Tip and Torque Control in Complex Extraction Treatment with Preadjusted Lingual Appliances

ENRICO ALBERTINI, DDS
PAOLO ALBERTINI, DDS
LUCA LOMBARDO, DDS
GIUSEPPE SICILIANI, DDS

Tip and torque control is one of the most difficult aspects of orthodontic extraction treatment, particularly with fixed lingual appliances.

Proper mesiodistal inclination (tip) is important in achieving an ideal occlusion, especially in extraction cases, where spaces are prone to reopen if the roots of adjacent teeth are not parallel.[1] As Deguchi and colleagues noted, "preserving root parallelism is challenging when using lingual appliances, so additional archwire bending may be necessary during detailing."[2]

Torque control is also critical in lingual extraction treatment, since anterior retraction may produce a reactive tipping force due to differences in the biomechanical force directions.[3] Deguchi and colleagues found that "exaggerated uprighting of the maxillary and mandibular incisors following treatment of Class II extraction cases with lingual appliances indicates the need for increased lingual root torque to regain control of incisor movement during retraction."[2]

A lingual straightwire system was introduced in 2001,[4] with the aim of simplifying treatment mechanics, expediting arch coordination, and eliminating the complicated wire bends of the mushroom archwires.[5] Management of extraction cases became more straightforward with the ability to use sliding mechanics. Other advantages were reduced chairtime and increased patient comfort from the elimination of severe canine-premolar bends.[6]

This article presents two complex extraction cases, both treated with preadjusted lingual appliances, in which tip and torque control was crucial to achieving successful results.


Dr. Enrico Albertini


Dr. Paolo Albertini


Dr. Lombardo


Dr. Siciliani

Dr. Enrico Albertini is an Adjunct Professor, Dr. Paolo Albertini is an Assistant Researcher, and Dr. Lombardo is the Chairman, Postgraduate School of Orthodontics, University of Ferrara, Via Montebello 31, Ferrara 44100, Italy. Dr. Siciliani is the Chairman, School of Dentistry, University of Ferrara. Dr. Enrico Albertini is also in the private practice of orthodontics at via Livatino 9, Reggio Emilia 42124, Italy; e-mail: info@dralbertini.com.

Fig. 1 Case 1. 26-year-old female patient with anterior open bite, lingually displaced lateral incisors, retrusive mandible, and skeletal Class II relationship before treatment.

Case 1

A 26-year-old female presented with the request to have her teeth aligned using an esthetic appliance (Fig. 1). From a frontal view, the lower third of the face appeared long, and a significant mandibular symphysis deviation to the right was combined with divergent mandibular angles. The patient showed a convex profile with a balanced nose, a deficient nasolabial angle, upper and lower lip protrusion, a flat labiomental sulcus, and a retrusive lower jaw. A slight lower midline deviation to the right and negative torque of the buccal and posterior teeth in both arches were observed; an anterior open bite and accentuated upper and lower curves of Spee were also present. The patient presented bilateral Class I canine and molar relationships. There was mild crowding in the upper and lower anterior regions, with the upper right lateral incisor and both lower lateral incisors lingually displaced. The upper arch was slightly constricted, while the upper and lower curves of Wilson were accentuated.

The periodontal biotype was thin. The panoramic radiograph indicated the presence of all teeth, including the third molars. Cephalometric analysis revealed a skeletal Class II relationship (ANB = 7°), with the mandible in a retrusive position (SNB = 72°). The skeletal pattern indicated severe hyperdivergence (SN/MP = 46°), with a clockwise-oriented occlusal plane. The upper incisors appeared normally inclined (110°), while the lower incisors were severely proclined (106°).

Surgical-orthodontic treatment involving mandibular advancement and anterior rotation of the maxillomandibular complex would have been ideal, but the patient rejected this approach. Considering her reduced nasiolabial angle, flat labiomental sulcus, upper and lower lip protrusion relative to the Ricketts E-line,[7] and significantly deficient Merrifield Z-angle (44°),[8] orthodontic extraction treatment was recommended. The four first premolars were chosen for extraction to facilitate anterior tooth retraction. Because the patient had requested esthetic treatment, a lingual appliance was selected. The lingual biomechanics would promote retroclination of the lower incisors during closure of the premolar extraction spaces and avoid proclination in the leveling phase, since the intrusion force would pass closer to the lower incisors' center of resistance.[3]

Extraction tip and torque overcorrections were included in the manual setup prescriptions for preadjusted Ormco STb* brackets[6] (Fig. 2).

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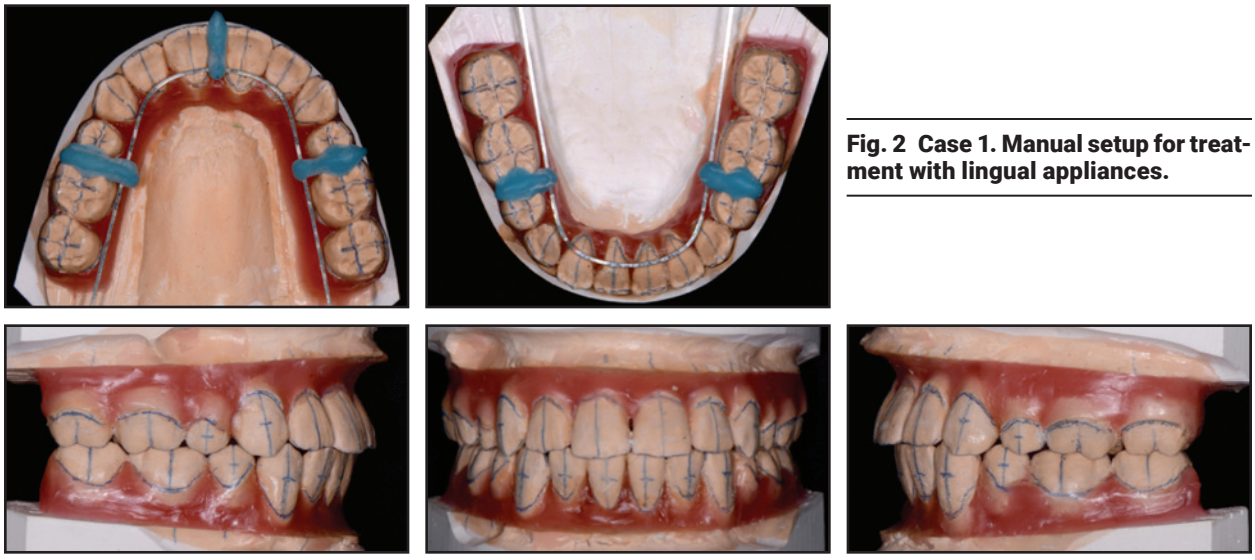

Fig. 2 Case 1. Manual setup for treatment with lingual appliances.

Indirect bonding was performed using single jigs, following the Komori KommonBase technique.[9]

The lower arch was bonded first (Fig. 3). A small .013" Copper NiTi** archwire was inserted for initial alignment, with a closed elastic chain placed between the lower right canine and first molar to start retraction. Two weeks later, the upper arch was bonded, and a medium .013" Copper NiTi lingual archwire was inserted for initial alignment. Occlusal build-ups were added to the upper second

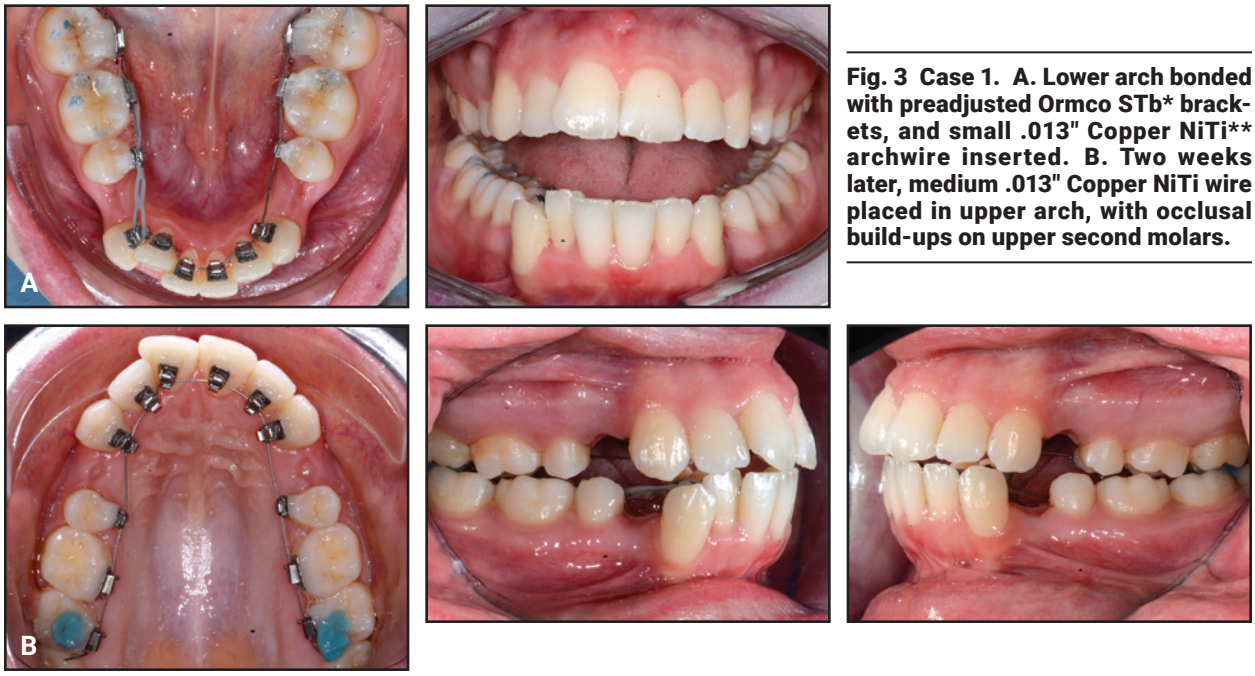

Fig. 3 Case 1. A. Lower arch bonded with preadjusted Ormco STb* brackets, and small .013" Copper NiTi archwire inserted. B. Two weeks later, medium .013" Copper NiTi wire placed in upper arch, with occlusal build-ups on upper second molars.**

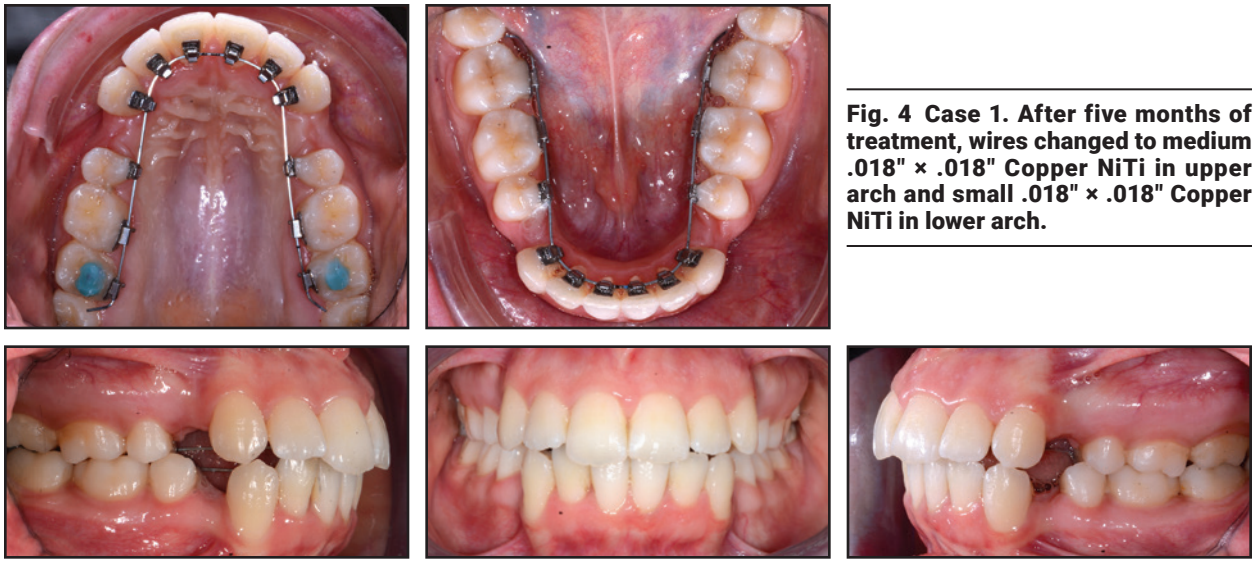

Fig. 4 Case 1. After five months of treatment, wires changed to medium .018" × .018" Copper NiTi in upper arch and small .018" × .018" Copper NiTi in lower arch.

molars to promote vertical control by molar intrusion. Two months later, the elastic chain was removed to suspend retraction of the lower right canine, thus avoiding the loss of a Class I canine relationship on the right side.

Another month later, the wires were replaced with medium .016" × .016" Copper NiTi in the upper arch and small .016" × .016" Copper NiTi in the lower arch. Five months after the start of treatment, a medium .018" × .018" Copper NiTi upper archwire and small .018" × .018" Copper NiTi lower archwire were placed for continued leveling and torque management (Fig. 4).

Two months later, palatal interradicular miniscrews were inserted for retraction of the upper anterior teeth (Fig. 5). An .017" × .025" posted stainless steel wire was placed in the upper arch, with the addition of upper right lateral incisor-upper left lateral incisor root-palatal torque and a super-Spee compensation curve. An .016" × .022" stainless steel wire with anti-Spee and transverse antibowing compensation curves was then inserted in the lower arch, and a closed elastic chain was added from lower first molar to first molar to prevent space reopening.

Twelve months after the start of treatment, an .0175" × .0175" TMA* wire was inserted in the lower arch, with finishing rotation bends at the lower left and right lateral incisors (Fig. 6). A step-down bend was placed between the lower left and right lateral incisors to complete the upper anterior retraction, in conjunction with the substitution of upper elastic chains. A closed elastic chain was extended from lower second molar to second molar to avoid space reopening.

Another four months later, the upper miniscrews were removed, and an .0175" × .0175" TMA upper archwire was inserted to complete space closure (Fig. 7). Three months later, upper finishing bends were added: a step-in at the right lateral incisor, step-downs at both canines, and a rotation bend at the upper right premolar. An open elastic chain was attached from upper first molar to first molar to complete space closure. In another two months, lower finishing bends were added: a step-in at the right canine and a rotation

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Fig. 5 Case 1. After seven months of treatment, interradicular miniscrews inserted and .017" × .025" posted stainless steel wire placed in upper arch.

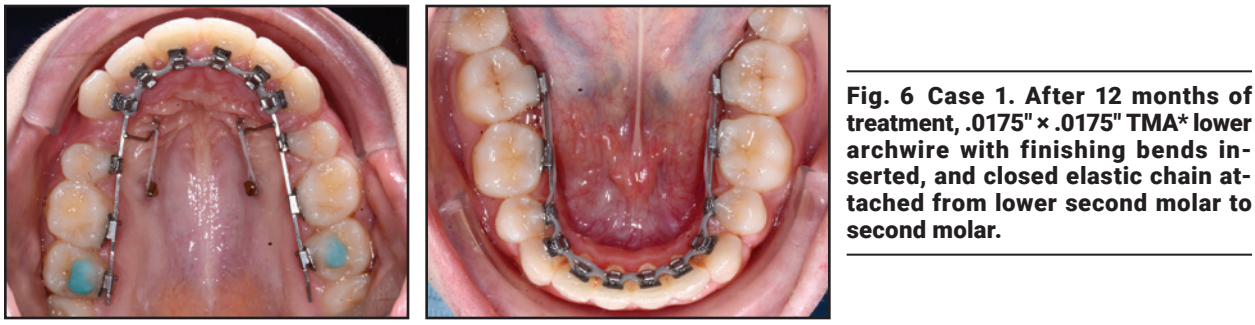

Fig. 6 Case 1. After 12 months of treatment, .0175" × .0175" TMA* lower archwire with finishing bends inserted, and closed elastic chain attached from lower second molar to second molar.

Fig. 7 Case 1. After 16 months of treatment, miniscrews removed and .0175" × .0175" TMA wire placed in upper arch.

bend at the right premolar. Two .012" Kobayashi ligatures were placed, one on the upper left lateral incisor and the other on the lower right canine, to allow a 3/16", 6oz Impala*** midline elastic to be worn at night.

After 23 months of treatment, the fixed appliances were removed (Fig. 8). A lower 3-3 lingual retainer wire was bonded, and upper and lower Essix† retainers were delivered. Digital Smile Design‡ was used to consult with the cosmetic dentist about the appropriate length and shape of direct reconstructions on the upper right and left lateral incisors and the upper left central incisor. After these composite reconstructions were performed, an upper 2-2 lingual retainer wire was bonded, and a new upper Essix retainer was delivered.

As a result of treatment, solid Class I canine and molar relationships were obtained on both sides. The crowding was resolved, the lower curve of Spee was flattened, and the open bite was corrected. The resulting light contact was ideal. Facial balance was achieved, with reduced muscular strain, a harmonious profile, and an esthetic smile arc. The panoramic radiograph confirmed root parallelism. Cephalometric analysis indicated a slight reduction in upper incisor torque (100°),

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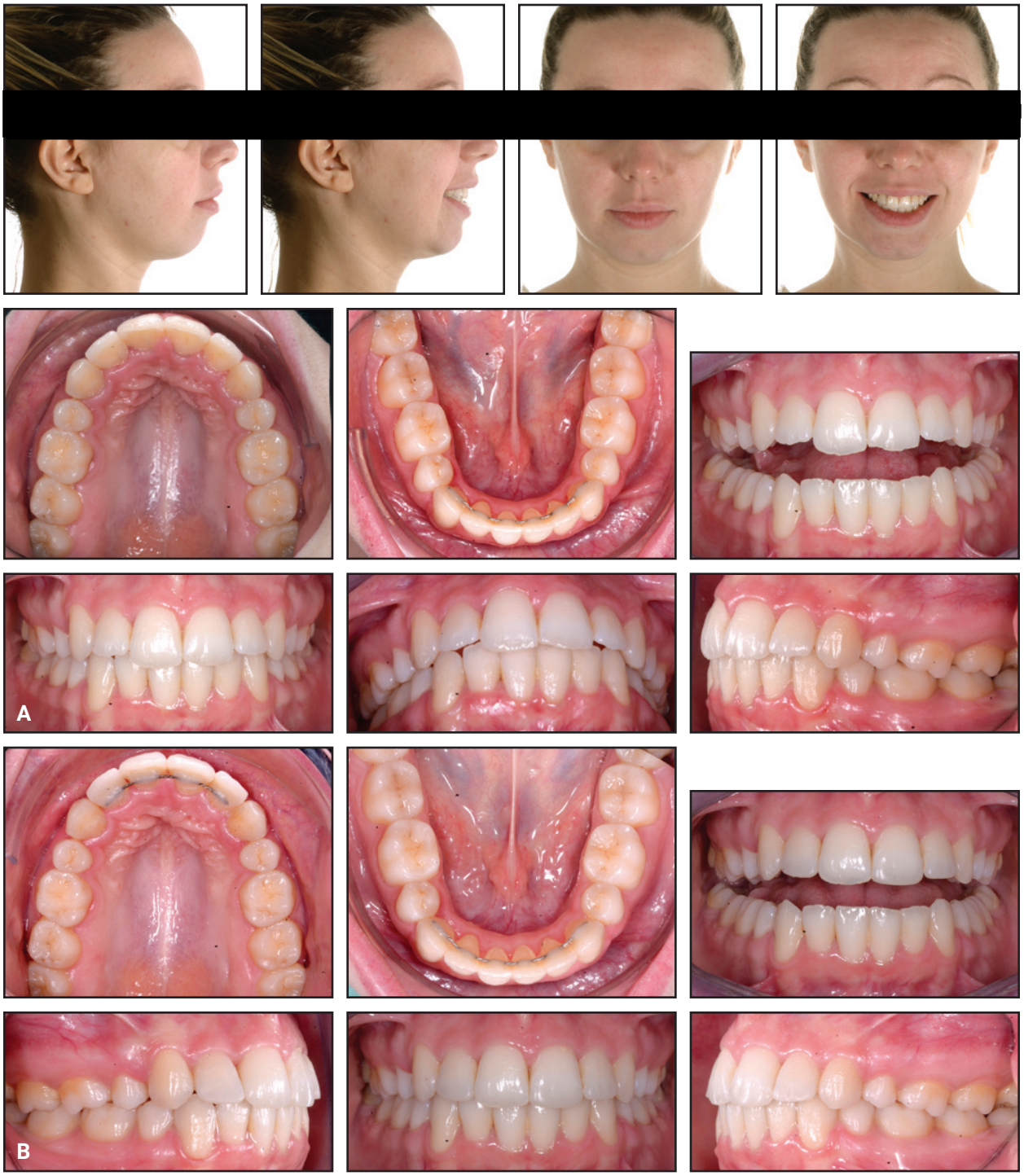

Fig. 8 Case 1. A. Patient after 23 months of treatment, before composite reconstructions on upper right and left lateral incisors and upper left central incisor. B. After reconstructions on upper lateral and left central incisors.

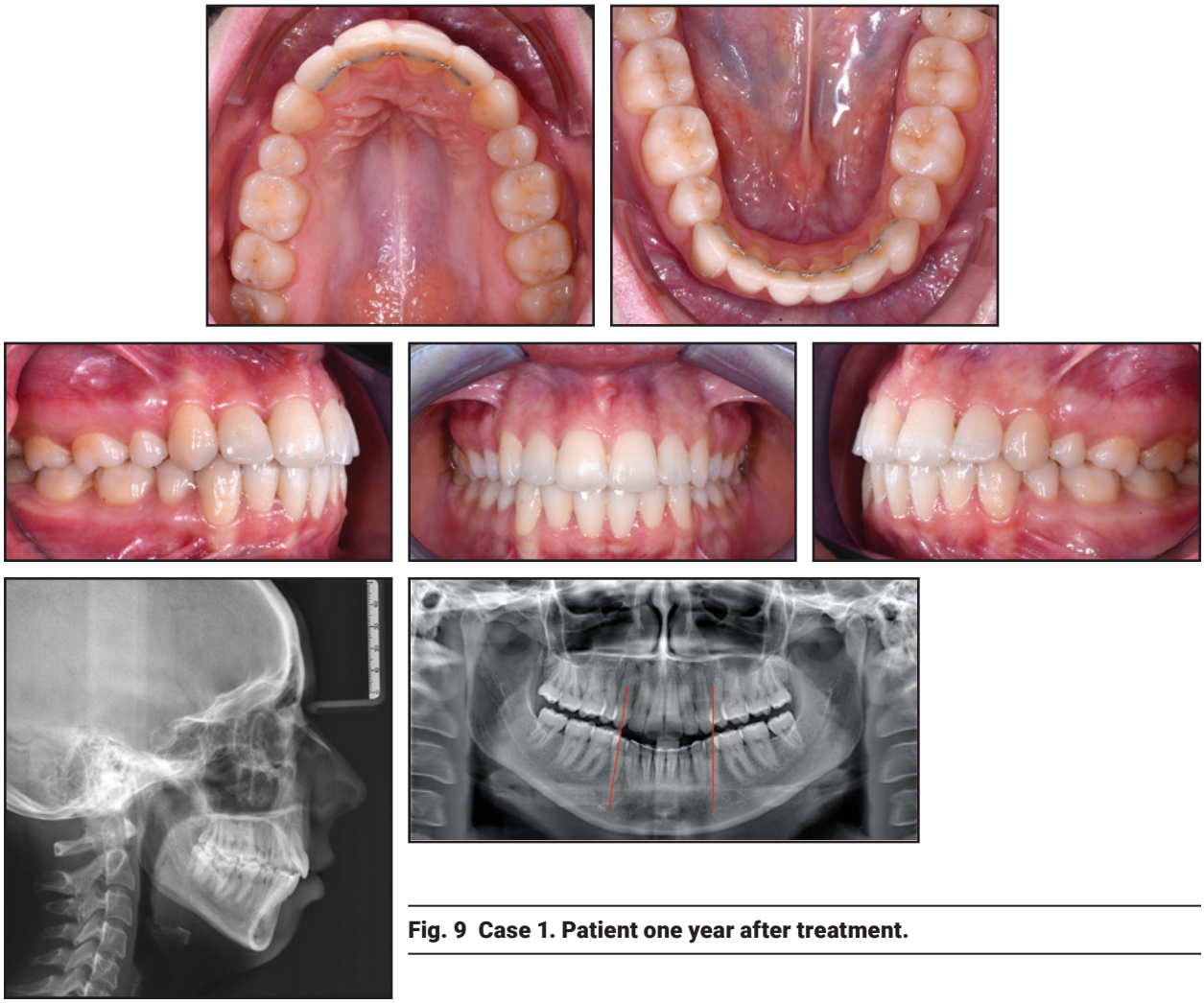

Fig. 9 Case 1. Patient one year after treatment.

while the lower incisor inclination was reduced from 106° to 100°. The congruence of the Ricketts E-line[7] and Merrifield Z-line[8] corroborated the extraction decision.

One year later, the treatment results remained stable (Fig. 9).

Case 2

A 20-year-old male presented with the request to have his teeth aligned by means of an esthetic appliance (Fig. 10). From a frontal perspective, the face was well proportioned, with a mandibular symphysis deviation toward the left and divergent mandibular angles. The patient exhibited a convex profile, a prominent nose, an open nasolabial angle, a marked labiomental sulcus, a retrusive lower jaw, and a prominent pogonion. The midlines were coincident, but there was an anterior deep bite with an accentuated lower curve of Spee. A negative torque affecting the upper right first and second premolars and the lower right second premolar was also present. The patient had bilateral full-step Class II canine and

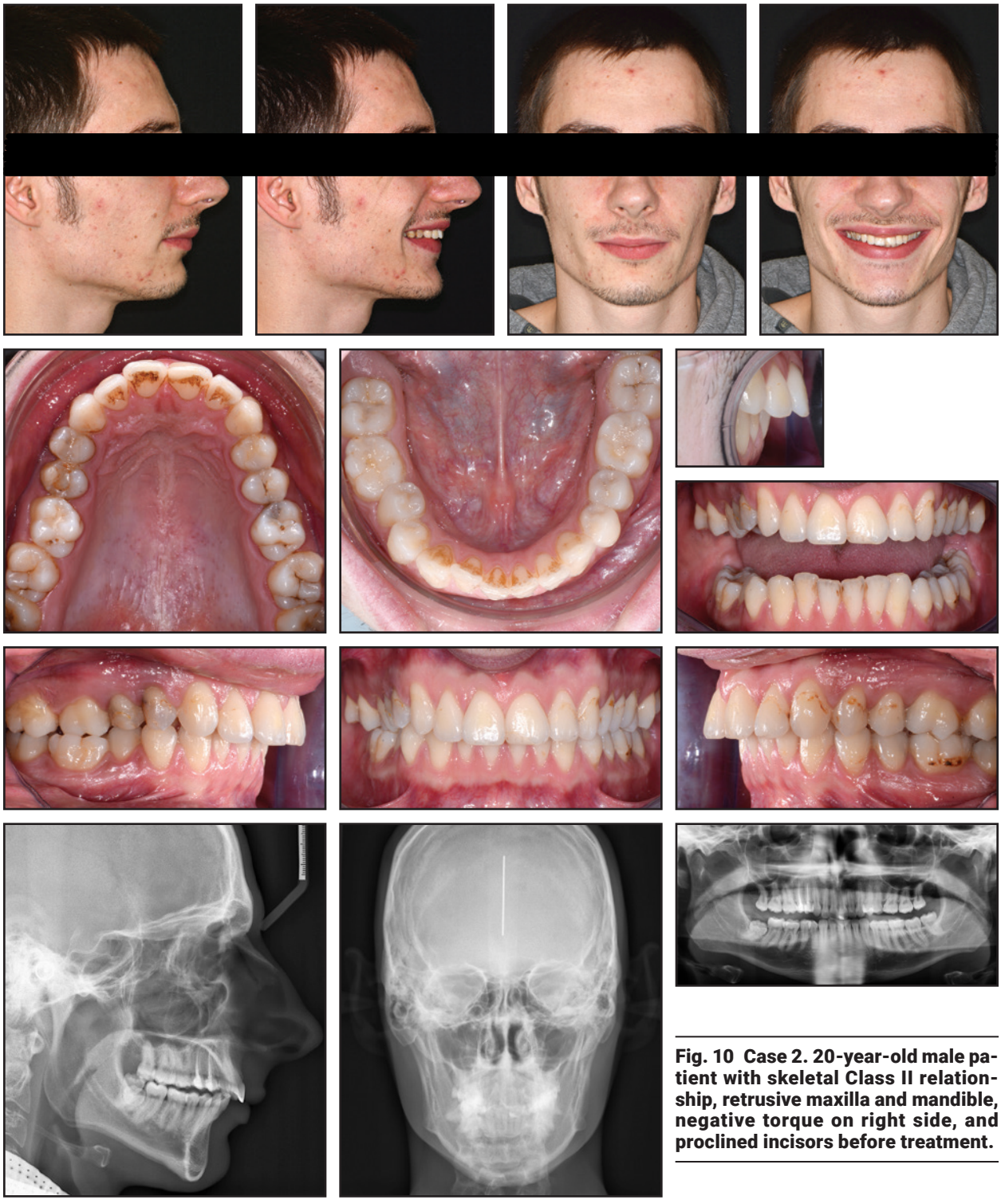

Fig. 10 Case 2. 20-year-old male patient with skeletal Class II relationship, retrusive maxilla and mandible, negative torque on right side, and proclined incisors before treatment.

molar relationships, a constricted upper arch, and an asymmetrical lower arch with mild crowding on the right side.

The periodontal biotype was thick. The panoramic radiograph showed the presence of all teeth, including the third molars. The upper right first and second premolars had been endodontically treated, and the lower right third molar was impacted. Cephalometric analysis indicated a skeletal Class II relationship (ANB = 9°) with both the maxilla and mandible in retrusive positions. The skeletal pattern was slightly hypodivergent (SN/MP = 28°), with a counterclockwise-oriented occlusal plane. The upper incisors were slightly proclined (115°), while the lower incisors were proclined (108°).

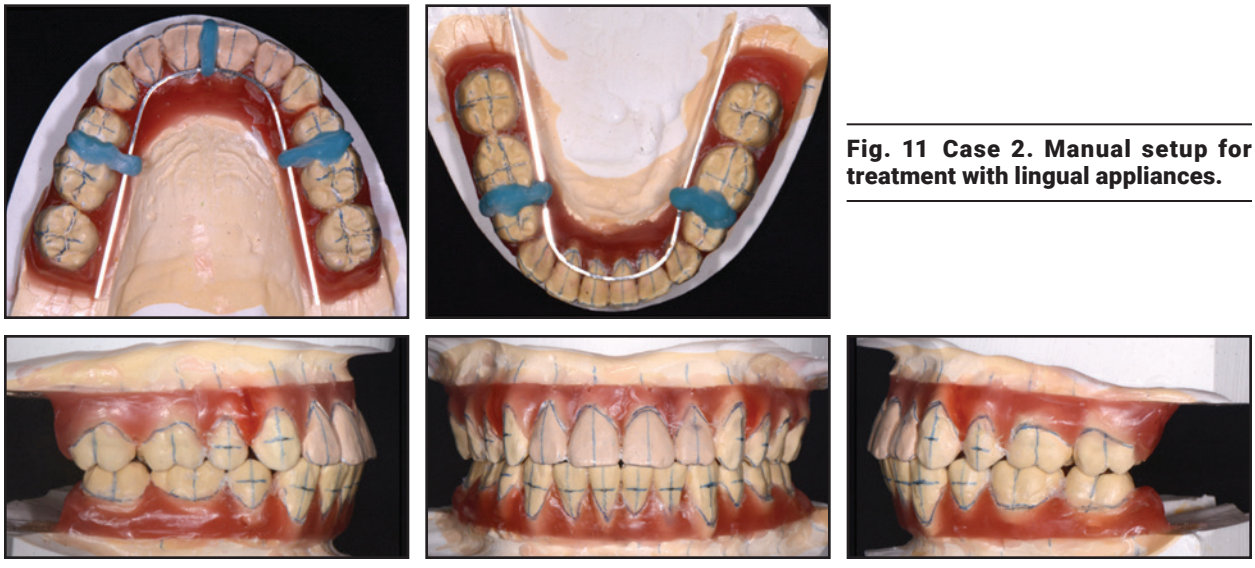

Fig. 11 Case 2. Manual setup for treatment with lingual appliances.

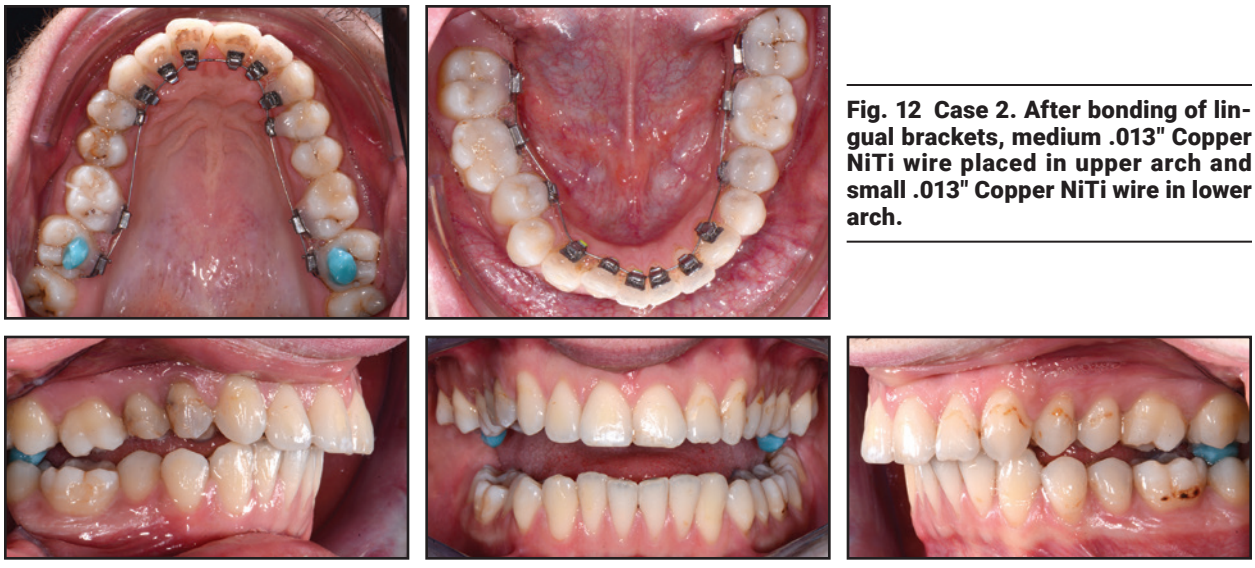

Fig. 12 Case 2. After bonding of lingual brackets, medium .013" Copper NiTi wire placed in upper arch and small .013" Copper NiTi wire in lower arch.

Considering the patient's convex profile, prominent nose, bimaxillary retrusion, and open nasolabial angle, orthodontic camouflage treatment with upper first-premolar extractions would have adversely affected his facial balance. Surgical-orthodontic treatment including maxillary and mandibular advancement, posterior rotation of the maxillomandibular complex, correction of asymmetry, and transverse maxillary expansion was recommended as the only possible solution. The upper second and lower first premolars would be extracted to obtain proper lower incisor inclination after the surgical correction. Since the patient had asked for esthetic treatment, a lingual appliance would be used. The lingual biomechanics would avoid lower incisor proclination during leveling, as a result of the intrusion force passing closer to the lower incisors' center of resistance.[3]

Extraction tip and torque overcorrections were included in the manual setup prescriptions for the preadjusted Ormco STb brackets[6] (Fig. 11). Indirect bonding was carried out with single jigs, according to the Komori KommonBase technique.[9]

After both arches were bonded, a medium .013" Copper NiTi wire was placed in the upper arch and a small .013" Copper NiTi wire in the lower arch for initial alignment (Fig. 12). Occlusal build-ups were added on the upper right and left second molars to obtain a tripod contact.

Four months later, after extraction of the upper second premolars and lower first premolars, the wires were changed to a medium .018" × .018" Copper NiTi in the upper arch and a small .018" × .018" Copper NiTi in the lower arch for leveling and torque management. Five months after the start of treatment, an .017" × .025" posted stainless steel upper archwire was inserted, with the addition of upper right lateral incisor-upper left lateral incisor root-palatal torque and super-Spee and transverse antibowing compensation curves (Fig. 13). A closed elastic chain was added from upper first molar to first molar to begin space closure.

One month later, an .016" × .022" stainless steel wire with anti-Spee and transverse antibowing compensation curves was inserted in the lower arch (Fig. 14). A closed elastic chain was extended from lower first molar to first molar to start space closure, and the upper elastic chain was replaced with one from second molar to second molar. At this point, the patient's profile had worsened due to the orthodontic preparation for surgery.

After 11 months of treatment, a vertical bowing effect on the left side of the upper arch

Fig. 13 Case 2. After five months of treatment, .017" × .025" posted stainless steel wire with upper right lateral incisor-upper left lateral incisor root-palatal torque and super-Spee and transverse antibowing compensation curves inserted in upper arch.

Fig. 14 Case 2. A. After six months of treatment, .016" × .022" stainless steel wire with anti-Spee and transverse antibowing compensation curves inserted in lower arch. B. Worsening profile as orthodontic treatment prepares patient for surgery.

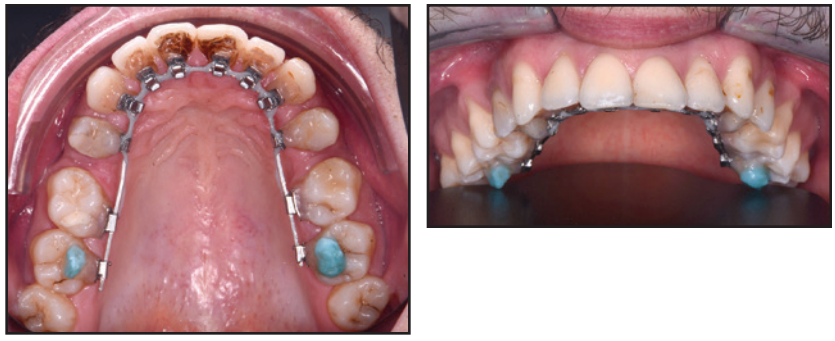

Fig. 15 Case 2. After 11 months of treatment, force reduction and increased upper super-Spee compensation curve needed on left side; transverse antibowing curve increased to expand upper arch slightly.

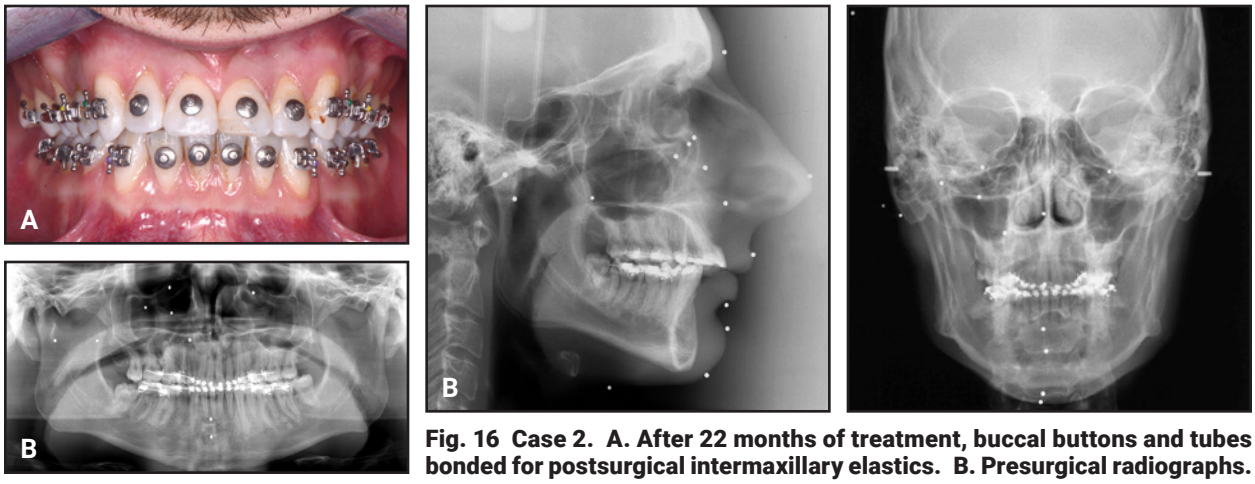

Fig. 16 Case 2. A. After 22 months of treatment, buccal buttons and tubes bonded for postsurgical intermaxillary elastics. B. Presurgical radiographs.

was apparent (Fig. 15). Therefore, the force was reduced and the super-Spee compensation curve was increased on the left side. At the same time, the transverse antibowing curve was increased to expand the upper arch slightly. Buccal brackets were bonded to the lower left first and second molars to correct the rotation of the lower left second molar with an .018" × .025" nickel titanium sectional wire.

Six months later, when the lower extraction spaces were almost closed, an .0175" × .0175" TMA lower archwire was inserted with finishing step-down bends at the lateral incisors, combined with an increase in the lower anti-Spee curve. A closed elastic chain was extended from the lower left first premolar to the lower right first molar to complete space closure. After 22 months of treatment, buccal brackets were bonded to the lower right first and second molars to correct the lower right second molar rotation with an .018" × .025" nickel titanium sectional wire.

One month later (two weeks before surgery), buccal buttons and tubes were bonded to the remaining teeth as attachments for postsurgical intermaxillary elastics (Fig. 16). The presurgical panoramic radiograph confirmed that root parallelism had been achieved. Cephalometric analysis showed an increase in upper incisor torque from 115° to 123°, despite the extraction space closure. This was important to enable the planned maxillomandibular posterior rotation without a final deficit in upper incisor torque. The lower incisor torque change was ideal (from 108° to 93°) for the sagittal mandibular advancement.

Maxillomandibular posterior rotation and advancement were planned to improve the profile, increase upper incisor exposure, and correct the maxillomandibular asymmetry (Fig. 17). Posterior maxillary expansion was also planned to correct the posterior crossbite.

The maxillofacial surgery was performed after 24 months of orthodontic treatment. Three weeks later, the surgical points and buccal buttons were removed (Fig. 18). The buccal brackets were left on the upper and lower posterior teeth for continued use with intermaxillary elastics and sectional wires. The profile improvement from the maxillary and mandibular advancement was evident, as was the asymmetry correction and the ideal anterior tooth exposure.

Two weeks later, esthetic buttons were bonded buccally to both lower canines for attachment of 3/16", 6oz Impala elastics to compensate for the Class II overcorrection. The elastics were prescribed on the buccal side to enable the patient to wear them full-time shortly after surgery. Closed elastic chains were added from the upper and lower first premolars to first premolars to complete space closure.

Six months later, buccal tubes were bonded

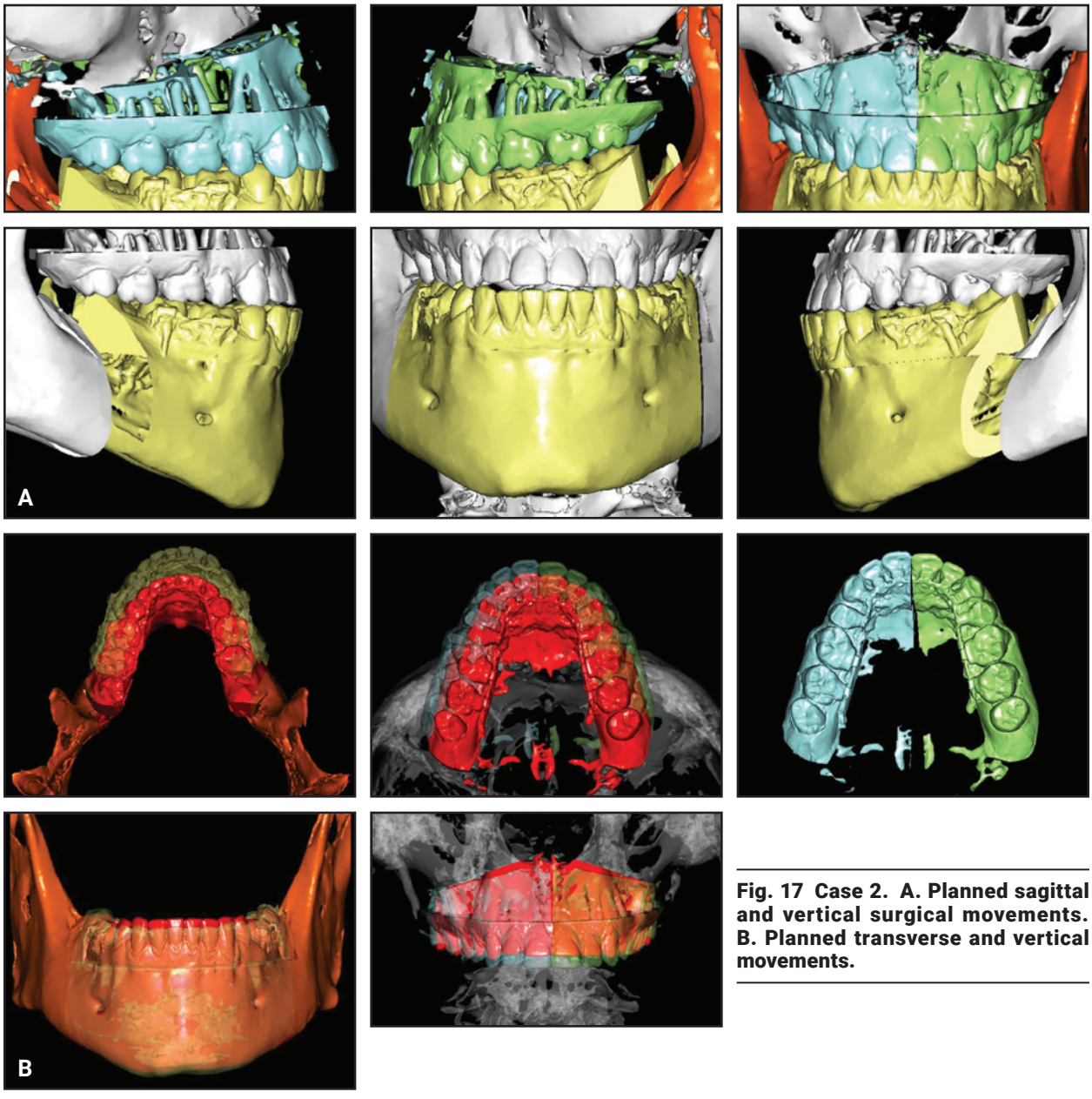

Fig. 17 Case 2. A. Planned sagittal and vertical surgical movements. B. Planned transverse and vertical movements.

to the upper right second and third molars, and an .019" × .025" nickel titanium sectional wire was inserted from the first to the third molar. Another month later, finishing bends were added in the upper arch: a rotation bend at the right central incisor, a tip bend at the right lateral incisor, and a tip bend at the left lateral incisor (Fig. 19). A buccal tube was bonded to the upper left third molar, and an .019" × .025" nickel titanium sectional wire was inserted from the first to the third molar. Full-time elastic wear was continued throughout this period.

Fig. 18 Case 2. Surgical points and buccal buttons removed three weeks after surgery.

Fixed appliances were removed 32 months after the start of treatment (Fig. 20). Upper 2-2 and lower 3-3 lingual retainer wires were bonded, and upper and lower Essix retainers were delivered.

Facial balance was achieved by means of the maxillary advancement, improved mandibular projection, and ideal anterior tooth exposure. A pleasant smile arc and harmonious profile were evident, and the asymmetry was corrected. A solid Class I canine and molar relationship was obtained on both sides, while the deep bite was resolved, the lower curve of Spee was flattened, and ideally minimal upper and lower curves of Wilson were attained. The resulting light contact was ideal. The final panoramic radiograph confirmed root parallelism. Cephalometric analysis showed that the upper incisor torque had increased to 122°, and the lower incisor inclination was normal (100°). The Ricketts E-line[7] and Merrifield Z-line[8] were congruent, substantiating the surgical treatment decision.

Treatment results remained stable at the two- and four-month follow-up appointments (Fig. 21).

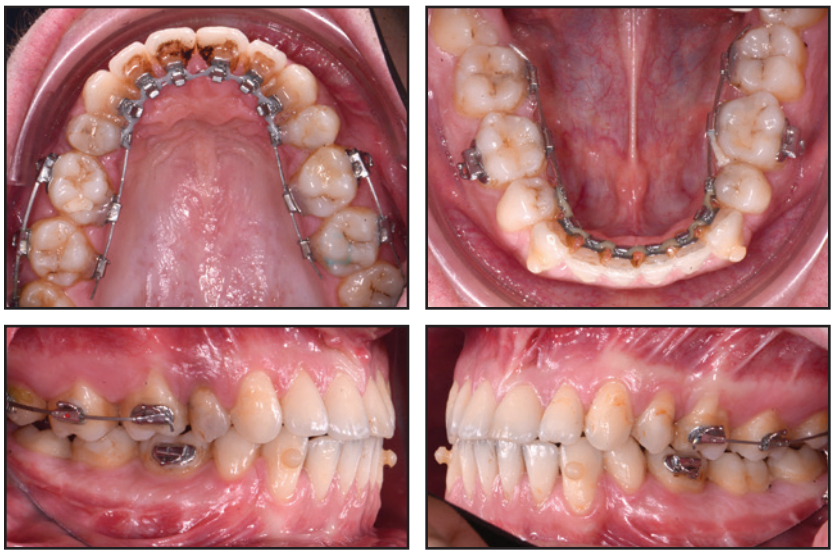

Fig. 19 Case 2. After 30 months of treatment, finishing bends added in upper arch.

Discussion

Preadjusted lingual appliances were developed to simplify treatment management.[4] Takemoto and Scuzzo, in a study of clinical crowns cut on plaster casts, found that buccolingual distances did not vary substantially at the gingival margin, indicating that lingual brackets can be placed close to the gingival margin to reduce composite thickness.[4] A preadjusted lingual appliance allows the use of sliding mechanics in extraction cases,[4] thereby reducing treatment time, eliminating the need for complicated wire bends, and providing more predictable results.[6]

Mckee and colleagues documented distortion of the angles between inclined teeth on panoramic radiographs.[10] Although statistically significant differences were found for 74% of the mesiodistal angulations in maxillary and mandibular images, compared with the true mesiodistal angulations, a similar trend was noted in overestimation and underestimation of tooth angulation among four different panoramic units.[10] Therefore, we deemed it possible to compare pre- and post-treatment mesiodistal inclinations from panoramic films in the present cases.

In Case 1, ideal root parallelism was obtained without the need for additional refinement tip bends. The lower second premolars, adjacent to the extracted first premolars, showed significantly more negative tip compared with their initial angulations, despite the extraction space closure. Even with a more negative tip on the lower second premolars, however, the tip overcorrection in the setup was effective in obtaining bodily space closure in all quadrants. Only simple sliding mechanics with elastic chains were needed, with interradicular miniscrews used as auxiliary anchorage in the upper arch, to obtain maximum anchorage and reciprocal space closure in the lower arch.

In Case 2, ideal control of upper and lower incisor torque was crucial to prepare the patient for maxillofacial surgery. The upper incisors, which were slightly proclined (115°) at the start of treatment, needed a mild increase in inclination, despite the premolar extractions. This would allow us to achieve the correct torque for the posterior rotation of the maxillomandibular complex and the mandibular advancement. The lower incisors, which were severely proclined (108°) at the start of treatment, needed a reduction in torque to obtain the proper inclination for the surgical movements. In this case, anterior torque was managed using overcorrections in the setup and manual torquing bends in the archwires. The values

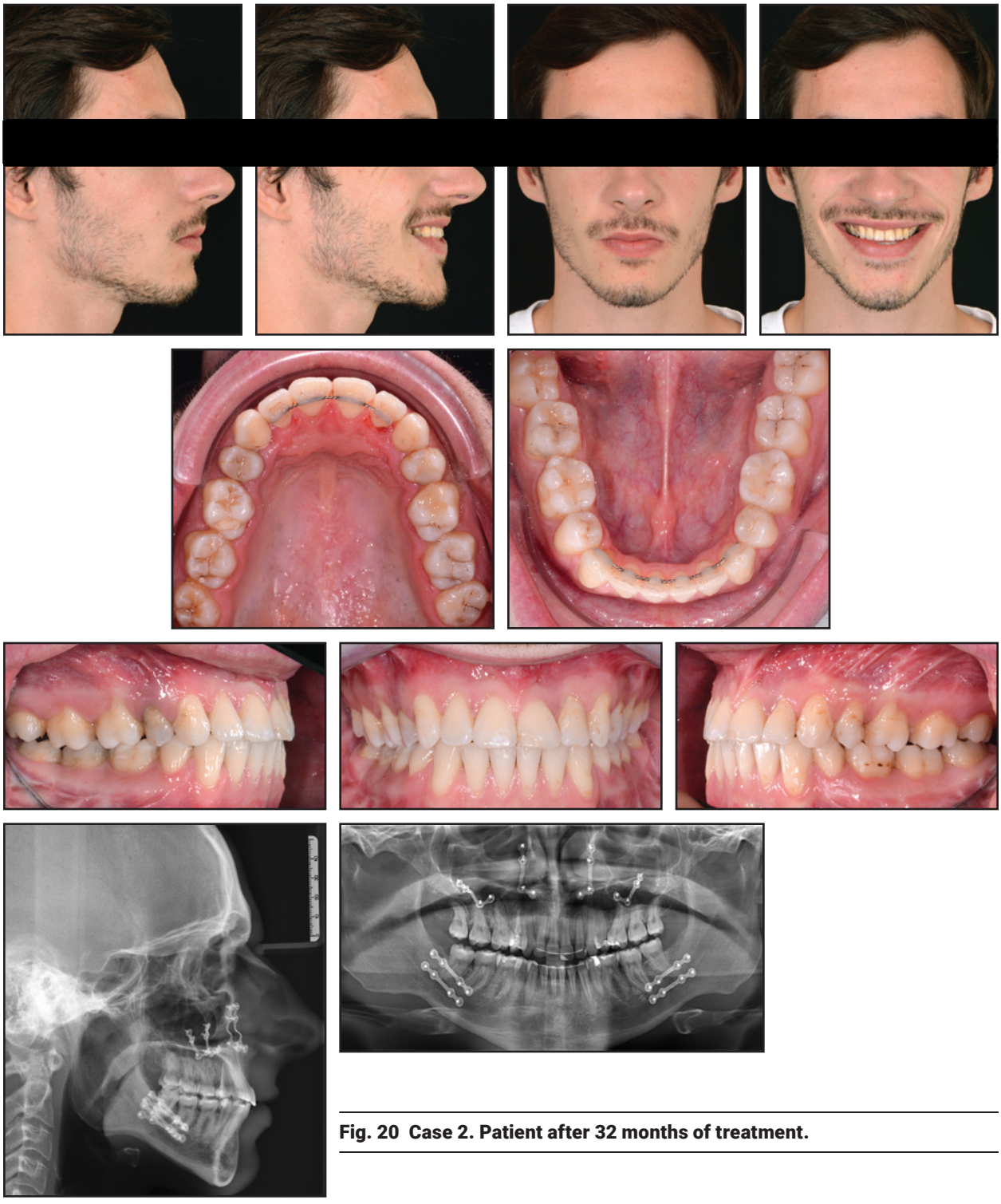

Fig. 20 Case 2. Patient after 32 months of treatment.

Fig. 21 Case 2. Patient four months after treatment.

obtained before surgery agreed with those recommended by Arnett and colleagues: 56° relative to the occlusal plane for the upper incisors (ideal 54-60°) and 67° for the lower incisors (ideal 61-68°).[11] At the end of treatment, the facial balance was improved, with better maxillary and mandibular projection and ideal anterior tooth inclination. The upper incisors finished with slightly higher inclination (122°) compared with the start of treatment, while the lower incisors were normalized to 100°. In this case, the increase in upper incisor torque was needed to allow for the surgical posterior rotation of the maxillomandibular complex and mandibular advancement.

Conclusion

Control of tip and anterior torque is a realistic goal of lingual orthodontic treatment, even in a complex extraction case, when overcorrections are included in the setup prescription and space closure is managed with light forces, appropriate stainless steel archwires, and compensation bends and curves to limit bowing effects. No complicated biomechanics are required; the simple sliding mechanics enabled by preadjusted lingual appliances are sufficient to achieve these effects.

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