CASE REPORT

Treatment of a Patient with Apparent Primary Failure of Eruption Using a Modified Hyrax Expander and Miniplate Anchorage

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Failure of eruption is a spontaneous or inherited disorder that typically manifests as a severe posterior open bite and is difficult to treat orthodontically. These eruption disorders are generally divided into two categories. Mechanical failure of eruption is caused by an obstruction such as a cyst, lateral tongue pressure, crowding, impaction, or ankylosis and can be resolved by removal of the obstruction. Eruption disorders with genetic underpinnings include primary failure of eruption, cleidocranial dysplasia, Hunter syndrome, and osteopetrosis.

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Primary failure of eruption, first described by Proffit and Vig, is a condition in which nonankylosed teeth may partially erupt and then become submerged.[1,2] Baccetti reported primary failure of eruption for 1.7% of the first and second permanent molars in 1,520 nonsyndromic patients.[3] The condition is seen more in females than in males; although it may be uni- or bilateral, it is no more prevalent in either arch or on either side.[3-5]

Because the posterior teeth are mainly affected, the result is usually a significant posterior open bite accompanying normal vertical facial growth. Primary failure of eruption is often, but not always, associated with Class III malocclusion and agenesis or ankylosis of the deciduous molars. Affected teeth show little or no response to treatment, with a tendency to ankylose or to intrude the adjacent teeth as soon as orthodontic traction is applied.[6] Therefore, a differential diagnosis is extremely important to avoid undue consequences.[7]

A detailed family record and clinical examination of both parents should be used to establish any family history of tooth submergence. A diagnosis of primary failure of eruption can be confirmed by sequencing the parathyroid hormone 1 receptor (PTH1R) gene. Although three heterozygous mutations were initially identified, more than 40 mutations have now been reported.[8] In some cases involving primary failure of eruption, however, the patient may be negative for mutation screening.

Various treatment approaches have been suggested for cases involving primary failure of eruption. Surgical options include extractions followed by implant placement, as well as corticotomies, segmental osteotomies, and distraction osteogenesis, all of which are invasive procedures. Restorative options include composite build-ups or onlays, which can preserve the alveolar bone level in younger patients and minimize infraocclusion of the adjacent teeth, and removable partial dentures, which may require frequent replacement.[9]

Orthodontic treatment is considered ineffective by most authors because of the high risk of ankylosis, particularly in patients with PTH1R mutations.[10,11] A continuous archwire will have a detrimental effect on the adjacent teeth, potentially extending the lateral open bite. A segmental archwire will not correct the affected molars and therefore will not eliminate the need for future implant replacement.

The following case demonstrates successful orthodontic treatment of a patient who evidenced signs of primary failure of eruption but tested negative for PTH1R mutations.

Diagnosis and Treatment Plan

A 17-year-old male presented with the chief complaint of an inability to bite and chew on the left side. Clinical examination found a dolichofacial pattern and symmetrical facial structures, with a straight profile, protrusive lower lip, normal nasolabial angle, and excessive lower anterior facial height (Fig. 1). The patient exhibited crowded incisors, mesially angulated lower anterior teeth, a constricted maxillary arch, a bilateral posterior crossbite from the canines to the second premolars, and an anterior crossbite of the upper left lateral incisor with the lower left canine. There were Class I molar and canine relationships on the right side and a Class I canine relationship on the left, but the molar relationship on the left could not be determined because of the absence of maxillary left molars. The upper left first molar was submerged, with the mesial marginal ridge and half of the occlusal surface at the level of the alveolar mucosa, while the upper left second molar was unerupted, resulting in a lateral open bite. The upper midline was shifted 2.5mm to the left, the lower midline was coincident with the facial midline, and both arches were narrow and tapered. The overjet and overbite were 1mm and 1.5mm, respectively. The patient's periodontal condition was good, and oral hygiene was fair.

A panoramic radiograph revealed a distally tipped crown and mesially tipped root of the upper left second premolar, along with submerged upper left first, second, and third molars. No obstruction to the unerupted upper left second molar was observed. The upper right third molar was absent, and both lower third molars were impacted. Cone-beam computed tomography (CBCT) indicated that the submerged upper left first, second, and third molars were probably not ankylosed (Fig. 2). The patient's airway was slightly constricted.

Cephalometric analysis (Table 1) found a skeletal Class III relationship (ANB = 1°) with a protrusive mandible relative to the cranial base (SNB = 82°, SNA = 83°). The patient showed a hyperdivergent facial pattern (GoGn-SN = 36°) and excessive lower facial height.

Functional examination demonstrated oronasal breathing and a low tongue posture that was probably the cause of the skeletal Class III relationship, even though the tongue size and shape were normal. Analysis of the study casts determined an Index of Orthodontic Treatment Need (IOTN) score of 5i (impeded eruption) and a pretreatment peer assessment rating (PAR) of 39.

Special emphasis was given to the diagnosis in this case, considering the patient's age, height (6'1"), and Class III skeletal pattern, as well as the presence of a submerged upper first molar that had

only partially erupted and an unerupted upper second molar without mechanical interference. A detailed family history was taken, and the parents were clinically examined to rule out any history of submerged teeth. PTH1R sequencing was also negative.

Treatment objectives were to extrude and align the upper first and second molars, establish good interdigitation and a functional occlusion, and obtain a harmonious facial profile by reducing the mandibular protrusion and lower facial height. We also planned to establish ideal overjet and overbite, achieve Class I molar and canine relationships, align the dental midlines with the facial midlines, and promote long-term stability of the results.

The first recommended treatment option involved extraction of the upper left first and second molars and replacement with implant-supported prosthetic crowns, along with leveling and alignment of both arches and correction of the skeletal Class III relationship. The patient and parents rejected this plan and asked for other alternatives.

The second option was to proceed with orthodontic treatment using segmental mechanics while awaiting eruption of the upper left first and second molars. This plan was also rejected, given that the patient and parents had already waited several years longer than usual for the molars to erupt.

A third alternative was to correct the posterior crossbite using a banded Hyrax* expander, which could be modified to extrude the submerged first and second molars after surgical luxation. The patient and parents were informed that there was a risk of ankylosis as soon as orthodontic force was applied, which could necessitate extraction of the molars and replacement with implant-supported prostheses. A detailed plan was presented involving fixed appliances and mandibular distalization using skeletal anchorage. The patient and parents chose this third option, since it would remove the ambiguity of the upper-molar eruption.

Treatment Progress

The upper right first molar and first premolar and upper left first and second premolars were banded for attachment of the modified Hyrax appliance. An impression was taken, and the bands were transferred to the working casts. The arms of the Hyrax screw were adapted and soldered to the bands, and a lever arm was extended from the left second-premolar band to rest above the submerged first molar (Fig. 3).

The Hyrax expander was affixed with a glass ionomer luting cement, and slow dentoalveolar expansion was initiated using a protocol of one-half turn (.4mm) per week for 13 weeks[12] (Fig. 4). After 5.2mm of maxillary expansion had corrected the posterior crossbite, the expansion screw was sealed and left passively in place for another 13 weeks.

Following surgical luxation of the upper left first and second molars using a straight gouge elevator, a button was bonded to the occlusal surface of the submerged first molar. The tooth was extruded initially with an .010" stainless steel ligature wire and then with an elastomeric chain from the lever arm of the Hyrax. A trampoline effect was created by the patient's mastication, applying an intermittent extrusive force that erupted the tooth into occlusion within 16 weeks.

Meanwhile, standard-torque .022" Damon** brackets were bonded in the mandibular arch, and leveling and alignment were carried out using an .014" copper nickel titanium archwire for eight weeks, followed by an .014" × .025" copper nickel titanium archwire for eight weeks and an .018" × .025" copper nickel titanium archwire for another six weeks (Fig. 5). An .019" × .025" stainless steel archwire was then inserted, with hooks crimped distal to the lateral incisors.

The patient was referred for surgical extraction of the lower third molars under local anesthesia. During the same procedure, L-shaped titanium miniplates were inserted between the lower second premolars and first molars, and en-masse distalization was begun using elastomeric chain from the miniplates (Fig. 6).

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After the submerged upper left first molar was extruded, the modified Hyrax appliance was removed. Damon brackets were then bonded in the maxillary arch, and an .014" copper nickel titanium archwire was inserted. Box elastics (3/16", 4.5oz) were worn on both sides to extrude the molars and achieve good interdigitation. The archwire sequence progressed to .014" × .025" and .018" × .025" copper nickel titanium.

After 16 months of treatment, the upper left second molar started showing signs of eruption (Fig. 7). In the mandibular arch, the elastomeric chain was changed at six-week intervals, until a positive overjet and overbite and coincident midlines were achieved (Fig. 8). Final space closure and torque expression in the maxillary arch were carried out on an .019" × .025" stainless steel wire.

Once the buccal surface of the upper left second molar was completely visible, a buccal tube was bonded and engaged in the archwire (Fig. 9). Box elastics were used to extrude and settle the upper left second molar.

Sixteen weeks later, the maxillary archwire was changed to .013" copper nickel titanium, and settling elastics were worn for 10 weeks to promote good interdigitation.

Total active treatment time was 30 months. After the appliances were removed, fixed upper and lower 3-3 lingual retainers were bonded, and a maxillary wraparound retainer was delivered to be worn full-time for three months and then at night for long-term stability.

Treatment Results

A well-settled occlusion with Class I molar and canine relationships was achieved (Fig. 10). The posterior open bite was corrected, normal overjet (2mm) and overbite (2mm) were established, and the lower incisors were retracted about 4mm without undesirable tipping. The patient's profile was improved, and a consonant smile arc was obtained.

The panoramic radiograph indicated adequate root parallelism, good periodontal health, and minimal root resorption. Post-treatment CBCT showed well-aligned upper left first and second molars and an impacted third molar, while the airway was greatly improved (Fig. 11).

Cephalometric analysis demonstrated clockwise rotation of the occlusal plane and a reduction in lower facial height (Table 1). Cast analysis found a PAR score of 0, as compared to the pretreatment score of 39.

The impacted upper left third molar was extracted six months after the removal of fixed appliances. Results remained stable 24 months after treatment (Fig. 12).

Discussion

Diagnosis was critical in this case when the radiographic assessment revealed a distally tipped crown and mesially tipped root of the upper left second premolar, along with submerged upper left first, second, and third molars. Even though there was no family history and the patient tested negative for PTH1R mutations, we had to consider the possibility of a primary failure of eruption. Still, we wanted to treat the patient conservatively, in accordance with his young age and the parents' wishes.

After the advantages and disadvantages of various approaches were weighed, a modified Hyrax expander with a lever arm was designed not only to resolve the posterior crossbite, but to promote extrusion of the unerupted molars. Surgical luxation of the submerged upper left first and second molars was performed to enable further orthodontic movement in case the teeth were ankylosed. This technique assumes that if a tooth is moved enough to disrupt the area of ankylosis, but maintains a periapical blood supply, the subsequent inflammatory reaction can stimulate the formation of a new fibrous ligament in the area of ankylosis. Although Biederman advocated surgical luxation of an ankylosed permanent tooth, he suggested that if no change was apparent after six months, a second procedure should be performed.[13] In our case, the unobstructed second molar began to erupt after the luxation and eruption of the first molar.

The extended lever arm of the banded Hyrax expander provided a rigid anchor for extrusion and

eliminated the risk of wire fracture due to metal fatigue, which is often seen with soldered wire extensions.[14,15] Meanwhile, to correct the Class III malocclusion, en-masse distalization of the mandibular arch was anchored by boneborne L-shaped miniplates.[16] The miniplates enabled the force to be applied close to the center of resistance, and the length of the plates allowed the point of force application to be adjusted as necessary.

This case report underlines the need for a better understanding of the genetics of dental eruption disorders before ruling out potentially effective orthodontic management protocols.

TABLE 1
CEPHALOMETRIC ANALYSIS

	Norm	Pretreatment	Post-Treatment
Skeletal			
SNA	82°	83°	83°
SNB	80°	82°	82°
ANB	2°	1°	1°
Inclination	85°	95°	91°
Y-axis	53-66°	65°	62°
GoGn-SN	32°	36°	36°
Facial axis	0°	80°	84°
N perp-A	0mm ± 2mm	0mm	0mm
N perp-Pog	0mm to −4mm	0mm	−1mm
Dental			
U1-NA	22°	25°	26°
U1-NA	4mm	5mm	6mm
L1-NB	25°	25°	24°
L1-NB	4mm	7mm	4mm
U1-L1	130°	118°	115°
IMPA	90°	85°	83°
L1-APog	1-2mm	3mm	2mm
Soft tissue			
Nasolabial angle	90-110°	107°	100°
Upper S-line	−2mm	0mm	0mm
Lower S-line	0mm	+4mm	+3mm

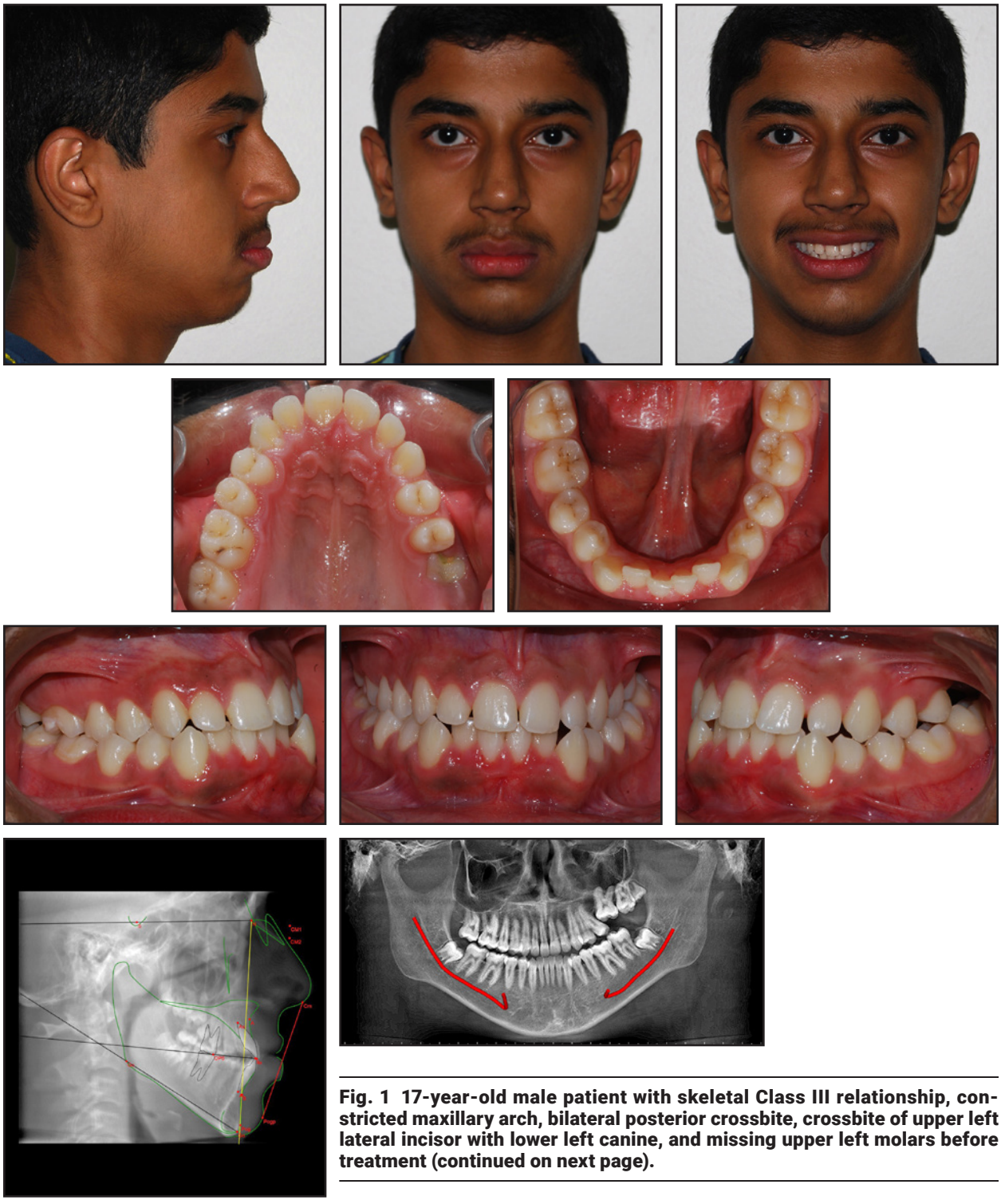

Fig. 1 17-year-old male patient with skeletal Class III relationship, constricted maxillary arch, bilateral posterior crossbite, crossbite of upper left lateral incisor with lower left canine, and missing upper left molars before treatment (continued on next page).

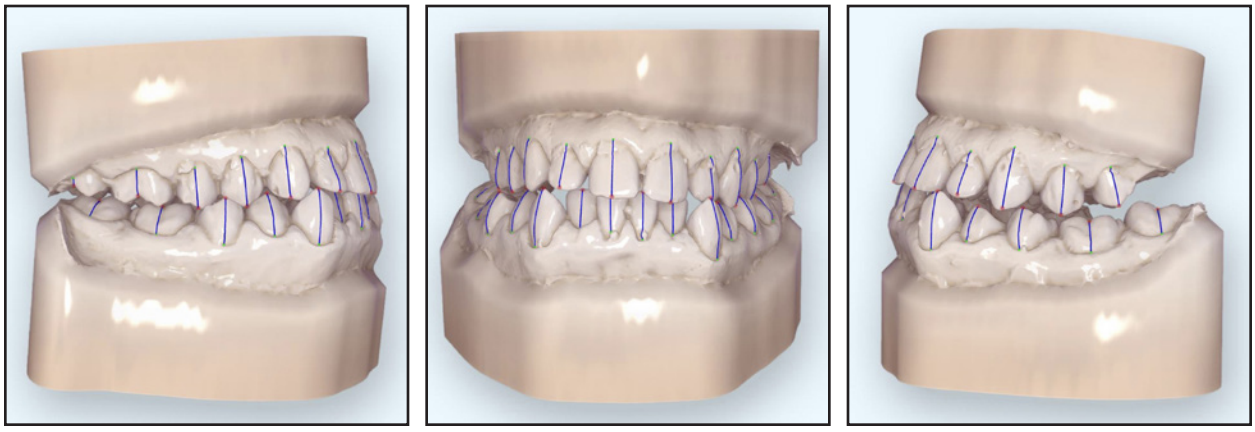

Fig. 1 (cont.) 17-year-old male patient with skeletal Class III relationship, constricted maxillary arch, bilateral posterior crossbite, crossbite of upper left lateral incisor with lower left canine, and missing upper left molars before treatment.

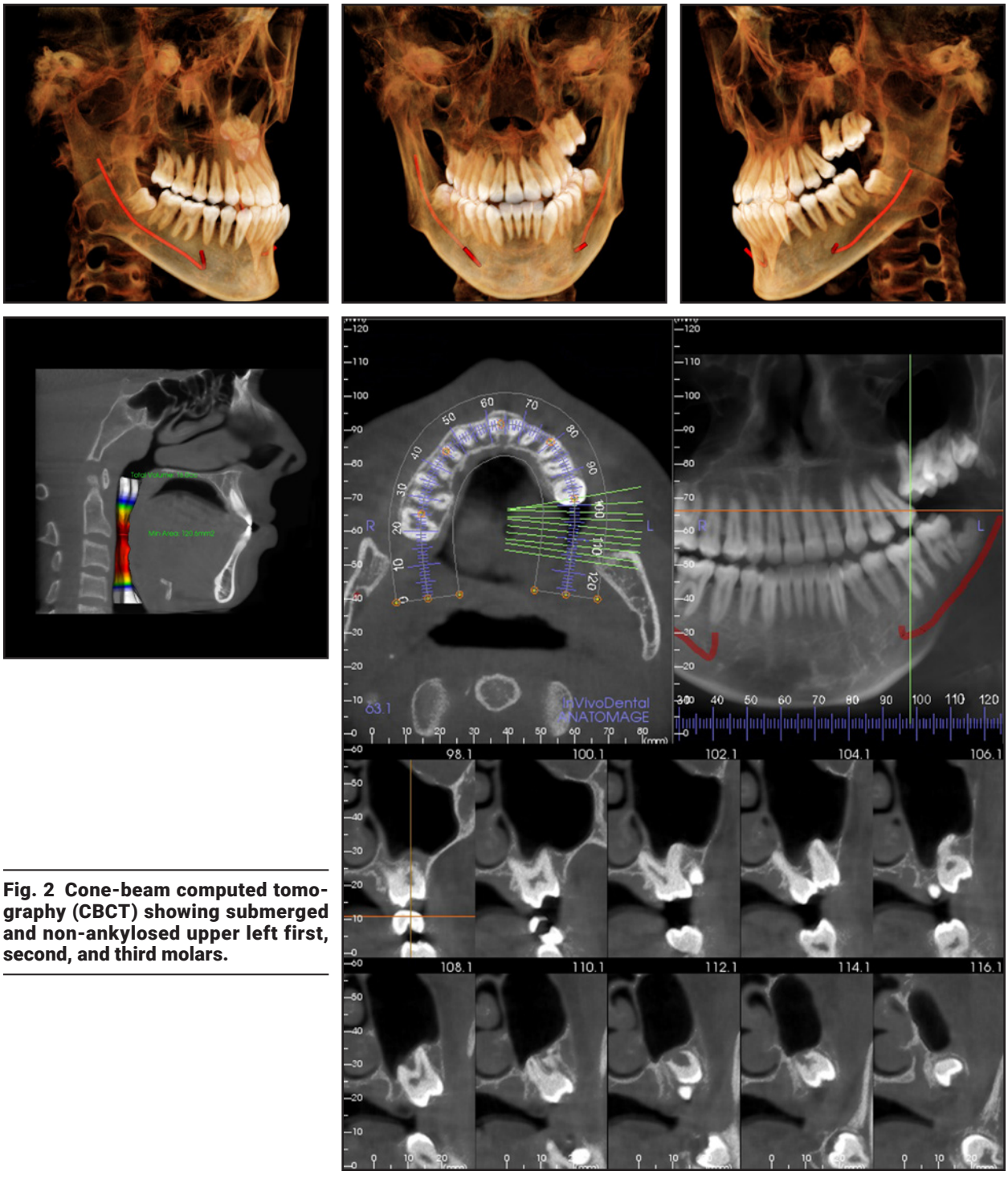

Fig. 2 Cone-beam computed tomography (CBCT) showing submerged and non-ankylosed upper left first, second, and third molars.

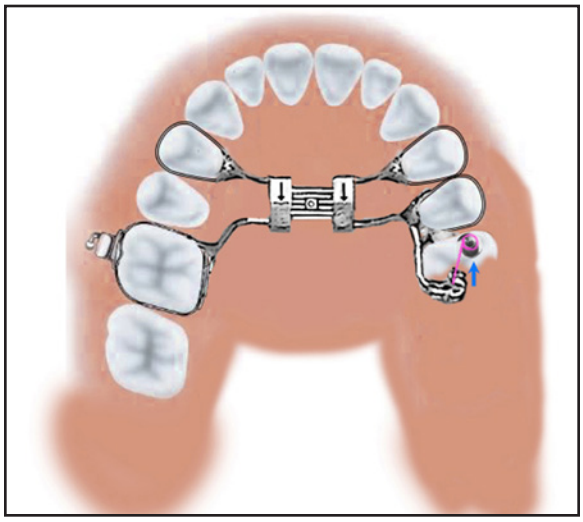

Fig. 3 Design of modified Hyrax* expander with lever arm resting above submerged upper left first molar.

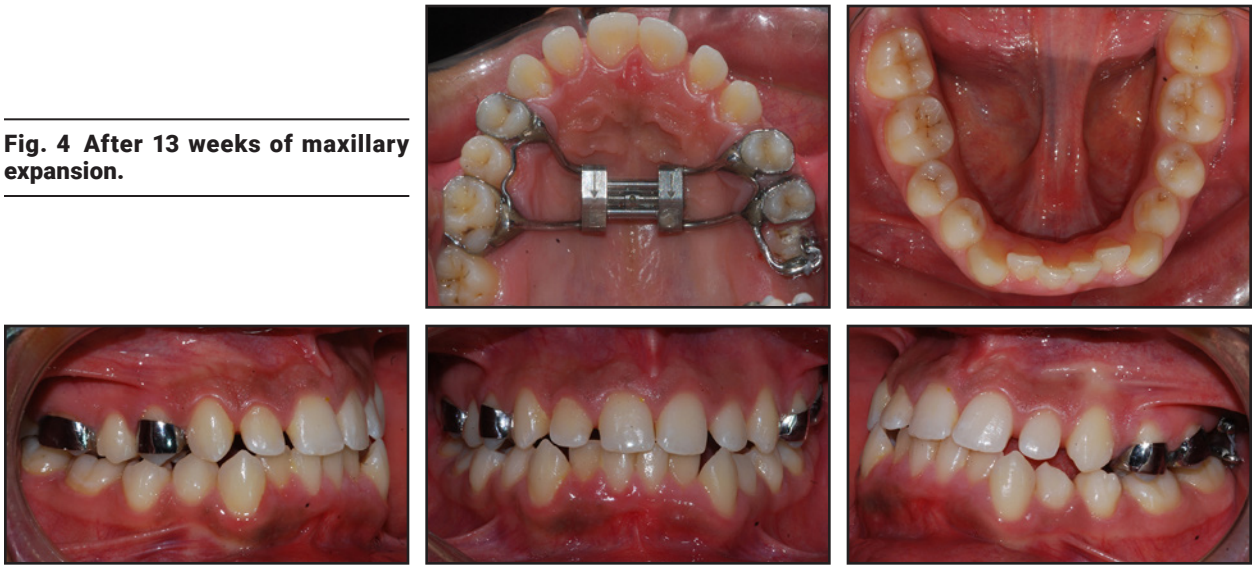

Fig. 4 After 13 weeks of maxillary expansion.

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Fig. 5 After 16 weeks of traction of submerged upper left first molar and simultaneous lower leveling and alignment, with standard-torque Damon brackets and .018" × .025" copper nickel titanium archwire in place.**

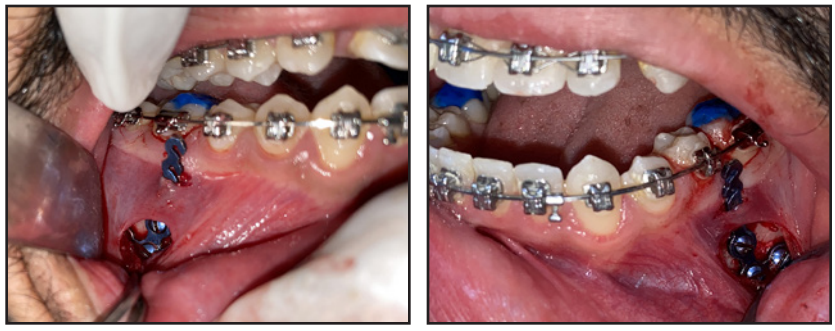

Fig. 6 After extraction of lower third molars, miniplates inserted between lower second premolars and first molars for attachment of elastomeric chain to begin en-masse distalization.

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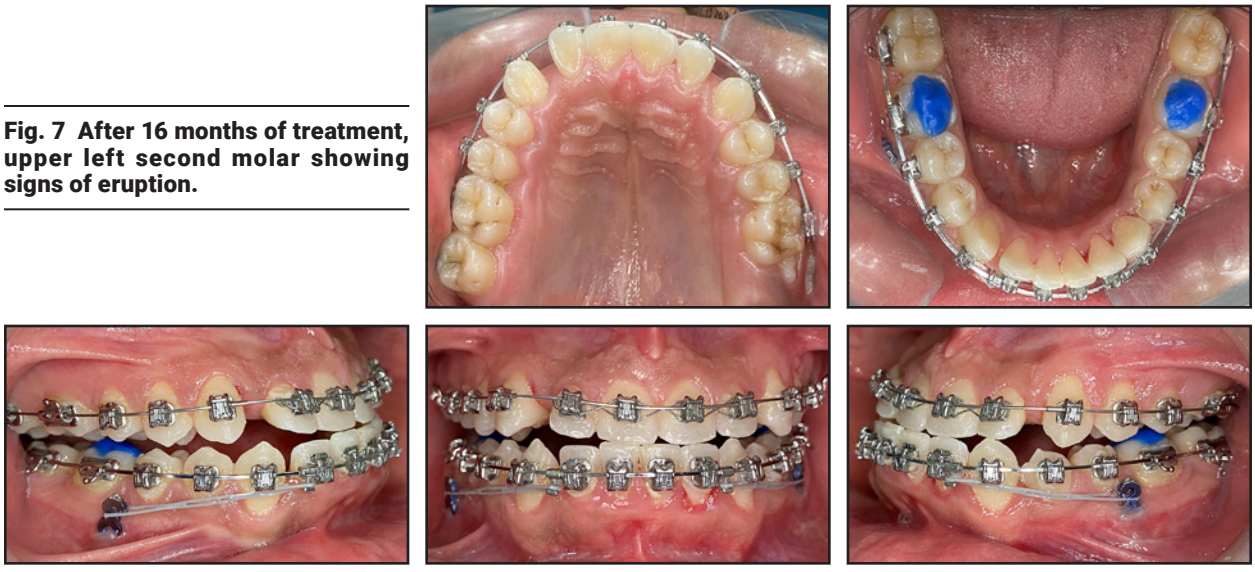

Fig. 7 After 16 months of treatment, upper left second molar showing signs of eruption.

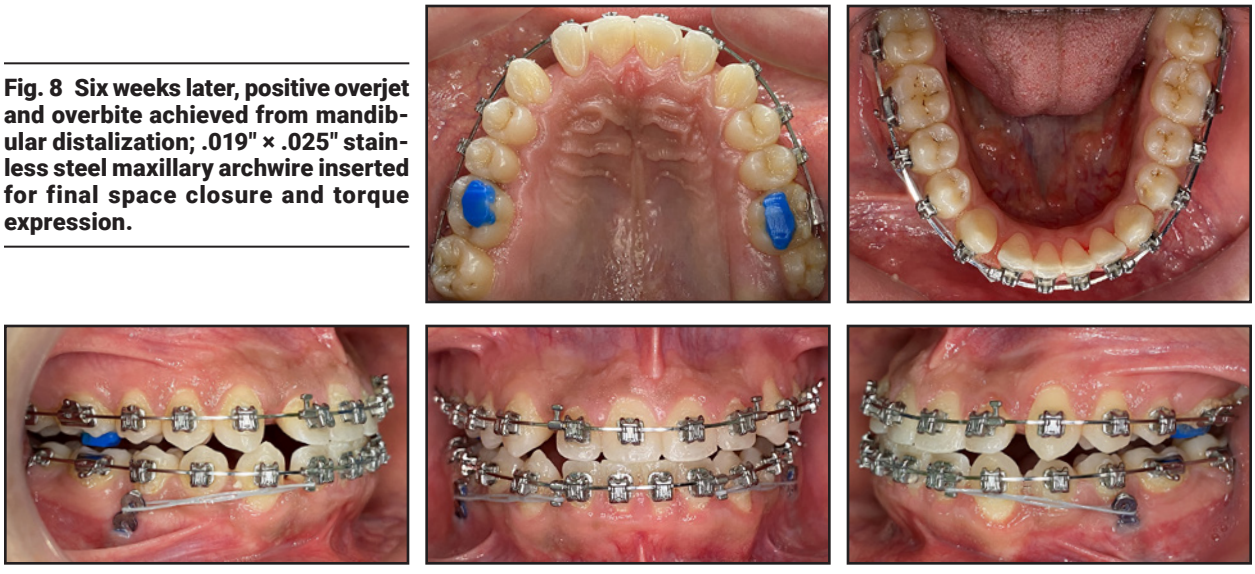

Fig. 8 Six weeks later, positive overjet and overbite achieved from mandibular distalization; .019" × .025" stainless steel maxillary archwire inserted for final space closure and torque expression.

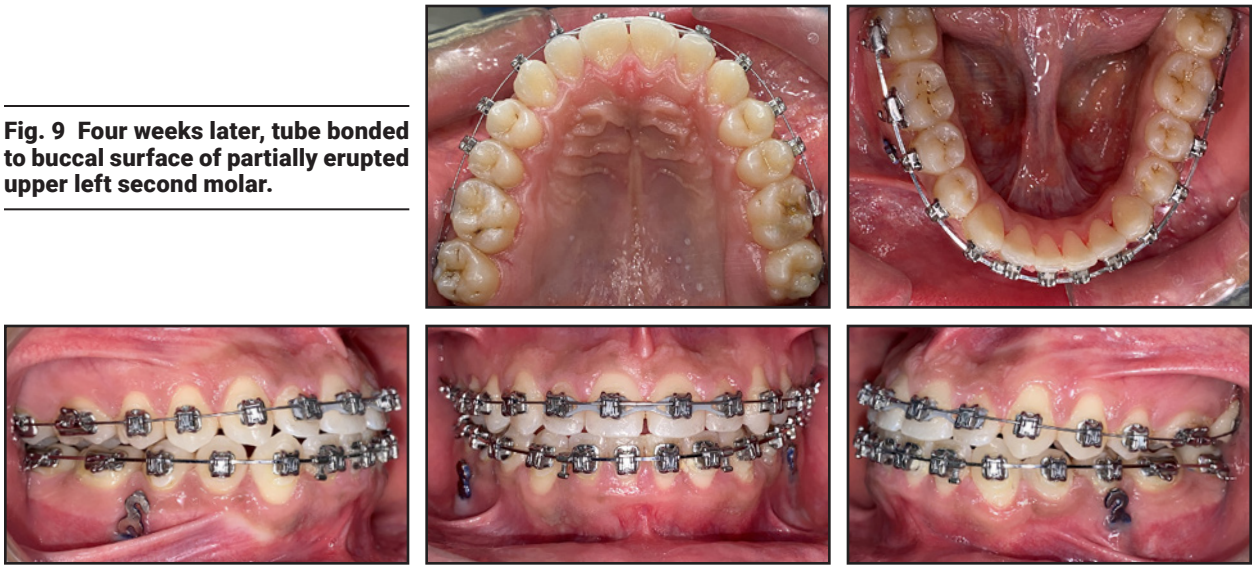

Fig. 9 Four weeks later, tube bonded to buccal surface of partially erupted upper left second molar.

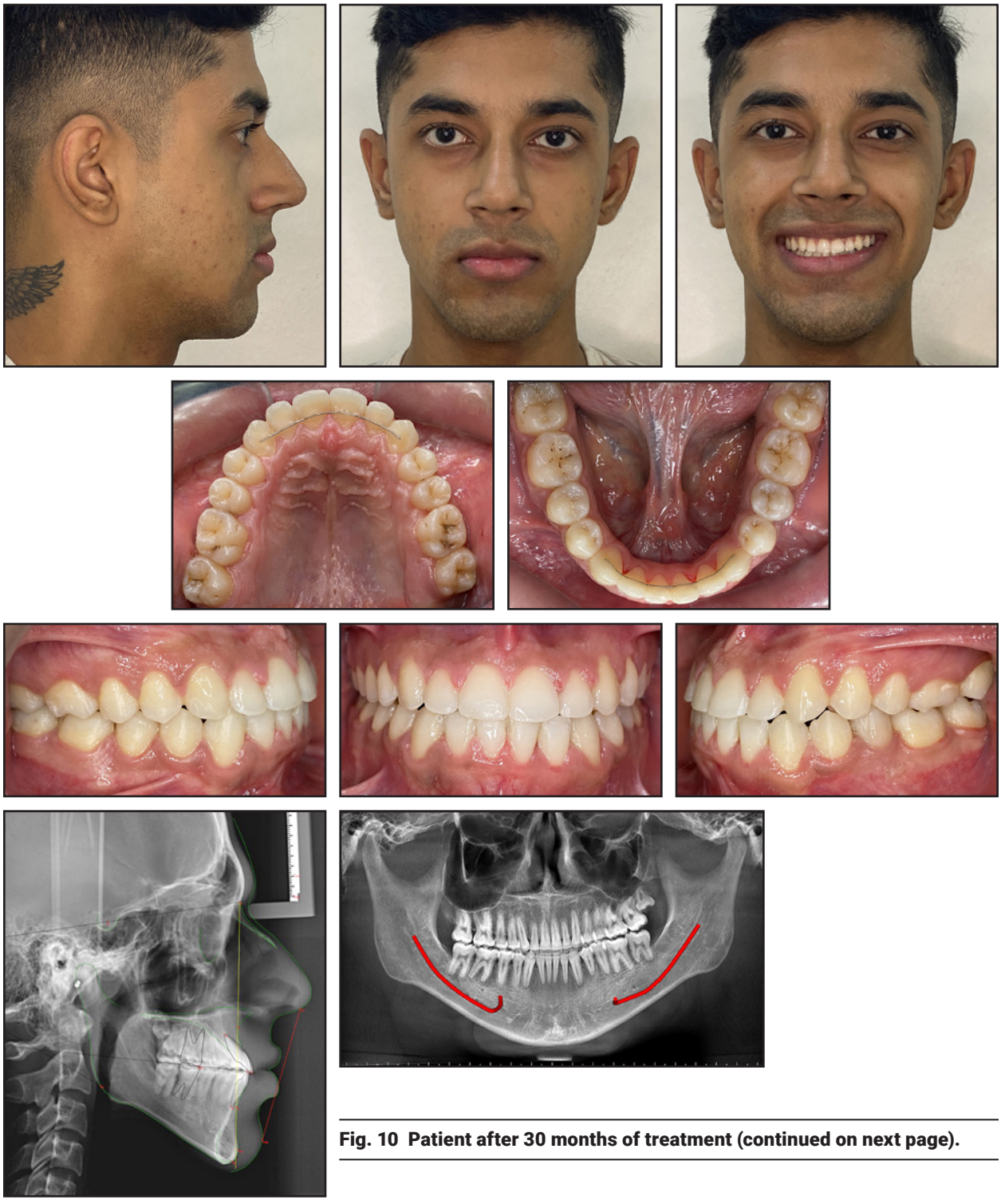

Fig. 10 Patient after 30 months of treatment (continued on next page).

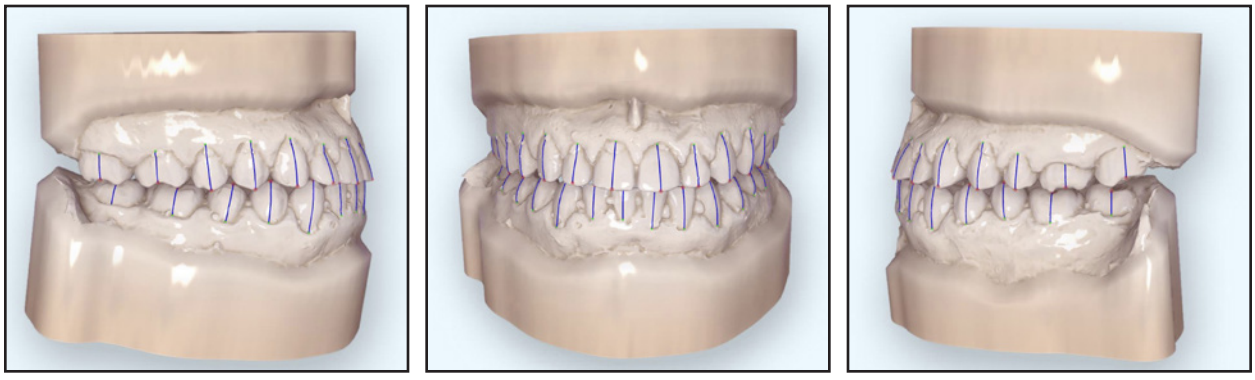

Fig. 10 (cont.) Patient after 30 months of treatment.

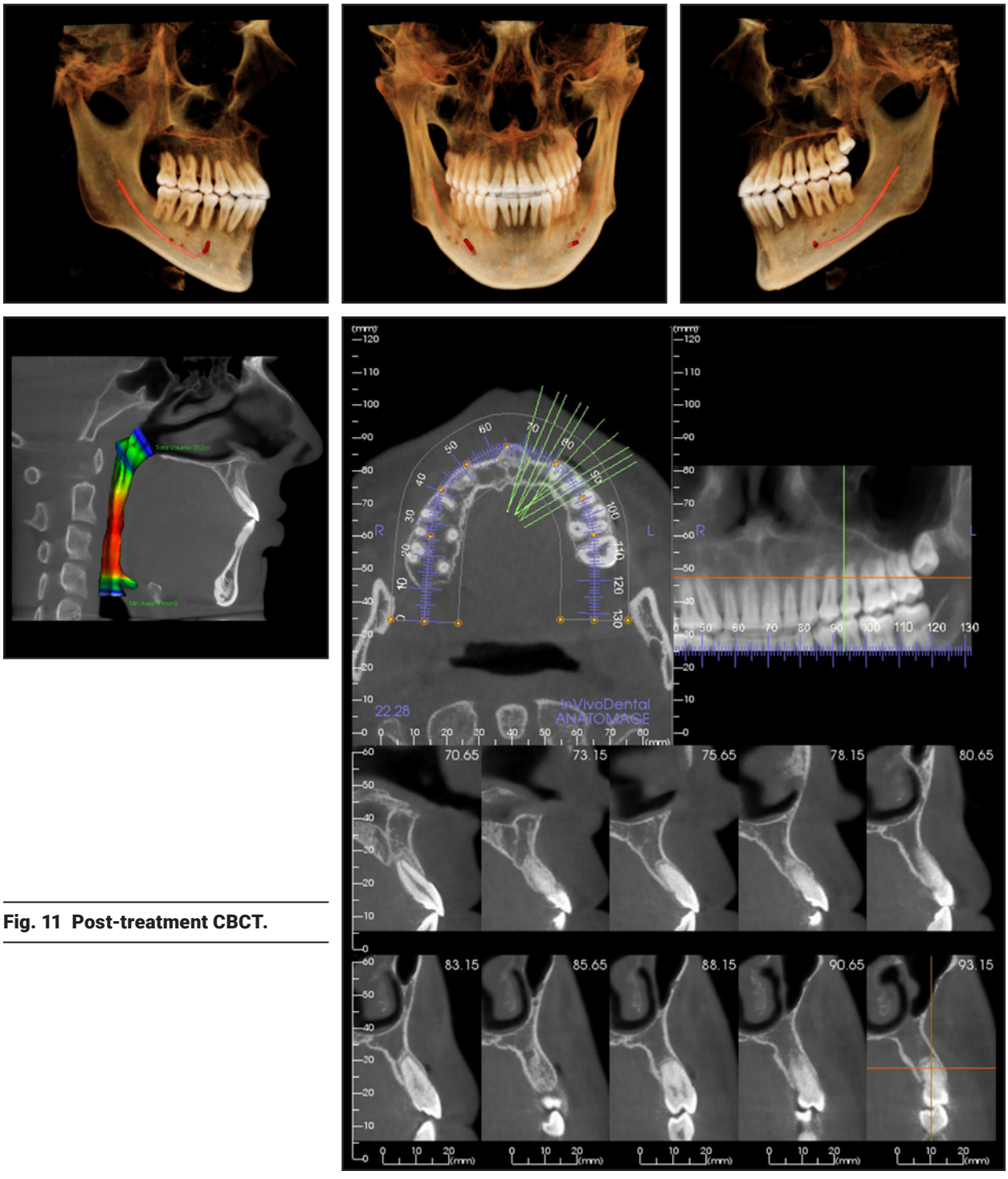

Fig. 11 Post-treatment CBCT.

Fig. 12 Patient 24 months after treatment.

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