CASE REPORT

Surgical-Orthodontic Treatment Using the Invisalign System

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Orthodontic malocclusions involving severe skeletal jaw discrepancies are best managed with a combination of orthodontic and surgical treatment. Historically, the surgery has been performed with fixed orthodontic appliances in place, even in patients treated primarily with the Invisalign* system.[1-5] Recent advancements in Invisalign treatment[6] and refinements in orthognathic surgical techniques, however, have allowed new approaches to the treatment of patients requiring both orthodontic and surgical treatment. The present article describes such a case in which the Invisalign system was used without fixed appliances.

Diagnosis

A 37-year-old male presented with a classic Class II, division 2 malocclusion (Fig. 1). Although the bite deformity was his primary concern, he also wanted esthetic improvement of his profile, which featured a retrognathic mandible. In addition, he reported chronic snoring and occasional episodes of sleep apnea that disrupted his sleep, causing excessive daytime tiredness, although no documented sleep study for obstructive sleep apnea had been performed. Cephalometric analysis confirmed the mandibular retrusion as well as mild maxillary retrusion, a slightly obtuse nasolabial angle, and posterior maxillary transverse hypoplasia (Table 1). The patient was informed that changing his profile would require orthognathic surgery,[7] which would simultaneously improve the orthodontic result.

The patient requested Invisalign treatment, stating that fixed appliances were incompatible with his business activities. After the results of a previous case involving mandibular advancement solely with aligners were reviewed with the patient, he committed to strict compliance with the Invisalign regimen, which is essential to achieving a good result.[6]

The patient was referred to a maxillofacial surgeon (Dr. Day) for surgical consultation, with the recommendation that the third molars be removed at the beginning of Invisalign treatment.

Treatment Plan

The orthodontic treatment plan involved alignment of both arches and advancement of the

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upper anterior teeth slightly beyond the ideal position, leaving open contacts distal to the lateral incisors (Fig. 2). This would allow the posterior segments to be seated in a Class I occlusion during the surgical advancement without incisor interference. The spaces would be closed after surgery with Invisalign Case Refinement.

The surgical treatment options were either mandibular advancement or a combination of bimaxillary advancement and chin

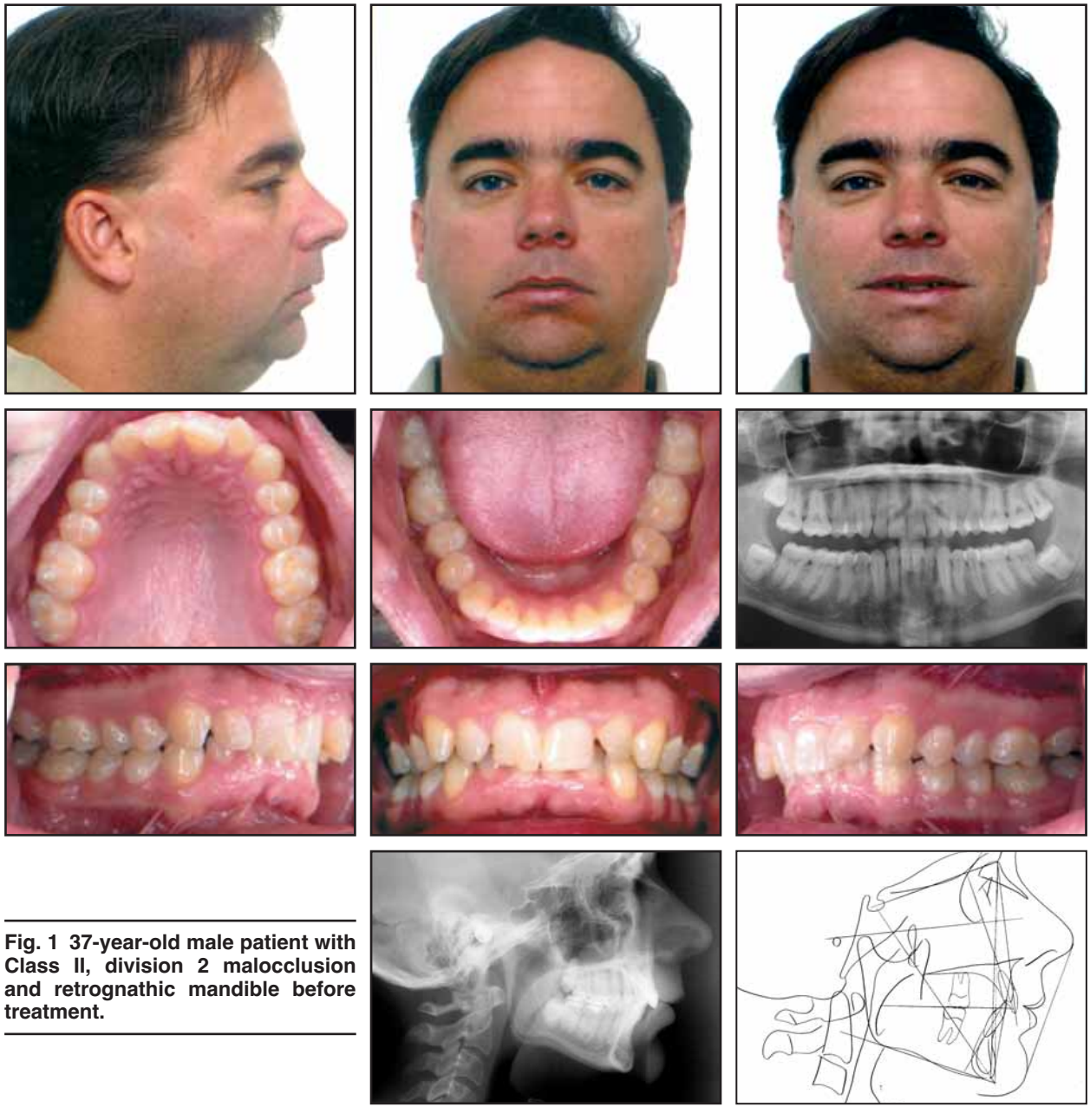

Fig. 1 37-year-old male patient with Class II, division 2 malocclusion and retrognathic mandible before treatment.

advancement. Advancing the mandible alone would correct the malocclusion but would not open the airway, and the patient did not want a uvulopalatopharyngoplasty (UP3) to resolve his snoring. Therefore, we planned a maxillomandibular advancement, which is now a widely accepted approach to the correction of snoring and sleep apnea.[8,9] After the preoperative tracing analysis, a plan was made for a two-piece Le Fort maxillary advancement of 7mm, with posterior widening for better occlusion; a mandibular advancement of 10mm; and a chin advancement of 8mm. The chin advancement was intended to

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TABLE 1
CEPHALOMETRIC DATA

	Pre-treatment	Post-Treatment
Facial angle	83.4°	89.6°
Mandibular plane angle	24.4°	28.9°
Y-axis	61.6°	58.4°
Angle convexity	15.9°	3.3°
SNA	76.4°	79.6°
SNB	68.1°	75.1°
ANB	8.3°	4.6°
Wits appraisal	9.9mm	0.0mm
Interincisal angle	128.9°	126.3°
U1-APo	7.0mm	3.8mm
U1-APo	30.1°	23.1°
L1-APo	–5.0mm	0.0mm
L1-APo	21.0°	30.6°
Facial height	43.9%	44.7%

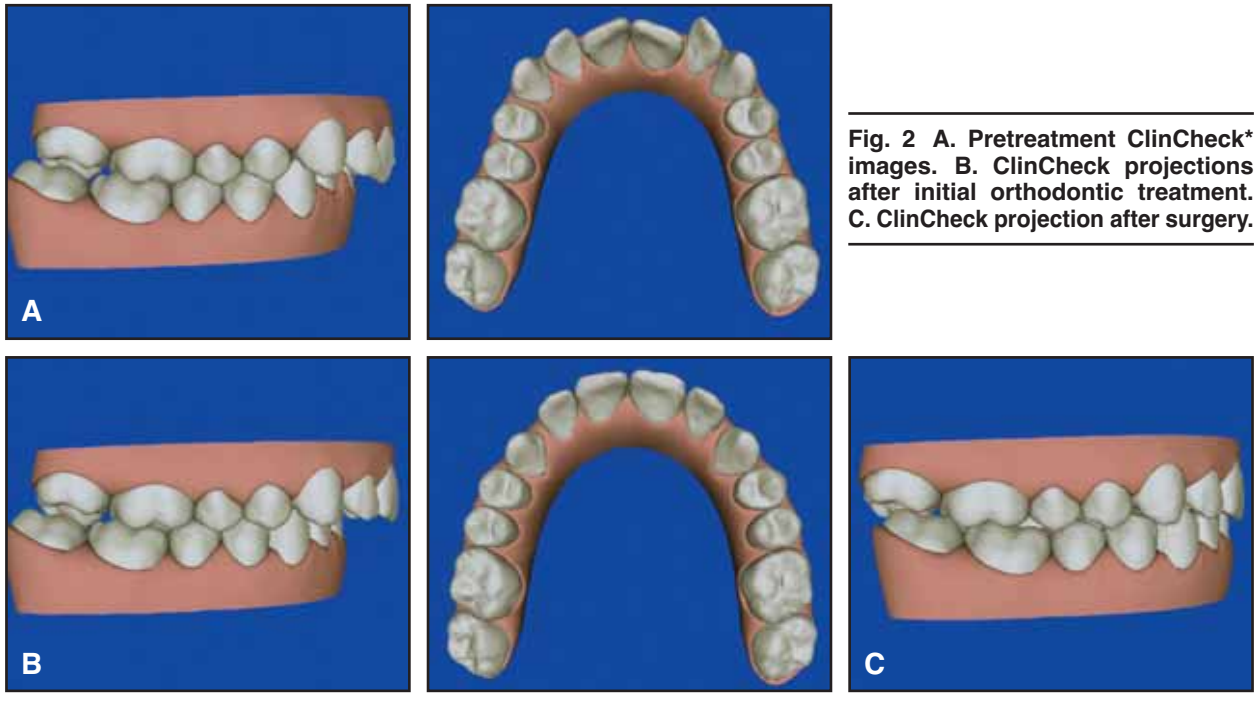

Fig. 2 A. Pretreatment ClinCheck* images. B. ClinCheck projections after initial orthodontic treatment. C. ClinCheck projection after surgery.

Fig. 3 Fracture bars placed during surgery.

improve the position of the hyoid bone and the genioglossal muscle, which would further open the posterior airway without creating a cosmetic imbalance.

Presurgical Treatment

Presurgical orthodontic treatment involved 22 upper and 13 lower aligners, along with lower interproximal reduction. The duration of aligner treatment was eight months.

Surgical Procedure

Surgery was performed six weeks following the end of aligner treatment. After induction of anesthesia, surgical arch bars were placed for stability during the procedure (Fig. 3). Bilateral sagittal split osteotomies of the mandible were performed, with an advancement of 10mm to create a temporary Class III occlusion, using maxillomandibular fixation (MMF) with a prefabricated splint as a guide. Three superior border screws were used for rigid fixation with the condyle in its proper position. The MMF was then released and the splint removed prior to maxillary surgery.

A two-piece Le Fort I osteotomy was performed, with a 7mm maxillary advancement to achieve a Class I relationship with the mandible. A prefabricated plastic palatal soft-tissue splint made from orthodontic plaster casts, cut precisely to widen the posterior maxilla about 4mm, was wired in position after the maxilla was down-fractured and the two-piece cut was made from the nasal side. The splint provided cross-arch stabilization similar to that of a palatal expansion device. Rigid fixation was then applied with pre-bent titanium plates.** Next, a genioplasty with 8mm of advancement was stabilized with another pre-bent titanium plate.[10] After excellent stability and rigidity had been achieved, the wire fixation was removed.

Postsurgical Treatment

Postoperative occlusal stability was maintained with light intermaxillary elastics, which ensured the maintenance of a Class I occlusion and helped begin muscle retraining. After six weeks of weekly follow-up visits and elastic changes, the arch bars were removed under local anesthesia. The palatal soft-tissue splint was easily removed without anesthesia.

Approximately three weeks after surgery, the original aligner attachments were removed, and thermoformed retainers were placed. The patient reported that he would be out of the country for the next several weeks, but the stability of the rigid fixation was deemed sufficient to maintain the surgical result.

Eight weeks after surgery, diagnostic records and polyvinyl siloxane impressions were taken for the Case Refinement stage (Fig. 4). Although some remaining anterior protrusion with an adequate posterior relationship was expected after surgery (Fig. 2C), the anterior open contacts had partially relapsed prior to surgery, and the mandibular advancement therefore left a slight posterior open bite. The initial refinement ClinCheck* images (Fig. 5A) featured the beveled horizontal rectangular attachments

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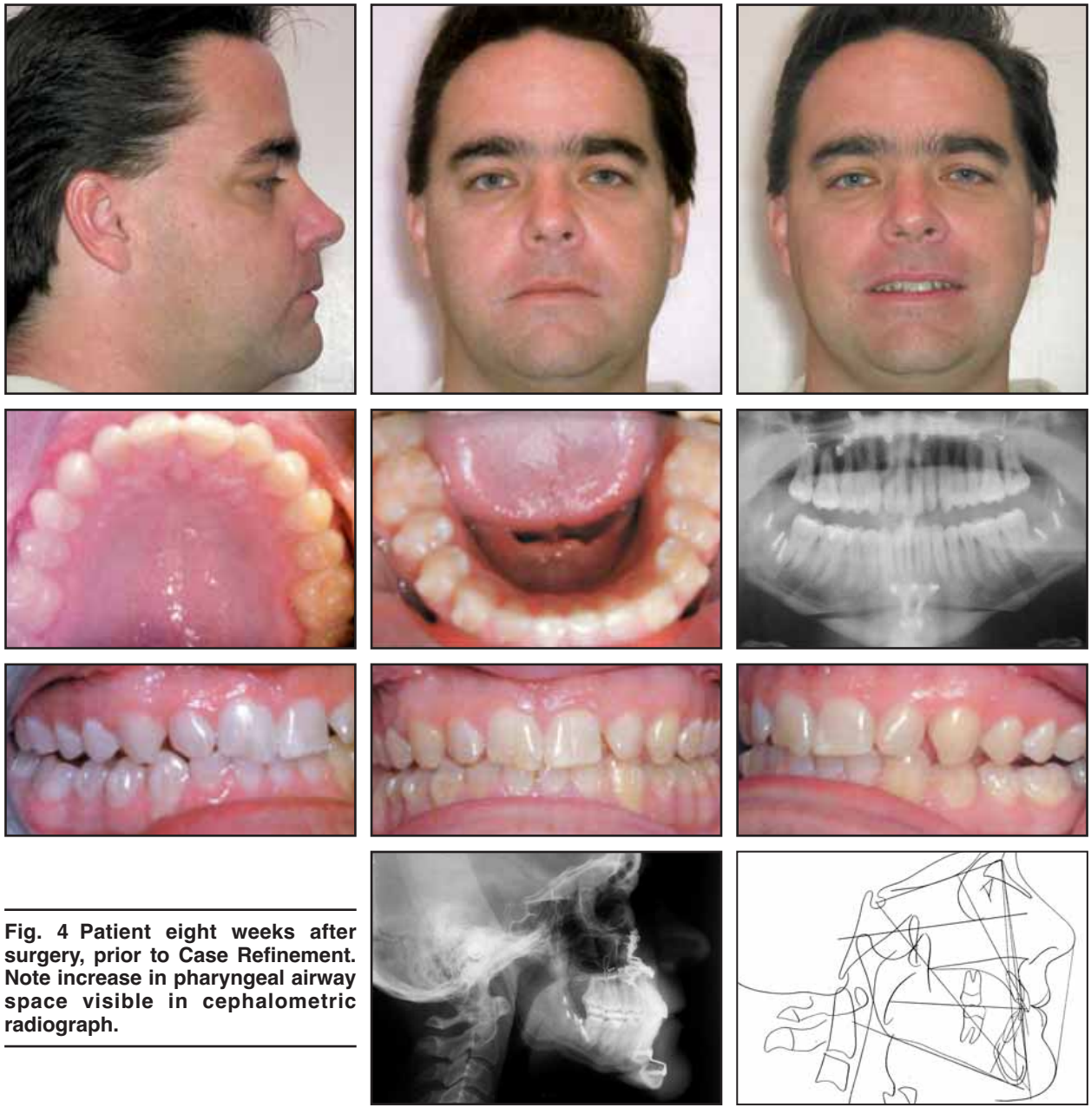

Fig. 4 Patient eight weeks after surgery, prior to Case Refinement. Note increase in pharyngeal airway space visible in cephalometric radiograph.

that have proved more effective than previous attachments in accomplishing vertical movements with aligners.[11,12] The post-refinement ClinCheck images (Fig. 5B) showed predictable movement with increments of .15mm per stage.[11,12]

The six-month refinement stage, which began six weeks after the postsurgical records were obtained, involved 15 upper aligners and six lower aligners (Fig. 6). Thermoformed retainers were then delivered, but the patient was

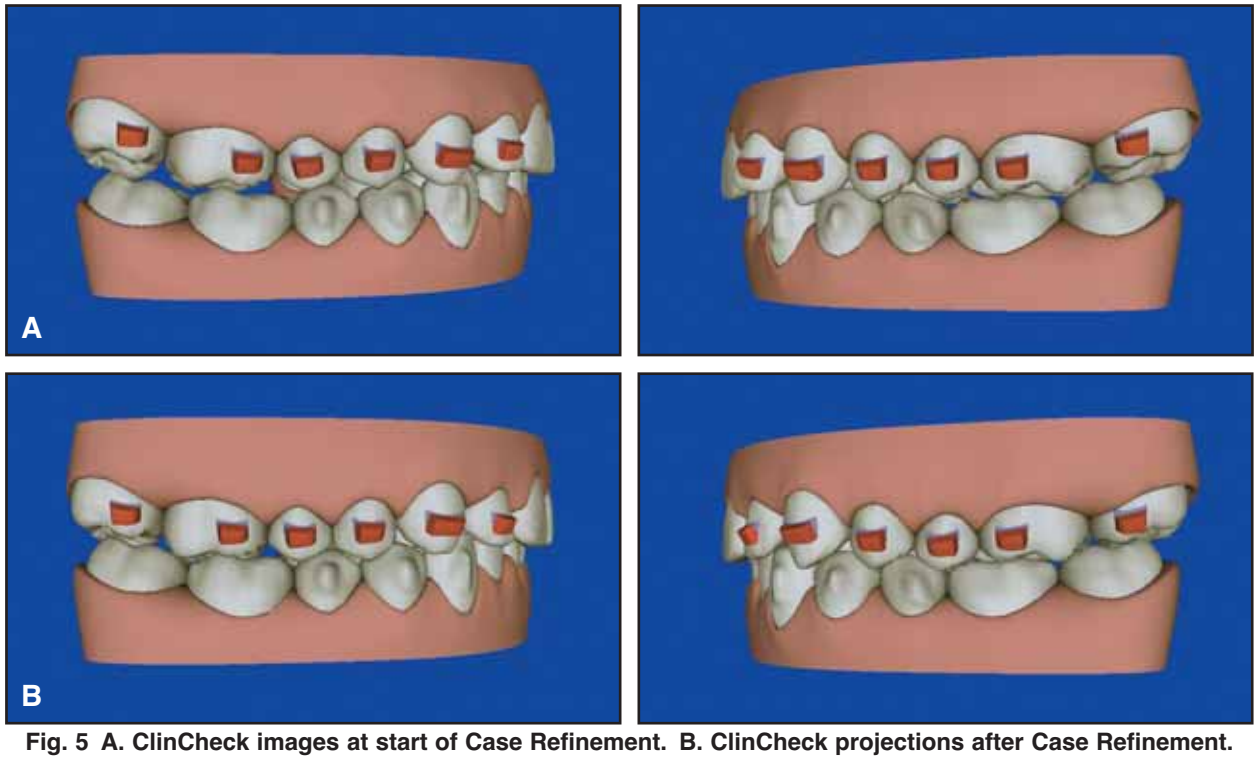

Fig. 5 A. ClinCheck images at start of Case Refinement. B. ClinCheck projections after Case Refinement.

Fig. 6 Patient after six months of Case Refinement.

not available for treatment for another six weeks. Further refinement of the molar occlusion was then carried out for an additional two months, using vertical elastics attached to buttons on the posterior teeth (Fig. 7). Final thermoformed retainers were delivered several days later. Including several periods when the patient was out of the country, the total treatment time was 22 months (Fig. 8).

Fig. 7 A. Patient before additional refinement with vertical elastics. B. After two months of refinement.

Treatment Results

A Class I occlusal relationship was achieved, and the retrognathic skeletal pattern was corrected. Superimposition of pre- and post-treatment cephalometric tracings demonstrated significant changes in the key skeletal measurements and improvement in the nasolabial angle (Fig. 8B, Table 1). Some postoperative rotational relapse in the upper lateral incisors was noted, but this was corrected during the Case Refinement, which is an integral part of the Invisalign treatment-planning process.

Postoperative cephalograms showed a significant increase in the pharyngeal airway space (Fig. 4). The patient experienced complete elimination of snoring and apnea episodes immediately after surgery.[13] No postoperative periodontal problems involving the interdental wires were noted.

The surgical results remained stable throughout the treatment period. At a retention follow-up visit nine months after the end of treatment, the patient showed excellent long-term orthodontic stability (Fig. 9), with the occlusion closely matching the ClinCheck projections (Figs. 2,5).

Discussion

This case demonstrates that placement of fixed orthodontic appliances is not always necessary prior to orthognathic surgery, even in the presence of complex orthodontic, surgical, and medical problems. Although the techniques used in this case are routine in orthognathic and facial fracture surgery,[7,13] the surgeon's experience with more than 2,000 orthogathic surgeries contributed to the excellent result. Rigid internal fixation of the maxilla, mandible, and chin has been shown to result in little or no relapse.[10,14]

The goal of maxillomandibular advancement in the treatment of airway disorders is to maximize the upper airway space and reduce airway resistance.[15,16] Maxillary advancement pulls the palatal soft tissues forward and upward and opens the nasal valve. Mandibular and chin advancements bring the base of the tongue and the palatoglossus muscle forward and improve the position of

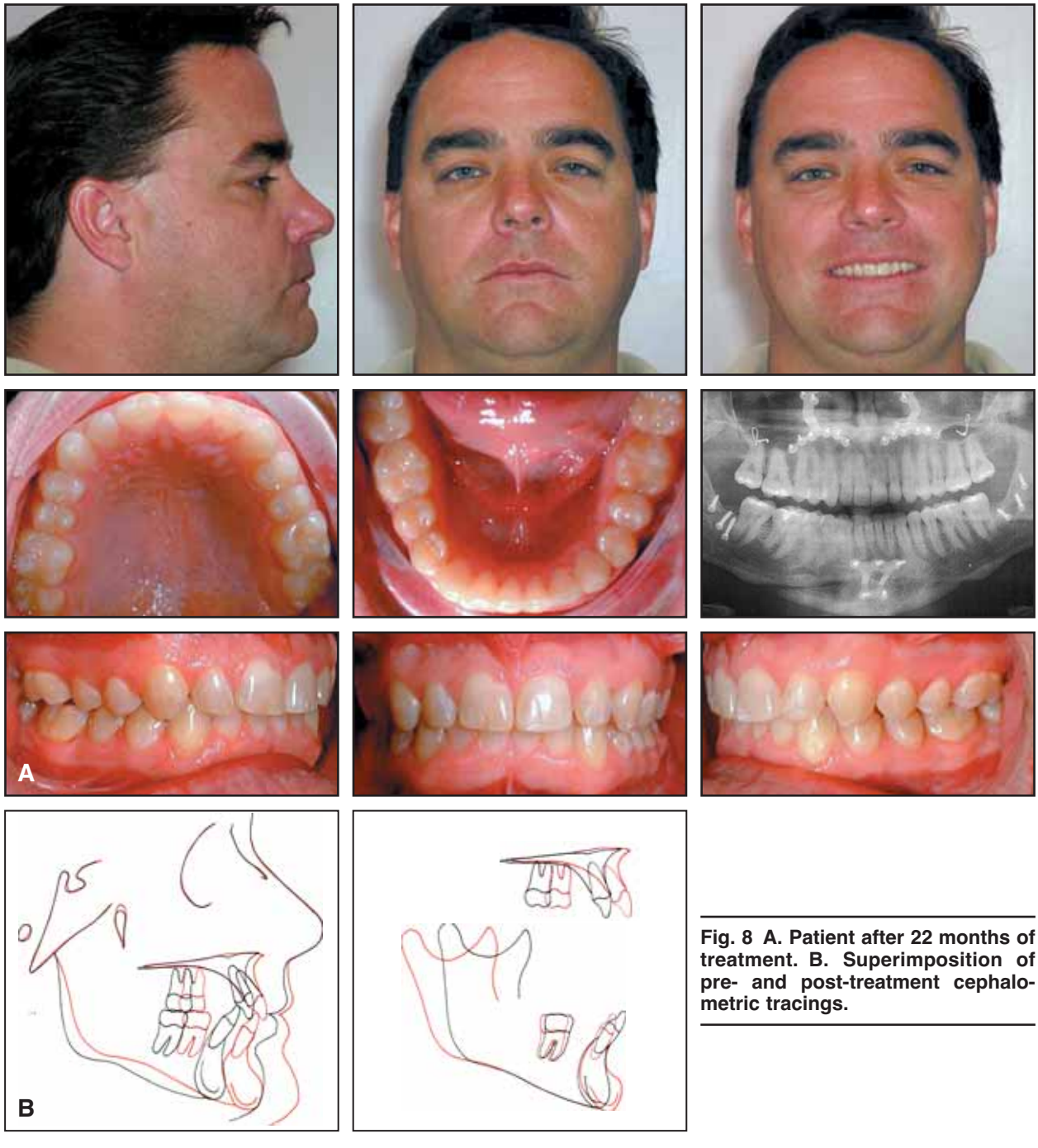

Fig. 8 A. Patient after 22 months of treatment. B. Superimposition of pre- and post-treatment cephalometric tracings.

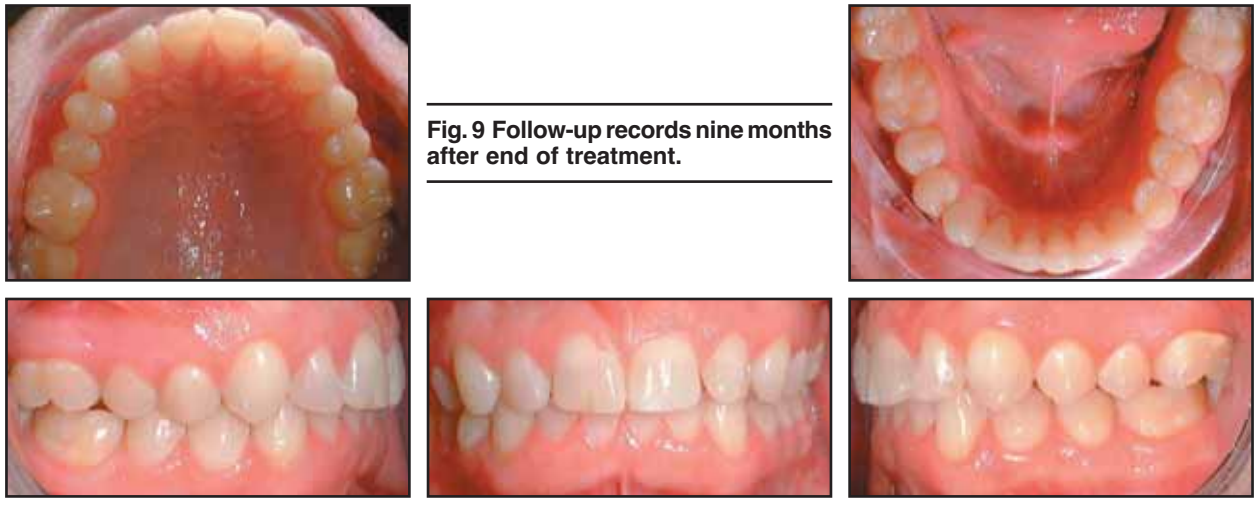

Fig. 9 Follow-up records nine months after end of treatment.

the hyoid bone. Avoidance of UP3 in this case prevented the development of hypernasal speech, which is a rare complication.[15,16]

The fracture bars attached during surgery allowed the use of light intermaxillary elastics, which enabled the patient to quickly resume wearing his trimmed Invisalign aligners after surgery (Fig. 3). Another option is to place miniscrews before surgery for elastic attachment in both arches.

The patient was highly satisfied with the final functional and esthetic outcome and reported a significant improvement in his sleep quality. His compliance with all phases of the treatment regimen contributed significantly to its success.

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