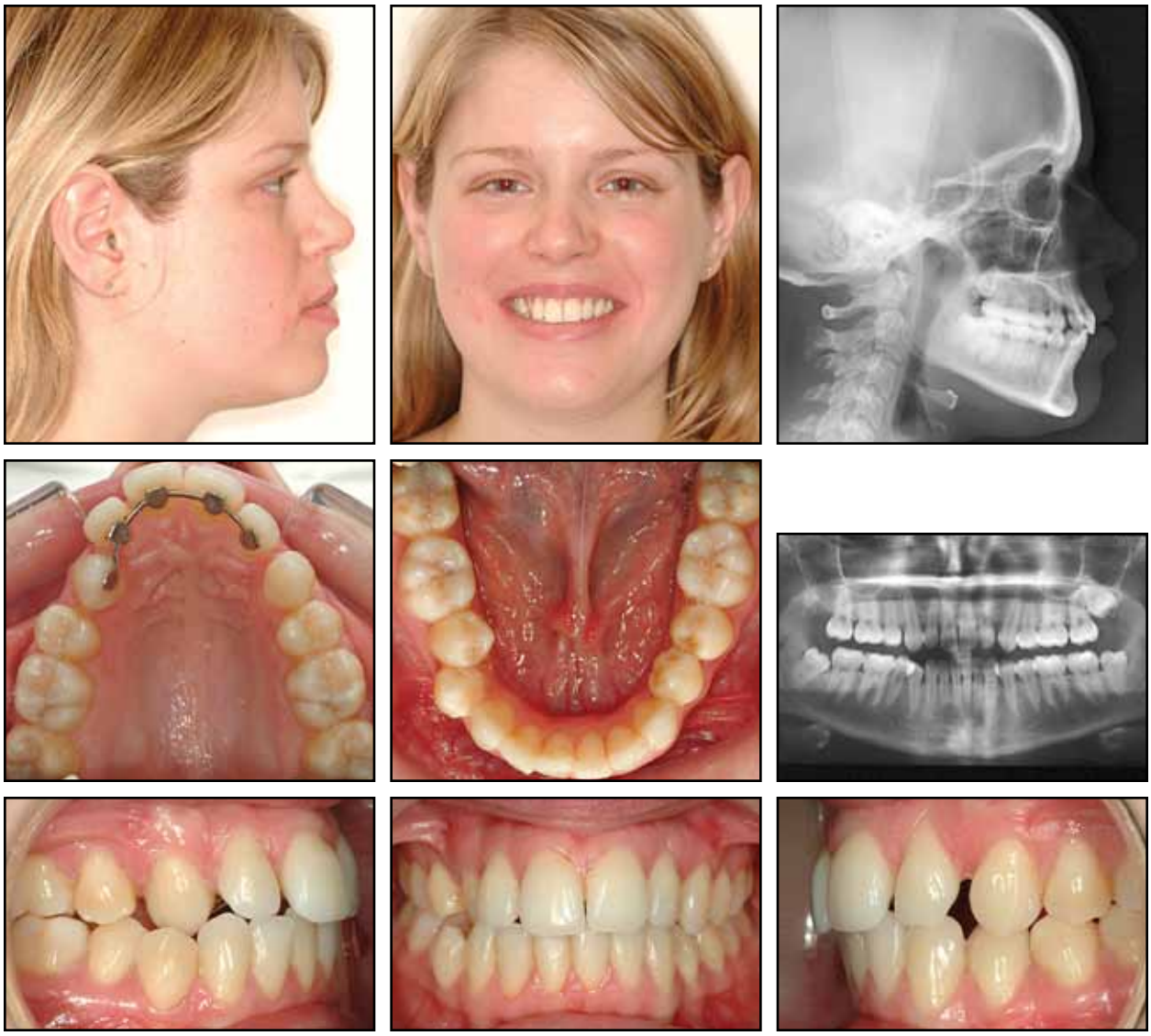

Fig. 9 Case 1. 28-year-old female patient with upper right canine in crossbite, upper-arch spacing, and Class III canine relationship on left side before treatment.

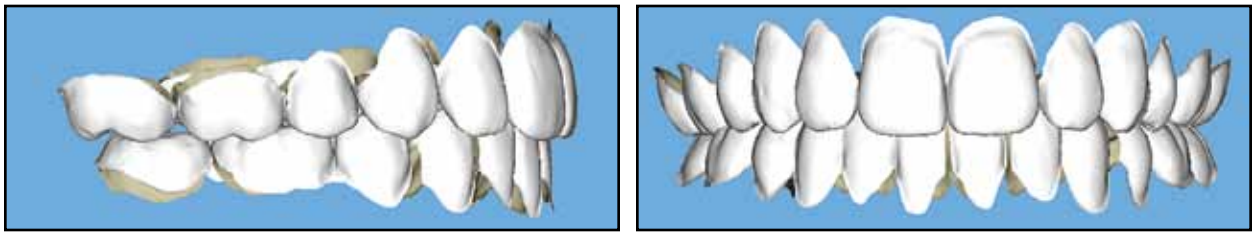

Fig. 10 Case 1. Virtual treatment setup involving lower incisor positioning with 0° of torque.

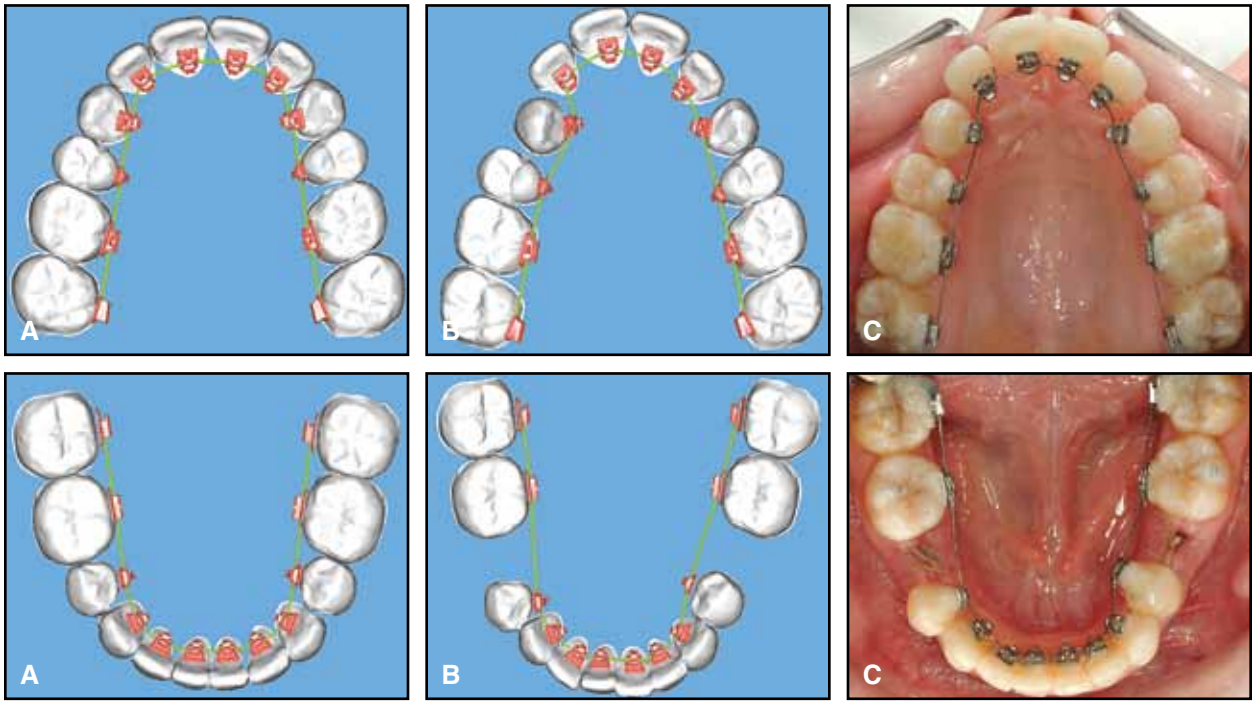

Fig. 11 Case 1. Virtual bracket placement on ideal setup (A) and initial setup (B). C. Initial lingual brackets with .012" nickel titanium archwires.

Fig. 12 Case 1. Combination wire (.018" × .025" in anterior segment, .018" round in buccal segments) used for retraction of lower arch.

TABLE 1
CASE 1 CEPHALOMETRIC DATA

	Pretreatment	Post-Treatment
FMIA	67°	69°
FMA	23°	24°
IMPA	91°	88°
SNA	81°	82°
SNB	79°	78°
ANB	2°	4°
SN-GoGn	35°	34°

anchorage in the maxillary posterior segments. On the virtual setup, the upper central incisors were placed with an inclination of 8° and the lower central incisors with an inclination of 0° (Fig. 15).

First-generation STb brackets were bonded first in the upper arch and eight weeks later in the lower arch (Fig. 16). The four first premolars were extracted after bracket placement.

The archwire sequence was as follows:

- .012" nickel titanium
- .016" × .016" nickel titanium in the upper arch
- .0175" × .0175" TMA for torque control
- Upper and lower .018" × .025"/.018" combination wires with sliding mechanics for retraction (Fig. 17)
- .0175" × .0175" wires for detailing

After 20 months of active treatment, the patient's occlusion and incisor inclination were similar to the virtual setup, and the profile was greatly improved (Fig. 18).

Discussion

The Orapix system places the virtual brackets in specific positions chosen by the user, then precisely reproduces these bracket positions in the clinic. This has allowed the development of a lingual straightwire technique that eliminates the disadvantages of mushroom archwires while reducing the thickness of the incisor resin pads.

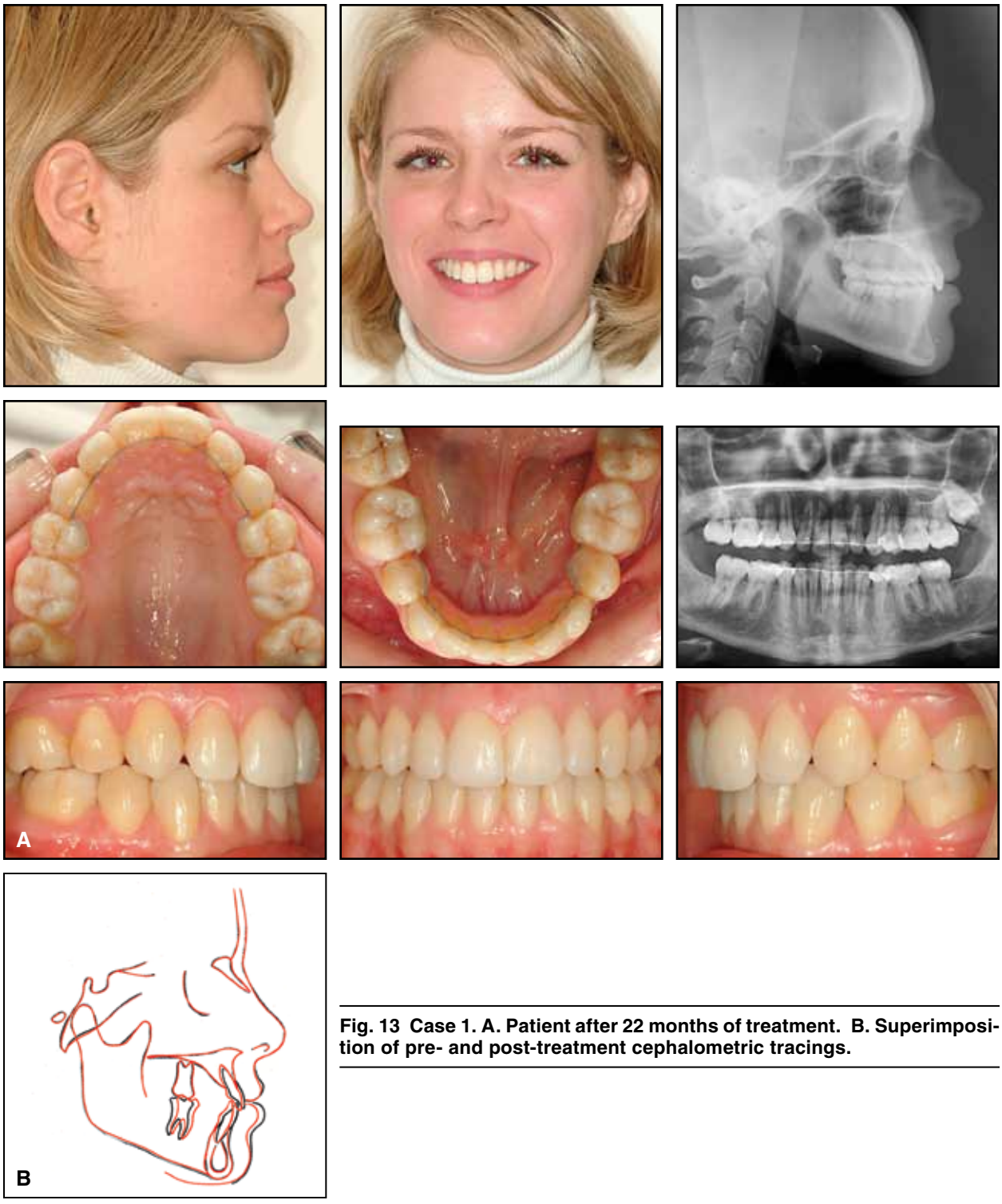

Fig. 13 Case 1. A. Patient after 22 months of treatment. B. Superimposition of pre- and post-treatment cephalometric tracings.

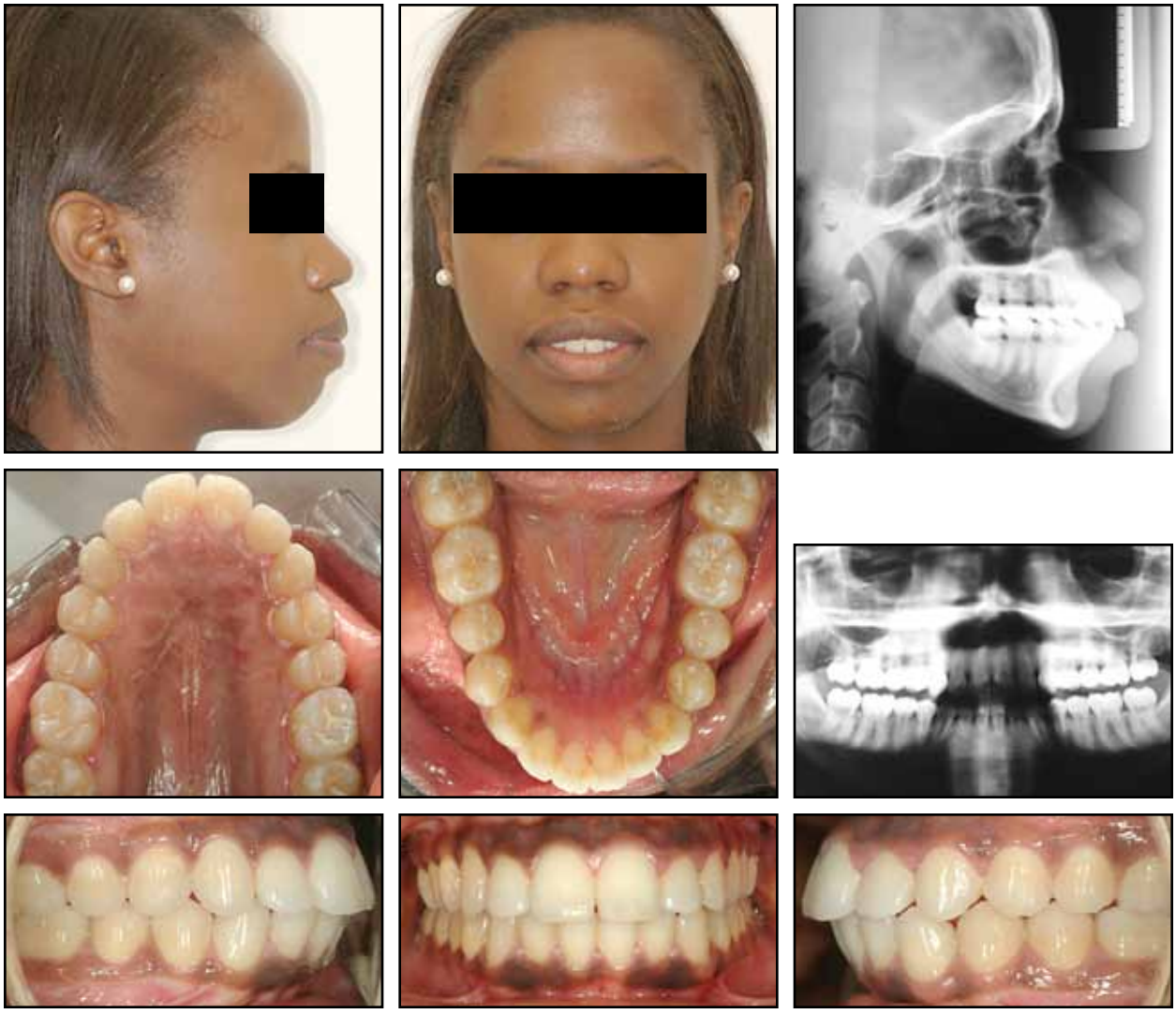

Fig. 14 Case 2. 22-year-old female patient with severe bimaxillary protrusion before treatment.

Fig. 15 Case 2. Virtual treatment setup involving upper incisor positioning with 8° of torque.

Other advantages are as follows:

- Visualizing the final result helps doctors and patients choose among possible treatment plans. Because overcorrections are accommodated in the bracket placement instead of the setup model, the patient can be shown a more realistic treatment prediction.
- The Orapix system enables every clinician to act as laboratory technician by modifying tooth and bracket placements with in-office software before fabricating the bonding jigs.
- Bracket positioning is fully customizable according to the patient's tooth anatomy and soft-tissue requirements, the treatment plan, and the selected

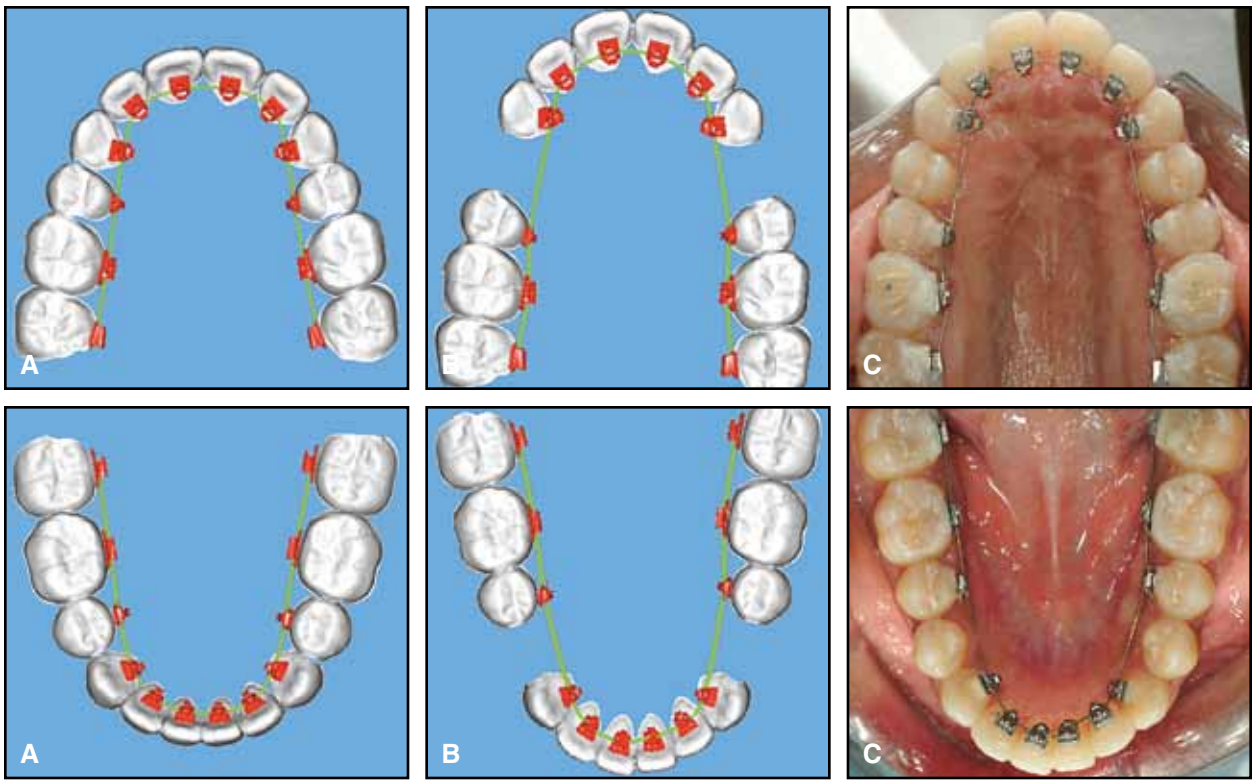

Fig. 16 Case 2. Virtual bracket placement on ideal setup (A) and initial setup (B). C. Initial lingual brackets with .012" nickel titanium archwires, prior to premolar extractions.

Fig. 17 Case 2. Upper .018" × .025" combination wire and palatal miniscrews used for retraction.

TABLE 2
CASE 2 CEPHALOMETRIC DATA

	Pretreatment	Post-Treatment
FMIA	46°	63°
FMA	26°	26°
IMPA	118°	91°
SNA	95°	93°
SNB	87°	85°
ANB	8°	8°
SN-GoGn	34°	34°

mechanics.

- Individualized lingual archwires make tooth movements more precise. The teeth are guided directly toward the ideal final positions from the beginning of treatment.
- The reduction in slot-tooth distances facilitates upper-incisor torque control.
- Virtually any type of lingual bracket can be used with the Orapix system.

Other advantages are attributable to the use of straight wires:

- The individualized straight wires chosen by the clinician are preformed at the Orapix center, eliminating the need for difficult archwire bends and considerably reducing chairtime.
- Teeth move more readily on a straight wire, simplifying extraction mechanics.
- The lingual appliance is more comfortable because of the absence of severe canine-premolar bends.

Conclusion

The Orapix system and lingual straightwire technique provide extremely accurate bracket positioning, thanks to CAD/CAM technology. Chairtime is reduced by using preformed, customized straight wires. Three-dimensional incisor control is improved, mechanics are simplified, and the appliance is more comfortable for the patient.

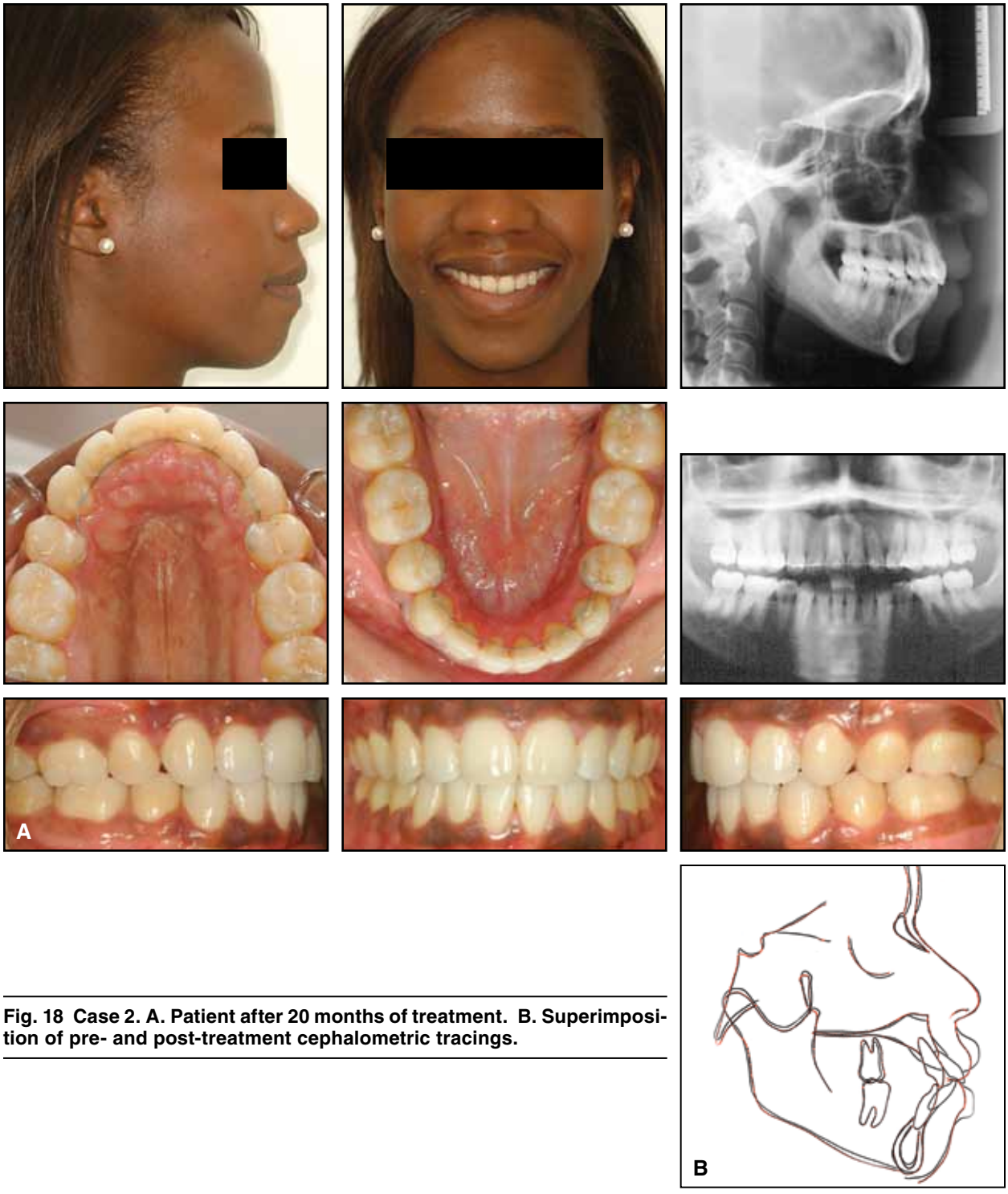

Fig. 18 Case 2. A. Patient after 20 months of treatment. B. Superimposition of pre- and post-treatment cephalometric tracings.

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