Anterior open bite correction with 2-jaw orthognathic surgery

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A 26-year-old man with an anterior open bite was treated with orthodontics combined with 2-jaw surgery. Total treatment time was 19 months. Both his occlusion and facial appearance were significantly improved by the surgical-orthodontic treatment. (Am J Orthod Dentofacial Orthop 2019;155:108-16)

The etiology of anterior open bite (AOB) includes dental, skeletal, soft tissue, respiratory, neurologic, genetic, and habitual factors.[1-3] Because of multiple etiologic factors and a high relapse rate, patients with AOB are difficult to treat.[2]

Patients with dental AOB display a normal craniofacial pattern with undererupted anterior teeth and inadequate mandibular curve of Spee. Skeletal AOB is generally associated with decreased posterior facial height and increased lower anterior facial height; steep mandibular plane angle; decreased angle between sella, nasion, and the palatal plane; increased gonial angle and angle between the palatal plane and the mandibular plane, with either normally erupted or overerupted anterior teeth.[4,5]

The treatment modalities to correct AOB depend on proper diagnosis and treatment planning. Conventional approaches have included high-pull headgear, multiloop edgewise archwires, tongue cribs, posterior bite blocks, posterior magnets, and vertical elastics.[2,5] The gold standard treatment for a patient with a skeletal AOB has been a combination of orthodontic treatment and orthognathic surgery.[2] LeFort I osteotomy with posterior impaction either alone or combined with mandibular osteotomy has also been commonly used to treat adults with skeletal AOB. Superior repositioning of the maxilla is used to obtain the correct facial height and maxillary incisor display, and mandibular osteotomies are used to adjust the sagittal position of the mandible if it does not rotate into the correct position after the maxilla is repositioned.[6] Proffit et al[6,7] reported the hierarchy of stability for orthognathic surgery procedures. They also reported that maxillary impaction alone is more stable than 2-jaw surgery to correct skeletal AOB.[6]

This article presents an anterior open bite correction with orthodontics combined with 2-jaw surgery.

DIAGNOSIS AND ETIOLOGY

A 26-year-old white man's chief complaint was an open bite. He had previously obtained orthodontic treatment when he was 13 years old. At his current presentation for orthodontic treatment, he was diagnosed by a speech pathologist who observed that he had severe articulation impairment and a tongue thrust habit. He was mesofacial with a straight profile, an obtuse nasolabial angle, paranasal hollowing with a wide alar base, nose deviation to the right, and chin deviation to the left. He had a Class III skeletal deformity, maxillary hypoplasia, mild mandibular prognathism, skeletal open bite, and an occlusal cant. In the temporomandibular joint evaluation, he did not have any signs or symptoms.

Intraorally, he had end-on Class III molar relationships bilaterally, a Class III canine relationship on the right, and a Class I canine relationship on the left. The maxillary dental midline was 1 mm to the right of the facial midline, and the mandibular dental midline was 2 mm to the left. His overjet was −1.0 mm on the maxillary left central incisor, and his anterior open bite was 7.0 mm on the maxillary right central incisor. He also had lateral open bites, a flat curve of Spee, and occlusal contacts on only his second molars.

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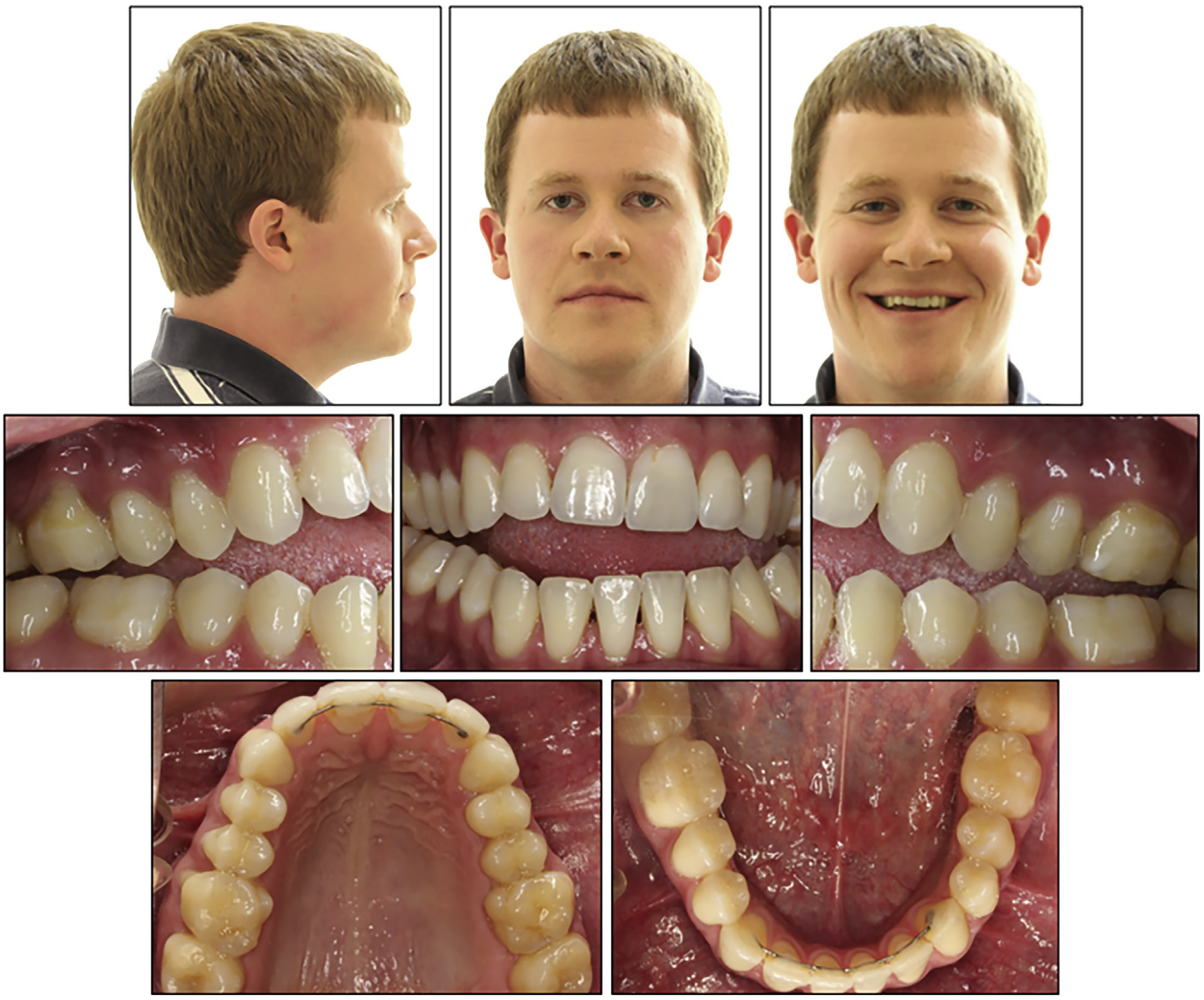

Fig 1. Pretreatment facial and intraoral photographs.

Even though he had anterior and posterior crossbites, when his mandible was guided into centric relation, a functional shift was not detected. Both arches had mild crowding, and there was minimal gingival attachment in the mandibular anterior teeth and gingival recession on the maxillary first molars. There was no maxillary incisor display at rest, but upon smiling, he showed approximately 50% of the maxillary incisors. There was also a Bolton discrepancy due to small maxillary lateral incisors (Figs 1 and 2).

A panoramic radiograph showed that all third molars had been extracted.

A posteroanterior cephalometric radiograph showed that the occlusal plane canted down on the left side. In addition, the mandibular right and left borders were not symmetrical. A Rocky Mountain transverse analysis[8] showed that the difference between the expected and actual differentials of the mandibular and maxillary widths was 6.3 mm. Therefore, surgically assisted rapid palatal expansion or segmental LeFort I osteotomy might be needed to correct the transverse maxillary deficiency.

The lateral cephalometric analysis indicated a skeletal Class III pattern (ANB, 1.1°; Wits appraisal, −7.9 mm) with a hyperdivergent growth pattern (SN-MP, 37.0°). The maxillary incisors had a normal inclination (U1-SN, 104.0°) and the mandibular incisors were retroclined (IMPA, 90.2°) (Fig 3; Table). The patient had a familial skeletal Class III and open bite pattern, so the etiology of his malocclusion appeared to be a combination of hereditary and environmental factors. His American Board of Orthodontics Discrepancy Index score was 77 (Supplemental Fig 1).

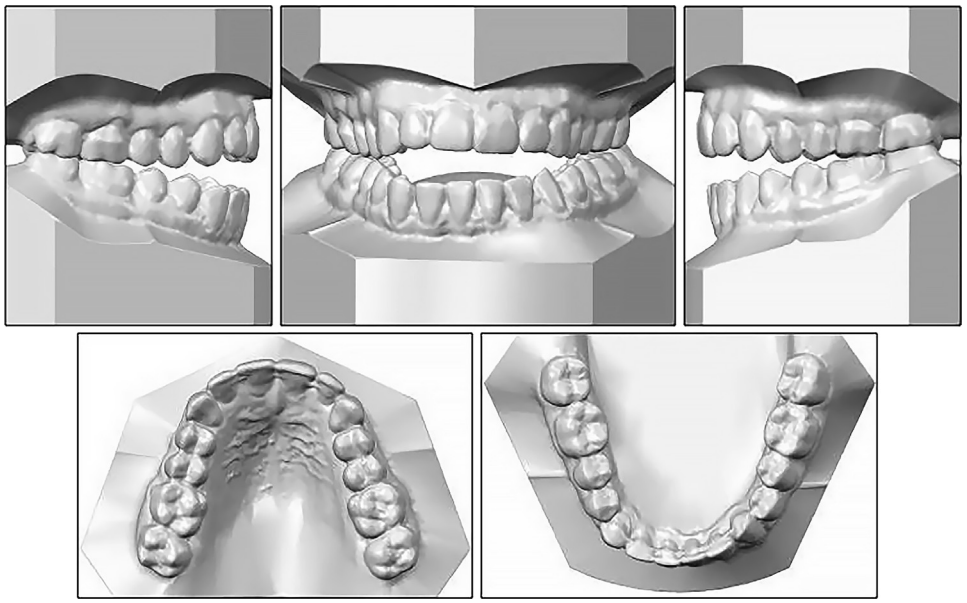

Fig 2. Pretreatment dental casts.

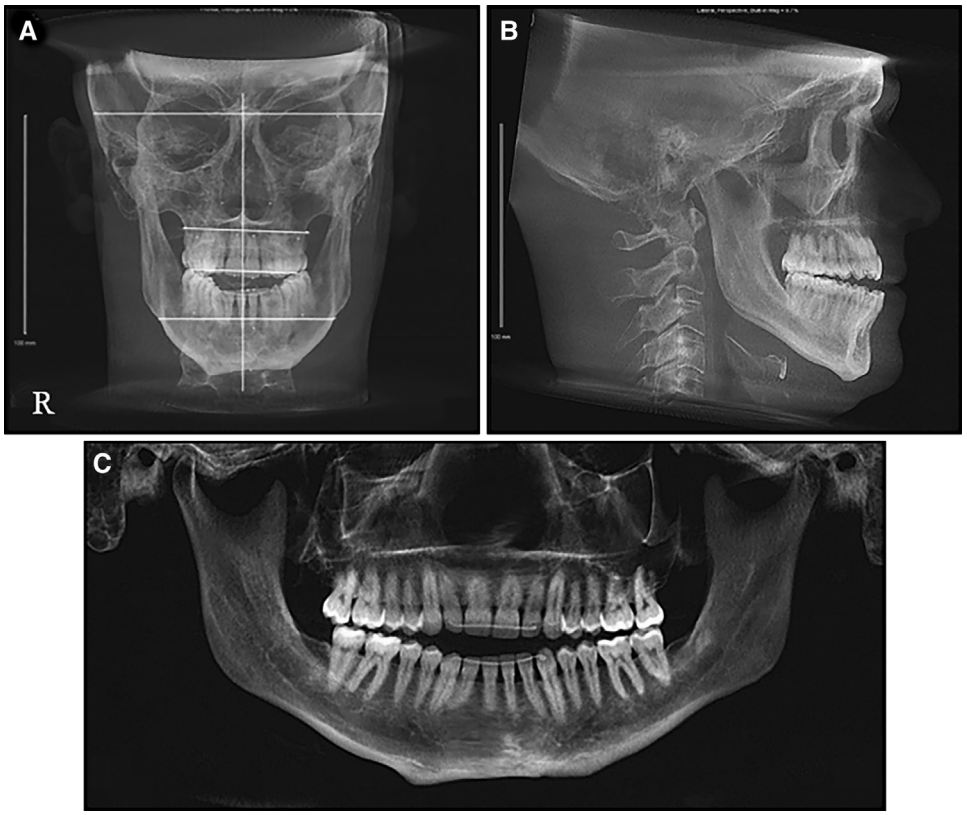

Fig 3. Pretreatment radiographs: **A,** posteroanterior cephalogram; **B,** lateral cephalogram; **C,** panoramic radiograph.

Table. Cephalometric measurements

Measurement	*Norm*	*Pretreatment*	*Posttreatment*
SNA (°)	82.0	83.1	85.2
SNB (°)	80.0	82.0	83.0
ANB (°)	2.0	1.1	2.2
Wits appraisal (mm)	−1.0	−7.9	−2.0
SN-MP (°)	32.0	37.0	36.5
FH-MP (°)	25.0	21.6	23.4
LFH (ANS-Me/N-Me) (%)	55.0	58.0	54.0
U1-SN (°)	104.0	104.0	106.0
U1-NA (mm)	4.0	5.0	4.2
IMPA (°)	90.0	90.2	88.5
L1-NB (mm)	4.0	7.0	4.0
U1/L1 (°)	131.0	128.0	136.0
Upper lip to E-plane (mm)	−4.0	−9.0	−6.0
Lower lip to E-plane (mm)	−2.0	−5.0	−4.0

TREATMENT OBJECTIVES

The following treatment objectives were established: (1) correct the jaw deformities, (2) correct the open bite, (3) correct the crossbites, (4) establish Class I molar and canine relationships, (5) obtain normal overbite and overjet, (6) correct the midlines, and (7) improve the facial and dental esthetics.

TREATMENT ALTERNATIVES

1. Since the patient was already fully grown, the ideal treatment would be a combination of orthodontics and orthognathic surgery: a 3-piece LeFort I maxillary advancement osteotomy with differential impaction; expansion of the posterior segments; and down-fracture of the anterior segment to correct the open bite, transverse discrepancy, midface deficiency, occlusal cant, maxillary midline, and maxillary incisor display. After autorotation of the mandible, a bilateral sagittal split osteotomy could be considered to correct the open bite, mandibular asymmetry, and midline. Computer-aided surgical simulation using NemoFAB software (Nemotec, Madrid, Spain) would be used to visualize the expected segment orientation and positioning, evaluate possible bony interferences and type of fixation, and assess the possible grafting needs. Virtual surgical planning would provide a detailed analysis for the presurgical workup and illustrate the multidimensional corrections at the dental and skeletal levels (Figs 4 and 5). In addition, the virtual surgical planning could be used to construct the surgical jigs and splints. Virtual surgical planning provides preoperative insight into the expected dental and skeletal movements, osteotomy orientation, and accurate transfer of the virtual plan into the surgery with a constructed surgical splint.[9]
2. Another possibility would be camouflage orthodontic treatment with temporary skeletal anchorage devices (TSADs). They would be used to slowly expand the posterior teeth and intrude the maxillary molars; this would allow autorotation of the mandible and thus closure of the bite. Extraction of the mandibular premolars or 1 mandibular incisor to correct the anterior crossbite could be considered.
3. An alternative camouflage treatment would be orthodontic treatment with extraction of the maxillary second premolars and mandibular first premolars, and extrusion of the maxillary and mandibular incisors. However, these treatment option results would be unstable and would compromise the facial esthetics.

The patient decided on the first treatment option that involved surgical correction.

TREATMENT PROGRESS

The patient was referred to a periodontist for evaluation of his thin mandibular anterior gingiva and recessions. He was also evaluated by a speech pathologist. Preadjusted appliances with 0.022 × 0.028-in slots were bonded on both arches. The teeth were leveled and aligned with a progression of wires to the final presurgical 0.019 × 0.025-in stainless steel wires. Nickel-titanium open-coil springs and V-bends were placed between the maxillary lateral incisors and canines to diverge the roots and open some space for the surgical cuts according to the surgeon's request. Surgical hooks were attached to both archwires.

Surgery proceeded without complications. The surgical splint was maintained for 6 weeks postoperatively to stabilize the maxillary expansion. Once the surgical splint was removed, posterior up-and-down elastics (3/16 in, 6 oz) were used to close the bite and establish interdigitation of the buccal segments. Interproximal reduction was used on the anterior teeth to eliminate some black triangles and establish proper overbite and overjet. The treatment was completed in 19 months, and retainers were placed. Maxillary and mandibular wraparound Hawley retainers were delivered, and the patient was instructed to wear them full time for 6 months and at night only thereafter. Myofunctional therapy was also strongly recommended to correct his tongue thrust habit.

TREATMENT RESULTS

Evaluation of the posttreatment records showed that the treatment objectives had been achieved (Figs 6-8). The posttreatment records showed improvement

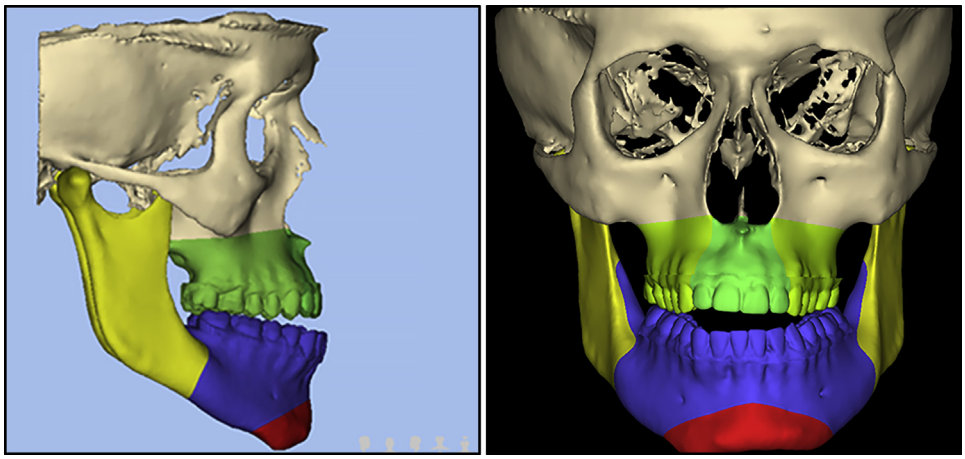

Fig 4. Virtual surgical planning: frontal and lateral 3-dimensional images via NemoFAB software.

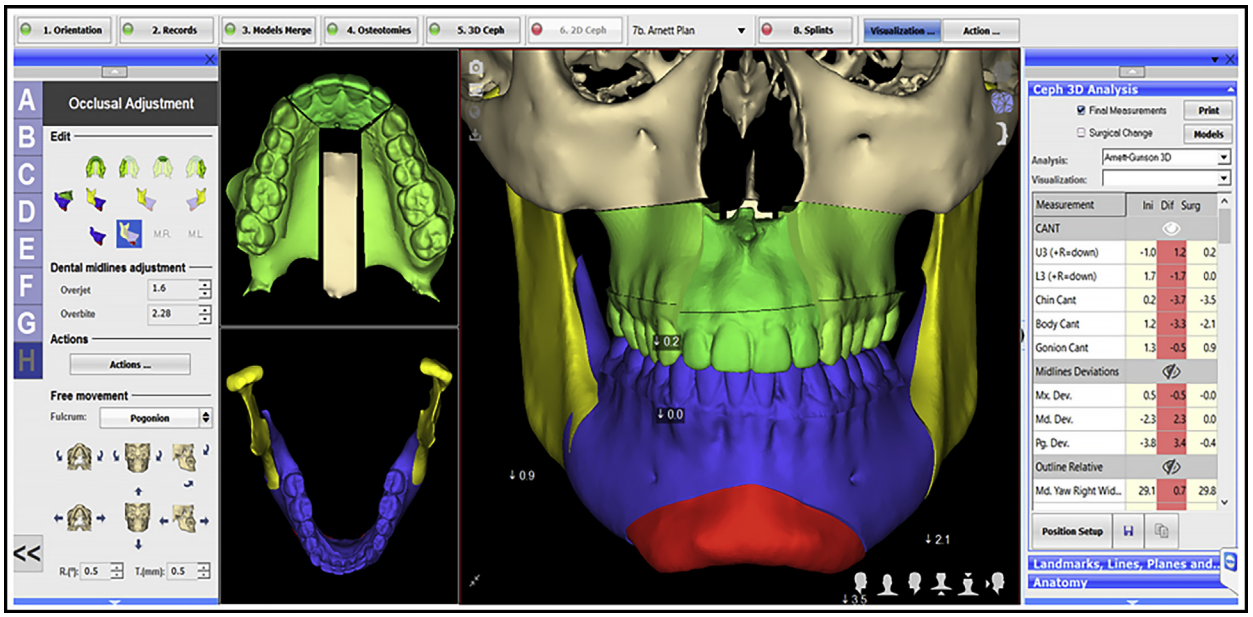

Fig 5. Virtual surgical cuts and numbers (NemoFAB software).

in facial esthetics, correction of mandibular asymmetry, established Class I dental relationships, corrected midlines, improved smile line and maxillary incisor display, and correction of open bites and crossbites. A posttreatment panoramic radiograph showed good overall root alignment and no evidence of significant root resorption except for the maxillary central incisors. A posteroanterior cephalometric radiograph showed correction of the occlusal cant and facial symmetry. Plastic surgery was suggested to contour the lower border of the mandible, but the patient rejected a second operation because he was satisfied with the treatment outcome and did not want the risk of inferior alveolar nerve damage.[10,11]

The lateral cephalometric analysis showed a slight skeletal improvement (ANB, 2.2°). The maxillary incisors showed no significant changes (U1-SN, from 104.0° to 106.0°), and the mandibular incisors showed a slight retroclination (IMPA, from 90.2° to 88.5°), and there was improvement of the facial profile as shown by the position of the upper and lower lips to the E-line. The temporomandibular series showed well-positioned condyles in the gleniod fossae, and the patient had no signs or symptoms of temporomandibular

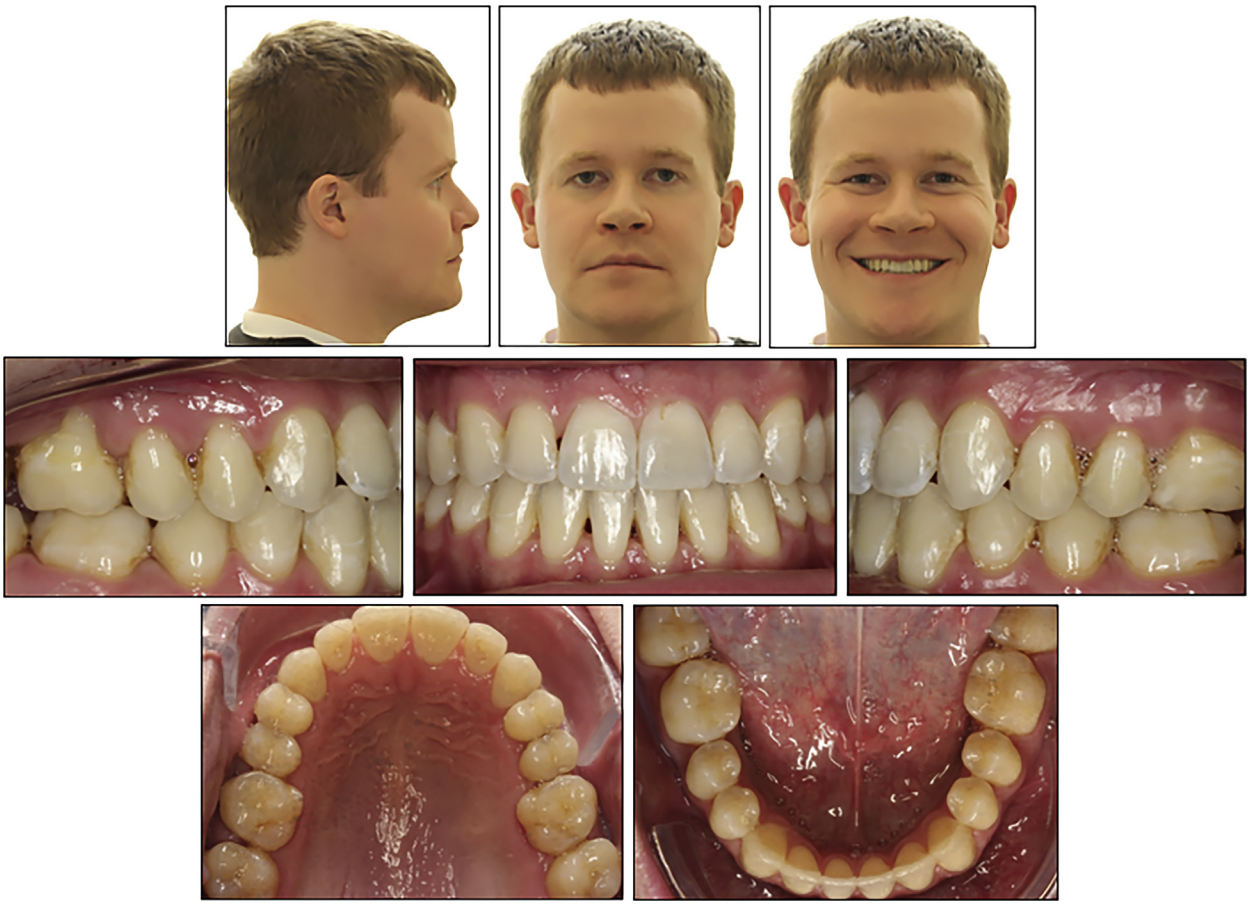

Fig 6. Posttreatment facial and intraoral photographs.

joint disorder (Figs 8-10; Table). The American Board of Orthodontics Cast-Radiograph Evaluation score was 24 (Supplemental Fig 2).

DISCUSSION

It is extremely difficult to close an interincisal gap of more than 5 mm with just orthodontics.[12] Orthognathic surgery has been an ideal treatment option to correct skeletal discrepancies in adults with AOB. Although it provides relatively stable outcomes by positive incisor overlap,[6] the actual stability of the AOB closure largely depends on the surgical procedure. Since maxillary procedures are hardly influenced by muscular activity and they allow for correction of the lip-to-incisor relationship,[13] superior repositioning of the maxilla with a Le-Fort I osteotomy is considered the most stable orthognathic procedure for correcting skeletal open bites.[7,14] Therefore, although it is possible to correct an open bite with mandibular ramus osteotomy as an isolated procedure,[15] the less stable results with mandibular surgery alone make 2-jaw surgery generally more preferred when there is an abnormal maxillomandibular relationship.[6]

The success of orthognathic surgery seems to depend on the severity of the initial malocclusion. Previous studies have reported that postoperative stability is greatest in Class III malocclusions when there is postural relaxation of the mastication and hyoid muscles due to mandibular backward repositioning.[13,16] In contrast, postoperative stability is insufficient for AOB closure of Class II malocclusions with just mandibular ramus osteotomy.[14] The greater instability with Class II patients could be due to postsurgical condylar resorption and relapse. These results can restore positive overjet and also cause the mandible to shorten.[6]

Skeletal Class III patients with AOB and mandibular excess or long faces are most favorably treated with orthognathic surgery because of the direct shortening of the mandibular skeletal excess and anterior face height.[12] There is, however, unavoidable relapse associated with all surgical procedures; this should be

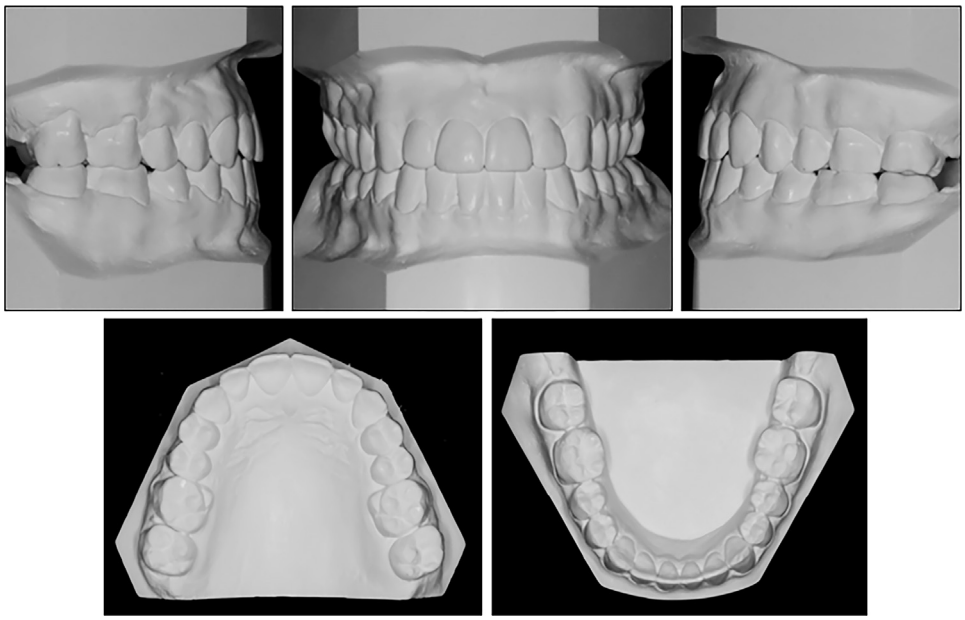

Fig 7. Posttreatment dental casts.

considered separately, depending on the dental and skeletal reorganizations. Dental relapse results in an increased open bite, whereas skeletal relapse is seen as an increased mandibular and intermaxillary plane angle postoperatively.

Profitt et al[6] reported a 7% overbite decrease (relapse) in the maxillary osteotomy group and a 12% relapse in the bimaxillary group. However, both groups maintained stable overbite relationships by the eruption of the anterior teeth. The relative skeletal relapse associated with overbite closure was determined by point B moving inferiorly by more than 2 mm as seen in a third of the patients in the maxillary osteotomy-only group and in 40% of the 2-jaw surgery group. Despite the increased skeletal relapse in that study, there was almost no change in overbite after the maxillary osteotomy procedures, and the small changes in the bimaxillary group were not statistically significant. Therefore, it is possible that the extent of skeletal relapse is concealed by dental compensation through incisor eruption, which maintains the overbite relationship.[6,14]

Too much incisor display is esthetically unappealing and should be avoided in patients with increased lower anterior facial height. Since AOB patients often have 2 occlusal planes, incisal elongation is likely during the leveling and finishing phases of treatment for surgery patients.[12] Ding et al[17] also reported that posttreatment stability of AOB closure after surgery largely depends on natural extrusion of the anterior teeth to allow for skeletal relapse. This means that other options should be considered for treatment that incorporate different methods for treating AOB.

Molar intrusion using TSADs has been shown to retard posterior vertical dentoalveolar development, something that makes TSADs the optimal treatment for adolescents with a hyperdivergent growth pattern.[18] When choosing AOB correction with TSADs for intrusion of posterior teeth rather than extrusion of anterior teeth, the ideal indication might be mild skeletal open bite with a slight Class II skeletal discrepancy, increased posterior alveolar height, increased lower anterior facial height, excess gingival display, and increased maxillary incisor display at rest. If a patient has a severe skeletal open bite, a severe anteroposterior discrepancy, facial asymmetry, and incompetent lips, orthognathic surgery might be the best option. In our patient, because he had a skeletal open bite along with a constricted maxilla and Class III skeletal deformity and asymmetry, the surgical treatment option was chosen.

There are other important factors to consider when considering orthognathic surgery vs TSADs as treatment options to correct AOB. The decision is more difficult in borderline patients such as those in late adolescence or the elderly. If TSADs are chosen, clinicians should be aware that not many long-term studies have evaluated their stability, whereas with orthognathic surgery, there is a possibility for incisal elongation during the retention stage. Therefore, cost vs benefit should be investigated for each procedure during the treatment-planning phase.

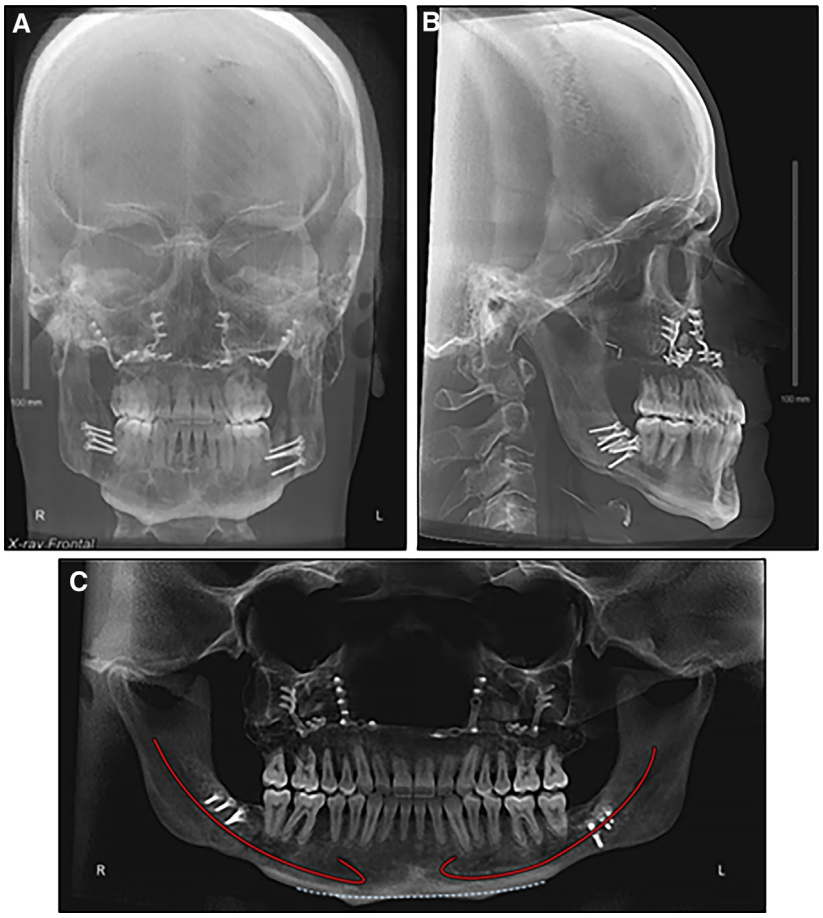

Fig 8. Posttreatment radiographs: **A,** posteroanterior cephalogram; **B,** lateral cephalogram; **C,** panoramic radiograph.

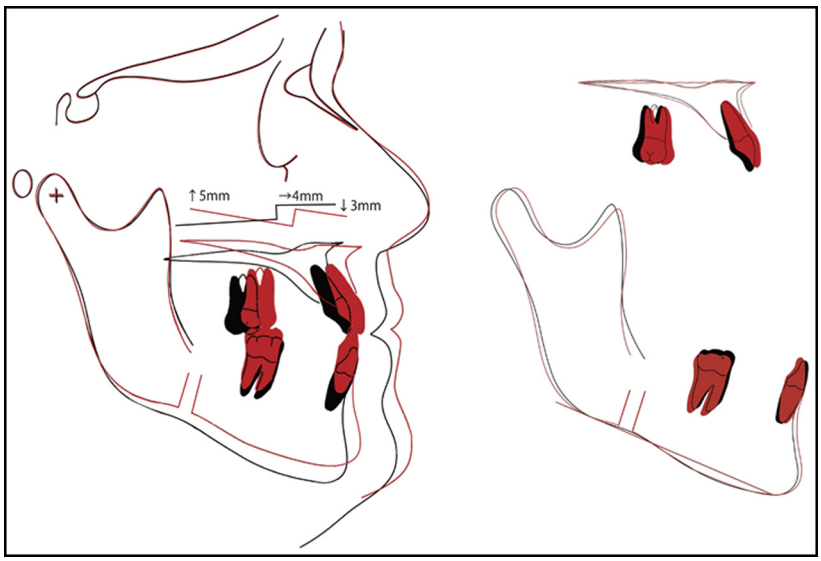

Fig 9. Cephalometric superimposition. *Black*, pretreatment; *red*, posttreatment.

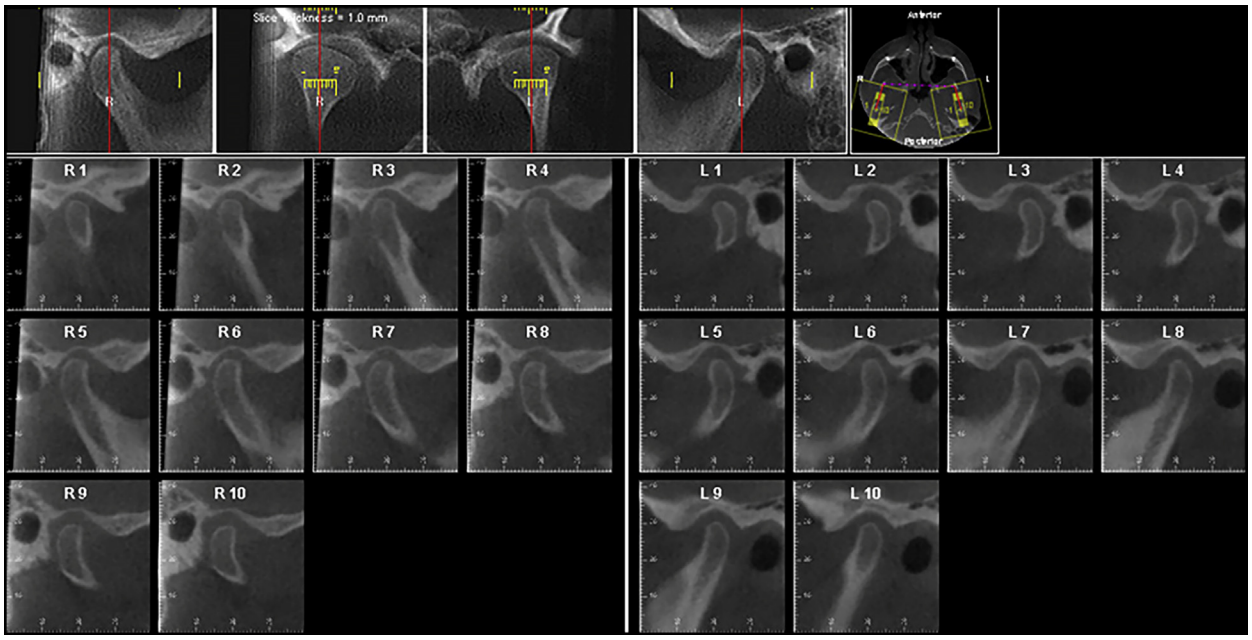

Fig 10. Posttreatment images of the temporomandibular joint from cone-beam computed tomography.

CONCLUSIONS

Orthodontic treatment can be combined with orthognathic surgery to achieve acceptable results. In this AOB case study, both skeletal disharmony and malocclusion were significantly improved, and the generalized esthetics and function were significantly improved after treatment.

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EXAM YEAR _____ **ABO DISCREPANCY INDEX**

ABO ID # _____ **CASE#** _____ **PATIENT** _____

TOTAL D.I. SCORE 77

For mm measures, round up to the next full mm.
Examiners will verify measurements in each category.

OVERJET

≥ 0 to < 1 mm (edge-to-edge)	= 1 pt
≥ 1 to ≤ 3 mm	= 0 pts
> 3 to ≤ 5 mm	= 2 pts
> 5 to ≤ 7 mm	= 3 pts
> 7 to ≤ 9 mm	= 4 pts
> 9 mm	= 5 pts
Negative Overjet (x-bite): 1 pt per mm per tooth	= 6 pts

Total 6

OVERBITE

> 1 to ≤ 3 mm	= 0 pts
> 3 to ≤ 5 mm	= 2 pts
> 5 to ≤ 7 mm	= 3 pts
Impinging (100%)	= 5 pts

Total 0

ANTERIOR OPEN BITE

0 mm (edge-to-edge), 1 pt per tooth = 6 pts
then 1 pt per mm per tooth = 33 pts

Total 39

LATERAL OPEN BITE

≥ 0.5 mm, 2 pts per mm per tooth

Total 20

CROWDING (only one arch)

≥ 0 to ≤1 mm	= 0 pts
> 1 to ≤ 3 mm	= 1 pts
> 3 to ≤ 5 mm	= 2 pts
> 5 to ≤ 7 mm	= 4 pts
> 7 mm	= 7 pts

Total 0

OCCLUSAL RELATIONSHIP

Class I to End On	= 0 pts	
End-to-End Class II or III	= 2 pts per side	4 pts
Full Class II or III	= 4 pts per side	____pts
Beyond Class II or III	= 1 pt per mm additional	____pts

Total 4

30130315

LINGUAL POSTERIOR X-BITE

> 0 mm, 1 pt per tooth Total 6

BUCCAL POSTERIOR X-BITE

> 0 mm, 2 pts per tooth Total 0

CEPHALOMETRICS (See Instructions)

ANB ≥ 6° or ≤ -2°	@4pts	= ___
Each full degree > 6°	___x 1 pt	= ___
Each full degree < -2°	___x 1 pt	= ___
SN-MP		
≥ 38°	@2pts	= ___
Each full degree > 38°	___x 2 pts	= ___
≤ 26°	@1pt	= ___
Each full degree < 26°	___x 1 pt	= ___
$\overline{1}$ to MP ≥ 99°	@1pt	= ___
Each full degree > 99°	___x 1 pt	= ___

Total 0

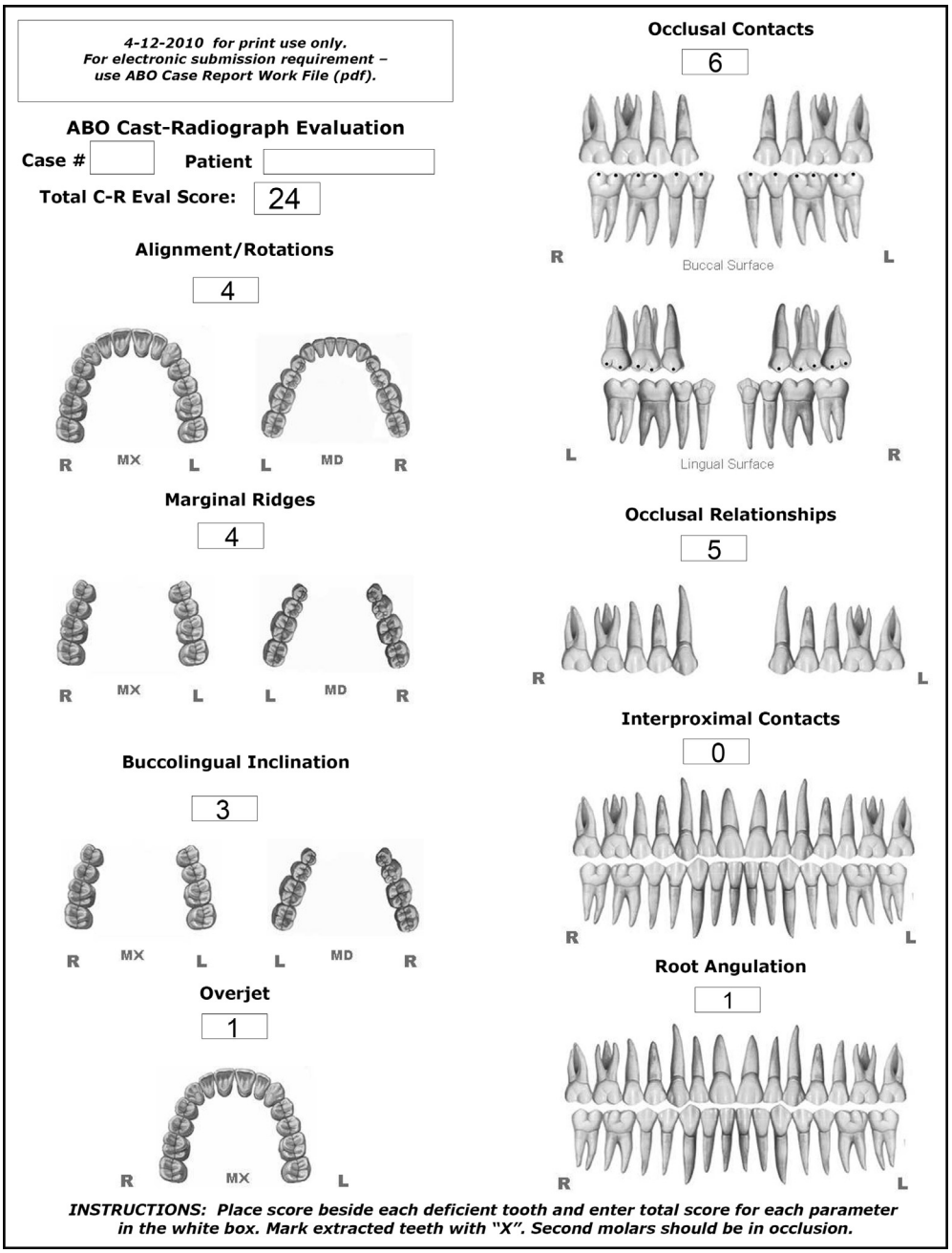
OTHER (See Instructions)

Supernumerary teeth	___x 1 pt	= ___
Ankylosis of permanent teeth	___x 2 pts	= ___
Anomalous morphology	___x 2 pts	= ___
Impaction (except 3rd molars)	___x 2 pts	= ___
Midline discrepancy (≥3 mm)	@ 2 pts	= 2
Missing teeth (except 3rd molars)	___x 1 pt	= ___
Missing teeth, congenital	___x 2 pts	= ___
Spacing (4 or more, per arch)	___x 2 pts	= ___
Spacing (mx cent diastema ≥ 2 mm)	@ 2 pts	= ___
Tooth transposition	___x 2 pts	= ___
Skeletal asymmetry(nonsurgical tx)	@ 3 pts	= ___
Addl. treatment complexities	___x 2 pts	= ___

Identify:

Total Other 2

Supplemental Fig 1. Discrepancy Index score form.



Supplemental Fig 2. Cast-Radiograph Evaluation form.