Case Report

Camouflage treatment for skeletal Class III patient with facial asymmetry using customized bracket based on CAD/CAM virtual orthodontic system: *A case report*

Ha Na Sha[a]; Sun Young Lim[a]; Sun Mi Kwon[b]; Jung-Yul Cha[c]

ABSTRACT

When considering camouflage orthodontic treatment for Class III malocclusion with skeletal facial asymmetry, it is crucial to preserve the favorable compensated posterior occlusion. Once the inclination of the compensated occlusion is changed during orthodontic treatment, unstable occlusion, such as crossbite or scissor bite may occur. A 23-year-old female patient had anterior spacing with Class III malocclusion and a mandibular asymmetry. A nonsurgical approach was adopted. The treatment objectives were to establish a Class I molar relationship with compensated inclination of the posterior dentition and to correct the midline deviation. To achieve these goals, the computer-aided design/computer-aided manufacturing (CAD/CAM) orthodontic system plus customized brackets was applied, and miniscrews were used to distalize the left mandibular dentition for midline correction. The results suggested that the CAD/CAM-based customized brackets can be efficiently used in camouflage treatment to achieve a correct final occlusion. (*Angle Orthod.* 2020;90:607–618.)

KEY WORDS: Camouflage treatment; Class III malocclusion; Customized bracket

INTRODUCTION

Skeletal Class III with facial asymmetry is one of the most challenging problems in orthodontics due to the complex diagnosis, difficult prognosis, and possibility of relapse. Major characteristics of skeletal Class III with facial asymmetry have been described in previous studies and include dental midline deviation, canted occlusal plane upward to the side of the mandibular shift, different buccal inclination of the right and left posterior teeth (both in the maxillary and mandibular dentition), a large curve of Spee, and unilateral crossbite.[1,2] These characteristics have multifactorial consequences that correlate with the skeletal transverse, sagittal, and vertical discrepancy.[1]

It is essential to recognize the dental compensation when developing an appropriate treatment plan for a patient with facial asymmetry. Whether to maintain or change the arch width by expansion or constriction primarily depends on the buccolingual inclination of the posterior teeth and the preexisting transverse dental compensation.[1]

For patients with severe mandibular asymmetry, orthognathic surgery can improve facial esthetics and correct skeletal and dental discrepancies. However, patients may be deterred by the surgery risk, high cost, and long recovery time. Therefore, for borderline cases of mandibular asymmetry, as well as compensated adapted posterior occlusion, camouflage treatment is another option, although it may result in a compromised outcome.[3]

It is necessary to maintain the asymmetric compensatory axial inclinations for camouflage treatment of mandibular asymmetry.[4] However, the preadjusted bracket renders it difficult to preserve the compensated posterior occlusion.[5] Once the inclination of the compensated occlusion is changed during orthodontic treatment, unstable occlusion, such as crossbite or scissor bite, may occur. There are methods to avoid

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Accepted: February 2019. Submitted: October 2018.
Published Online: March 28, 2019

Table 1. Cephalometric Analysis

Measurement	Norm	Pretreatment	Posttreatment	Retention
Skeletal				
SNA, °	81.6 ± 3.1	84.1	84.2	84.3
SNB, °	79.1 ± 3.0	87.8	87.2	88
ANB, °	2.4 ± 1.8	–3.7	–3.1	–3.7
SN-GoGn, °	34.0 ± 5.0	32.6	32.6	32.8
Gonial angle, °	118.7 ± 6.7	124.8	125	124.9
Ramus height, mm	57.6 ± 5.2	57.2	57.7	57.7
Mandibular body length, mm	76.0 ± 4.0	90.8	90.9	91.4
Dental				
U1-SN, °	106.0 ± 5.0	108.7	109.2	109.9
U1-NA, °/mm	24.0/6.0	24.5/10.8	25.0/10.7	24.5/10.8
L1-NB, °/mm	27.0/6.1	16.4/3.6	15.0/2.6	15.8/2.73
IMPA	94.0 ± 5.0	76	75.2	76.3
Soft tissue E-line, mm				
Upper lip	1.0 ± 2.0	–0.7	–0.8	–0.8
Lower lip	1.0 ± 2.0	1	0.9	0.8
Posteroanterior measurements, mm				
Maxillary width	63.0 ± 2.2	70.9	71.2	70
Mandibular width	76.0 ± 1.8	94.4	93.2	94.4
Menton-horizontal	–	–5	–4.2	–4.2
Mx6cusp,Rt-horizontal	–	23	23.5	24.2
Mx6cusp,Lt-horizontal	–	21	21.4	21
Antegonial notch, Rt-horizontal	–	47.5	47.2	47.2
Antegonial notch, Lt-horizontal	–	46.8	46	46.1

these side effects, such as torqueing the wire to a different degree on both sides, using round wires, or placing brackets without torque. However, wire bending is time consuming and skill sensitive. To overcome this challenge, a customized bracket system can be applied to more efficiently maintain the inclination of the compensated teeth during active treatment, which also decreases the requirements for wire bending.

This case report describes use of a virtual orthodontic treatment system plus a customized bracket on an adult with skeletal Class III malocclusion with facial asymmetry and favorable occlusion. The advantages of a virtual setup and customized bracket base for preserving the inclination of the compensated dentition are fully highlighted in this report.

Diagnosis and Etiology

A 23-year-old female patient presented with a chief complaint of space between the upper central incisors and mandibular asymmetry. She had been treated with a removable appliance for anterior crossbite during elementary school. In the frontal view, the mandible slightly deviated to the right. In the lateral view, the facial profile was concave with a retracted upper lip and protrusive lower lip according to the E-line, even though the nasolabial angle was normal and the upper lip appeared normal in relation to the nose and upper face. Her maxillary dental midline was coincident with her facial midline but the mandibular dental midline deviated 3 mm to the right side.

Intraorally, a Class III canine and molar relationship was found on both sides, which was more severe on the left. Crossbite was observed at the right lateral incisor and canine. In cast analysis, spacing was found in both arches (ALD: upper = –3.0; lower = –1.0) with a tooth-size discrepancy of the anterior teeth (sum of incisor = 4:3.13) due to the smaller lateral incisors. Transverse dental compensation of the posterior teeth was noticeable (intermolar width: maxilla = 50.4 mm, mandible = 43.3 mm). The right maxillary posterior teeth showed buccal inclination, and the right mandibular posterior teeth showed lingual inclination to compensate for the buccolingual occlusion.

The panoramic radiograph showed ectopic impaction of the right upper third molar. Lateral cephalometric analysis indicated a skeletal Class III jaw relationship (ANB, –3.7°; Wits, –18.9 mm; APDI, 96.7°; mandibular body length, 90.8 mm) with a normodivergent pattern (SN-MP, 32.6°). The maxillary incisors were proclined, and linguoversion of the mandibular incisors was observed (IMPA, 76°; L1 to NB, 16.4°; L1 to NB, 3.6 mm).

A posteroanterior cephalogram showed menton deviated to the right side by 5 mm, and the maxillomandibular transverse differential index was 23.1. Soft tissue analysis indicated that the distance of the upper and lower lips to the E-line was –0.7 mm and 1.0 mm, respectively.

The final diagnosis was skeletal Class III malocclusion with facial asymmetry (Figures 1 through 3; Table 1).

Figure 1. Pretreatment facial and intraoral photographs.

Treatment Objectives

The treatment objectives were as follows: (1) correct the mandibular prognathism and asymmetry; (2) correct anterior crossbite and space control to establish proper overjet, overbite, and molar and canine relationship; (3) correct the midline deviation; (4) decompensate inclined molars; and (5) improve facial harmony.

Treatment Alternatives

Three treatment options were presented to the patient. The first option was a combination of orthodontics, orthognathic surgical treatment, and genioplasty to correct the skeletal asymmetry as well as dental compensation with improvement of the facial profile. However, the patient rejected this option because she was reluctant to undergo surgery. The second treatment option was camouflage orthodontic treatment with extraction of maxillary second premolars, mandibular left second premolar, and right first premolar to correct the midline deviation and anterior crossbite. However, this treatment method could have led to adverse effects on the patient's facial profile. Therefore, a camouflage nonextraction treatment plan was adopted, involving protraction of the maxillary posterior teeth and distalization of the mandibular posterior teeth.

Individualized Treatment Goals

The patient refused to take the surgical approach, and skeletal discrepancy correction is impossible to achieve by orthodontic treatment alone in adult patients. Therefore, the modified individual treatment objectives for this patient were to correct the midline, crossbite, and tooth-size discrepancy; establish proper

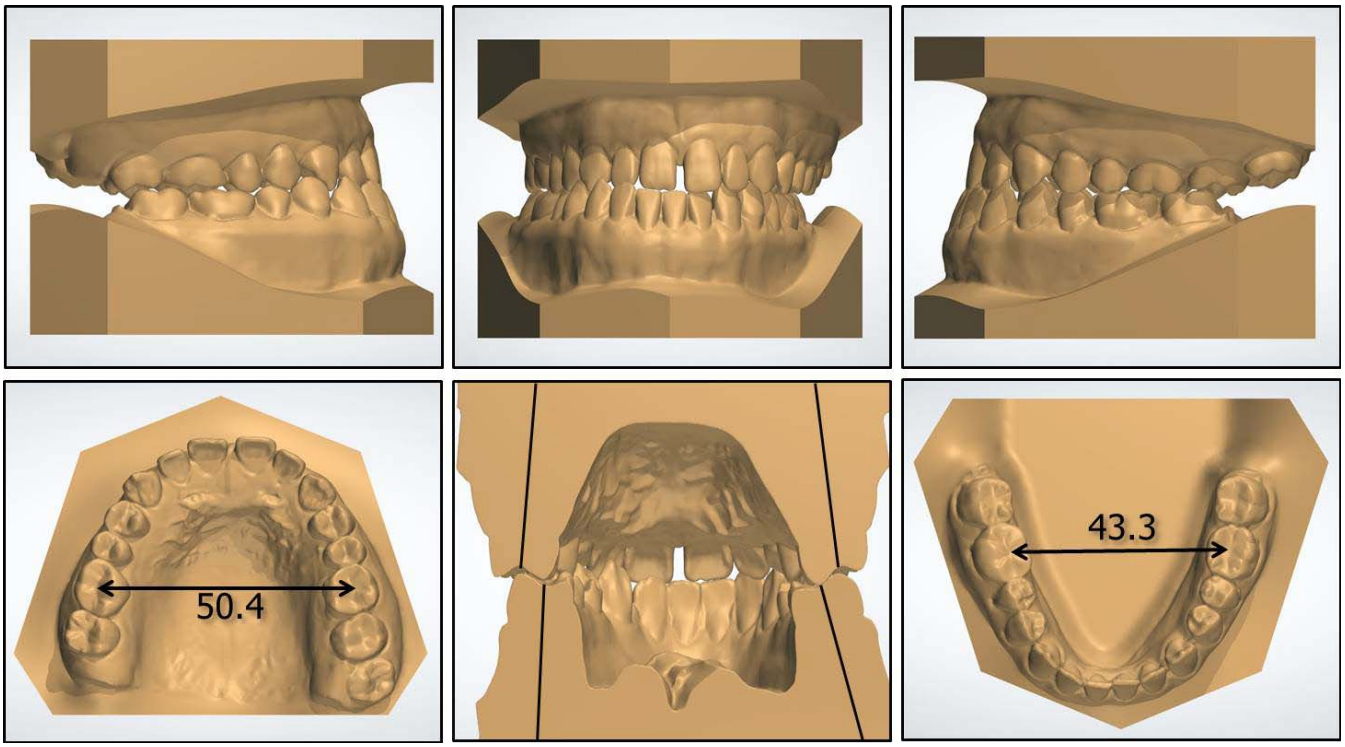

Figure 2. Pretreatment models. Solid line indicates axis of the first molars.

overjet, overbite, and Class I molar and canine relationships; and, by camouflage, improve the skeletal pattern and soft tissue profile. In accomplishing these goals, the transverse and vertical relationships of dentition would be maintained, and the anteroposterior relationship would be changed by mandibular retraction of the left side dentition. The inclination of maxillary incisors was planned to flare out 5° for more exposure but the inclination of the lower incisors was to be maintained. The spacing of the maxillary dentition would be closed with molar protraction and resin buildup on both maxillary lateral incisors.

In camouflage treatment for asymmetry patients, it is important to maintain the original inclination of the compensated dentition. To enhance the efficiency to preserve the compensated dentition, a computer-aided design/computer-aided manufacturing (CAD/CAM) bracket system was used in this camouflage treatment.

Virtual Setup and Fabrication of Customized Brackets With Transfer Trays

The patient's initial silicone impression model was scanned to create a virtual model, using the 3Txer program (Orapix, Seoul, Korea). A customized arch form based on the patient's arch form was created as a reference to move the individual teeth to the ideal position base on the treatment plan. For midline correction, 4 mm of distalization to the left side of the mandibular dentition was planned, and the maxillary molars were planned to protract 1 mm. The remaining spaces were redistributed to the lateral incisors and closed by resin build up. Considering the patient's skeletal asymmetry, inclination of the posterior teeth and arch width were planned to be maintained during active treatment. The final occlusal status would be a Class I canine and molar relationship. After overall alignment and final virtual outcome were confirmed, the three-dimensional (3D) virtual setup (3Txer, Orapix) was constructed (Figure 4A).

The 3D virtual brackets (0.018″ Slot, Clippy C, Tomy, Japan), which were fabricated by a 3D-CAD program according to the manufacturer's prescription, were engaged using the customized virtual wire, and the bracket wire combination was placed on the virtual setup model. To guarantee the precision of bracket placement, bracket movement was checked using the collision test to prevent unnecessary premature contact between the bracket and tooth surface.[6] After confirming ideal bracket position, a virtual transfer tray was designed and fabricated using a stereolithographic rapid-prototyping machine (Viper 2, 3D system, Circle Rock Hill, SC). In the dental laboratory, the real preadjusted brackets were engaged into the printed transfer tray. Adhesive resin paste (Transbond XT, 3M

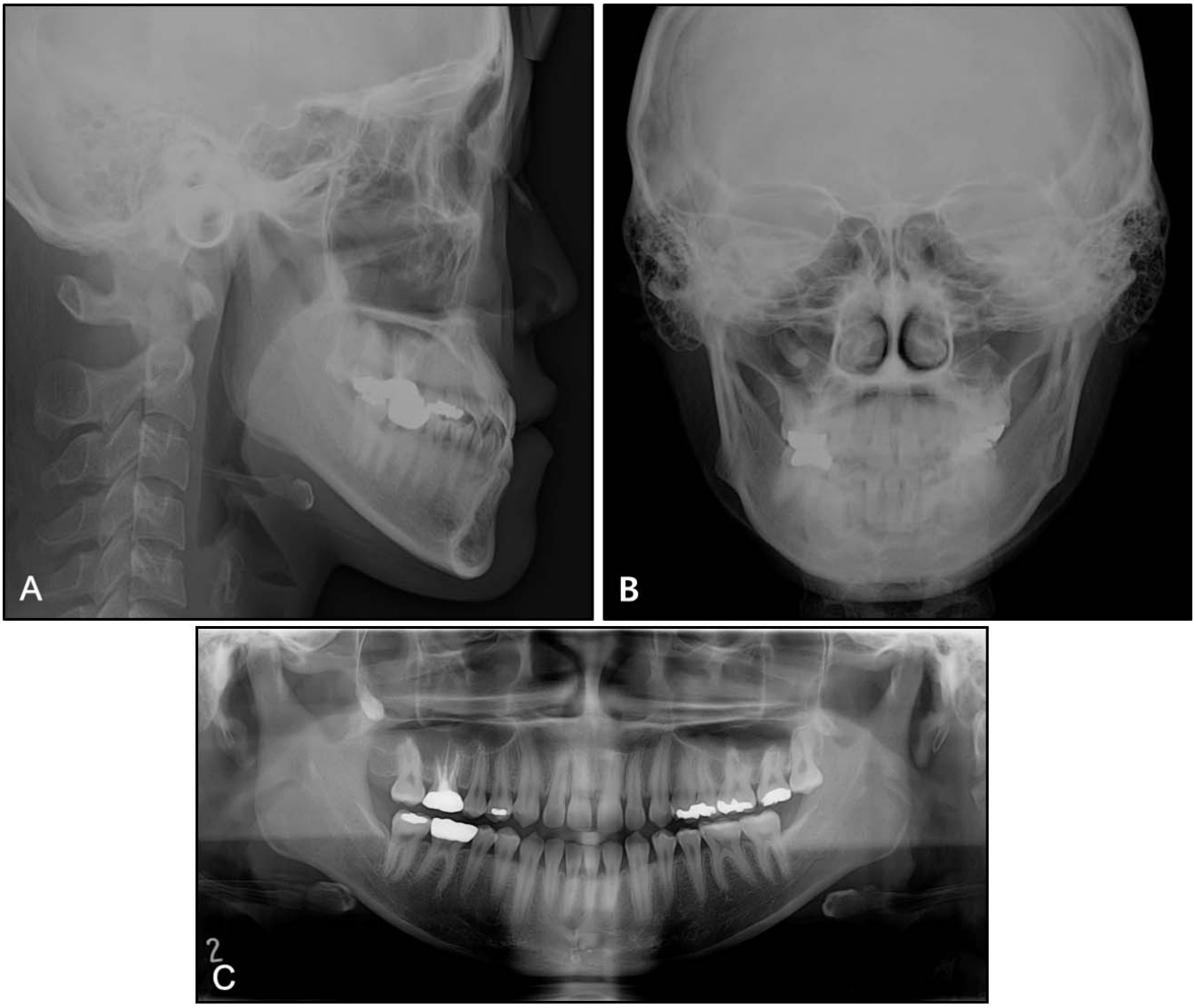

Figure 3. Pretreatment radiographs: (A) lateral cephalogram; (B) posteroanterior cephalogram;(C) panoramic.

Dental Products, St Paul, Minn) was applied to the bracket bases and then the bracket-transfer tray combination was placed over the initial plaster model. The adjusted resin base was cured for polymerization; then, the customized bracket bases were completed (Figure 4B,C).

Treatment Progress

Treatment was initiated using a transfer tray to bond customized brackets with 0.018″ slot to all teeth. Initial wires were as 0.014-inch NiTi wires, and 0.016 × 0.022 NiTi wires. After initial leveling and alignment, two miniscrews 1.5 mm in diameter, 7 mm in length (BMK; Biomaterials Korea, Seoul, Korea) were installed into the left retromolar area and the alveolar bone between the left lower second premolar and first molar to distalize the mandibular dentition. The upper and lower archwires were replaced with 0.016 × 0.022-inch stainless steel, and the lower wire was worked up to 0.017 × 0.025-inch stainless steel wire during the distalization of the left mandibular dentition (Figure 5). The elastomeric chains were replaced on every recall visit to achieve the Class I canine and molar relationship and the midline correction. In the finished state, a 10° torque was applied to the archwire to correct linguoversion of the mandibular incisors. In the upper dentition, 5° of overtorque was applied to the archwire to prevent inclination changes of the incisors. A set of open coil and closed coil springs was used to rearrange the space in the upper anterior dentition. After preparing appropriate spaces for each incisor,

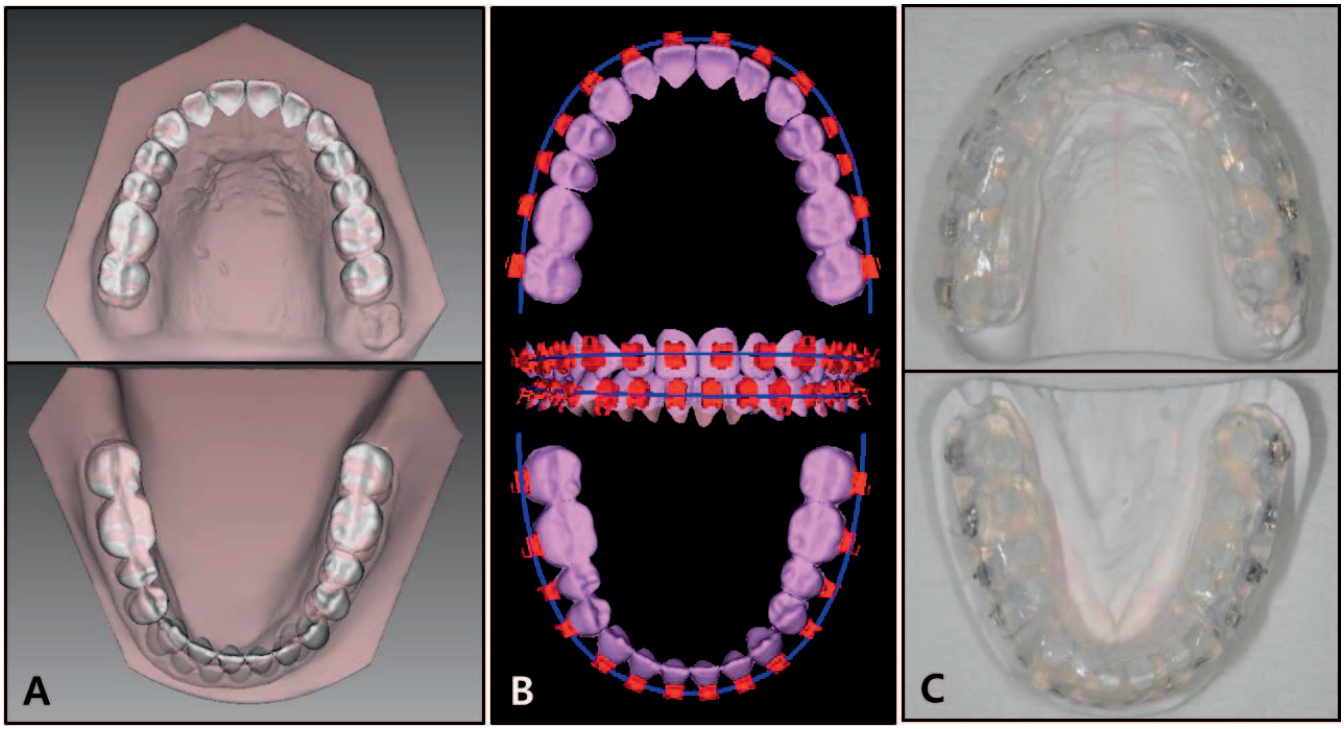

Figure 4. (A) Diagnostic setup using digital models to simulate upper dentition protraction and distalization of the mandibular left segment. Pink, pretreatment; white, simulation. (B) Virtual setup and customized bracket wire combination. (C) Customized bracket combined with transfer tray.

resin buildups were performed on the mesial aspect of both lateral incisors to achieve the ideal anterior teeth ratio. The patient was instructed to wear Class III elastics all day except when eating.

After 17 months of treatment, the midlines of both arches were coincident. The canine and molar relationship almost achieved Class I relationship. Finishing and detailing of the occlusion were performed with

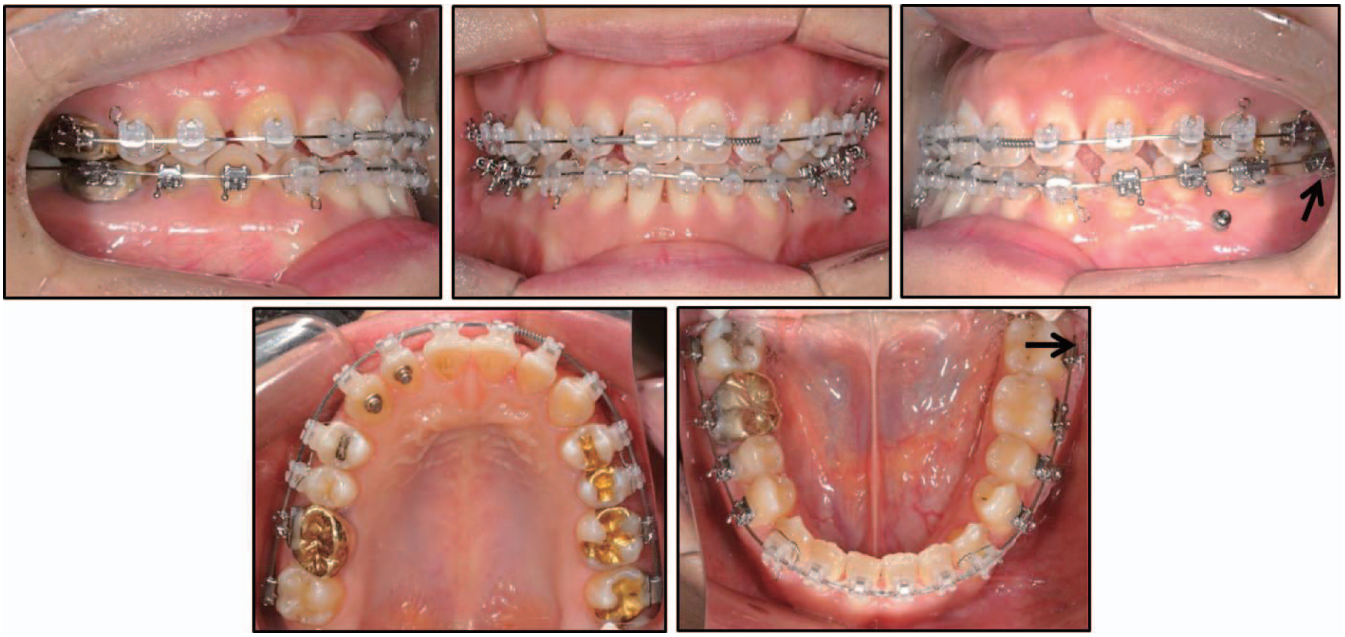

Figure 5. The 0.016 × 0.022 inch stainless steel archwire was engaged in both arches. One elastic chain was placed from the mandibular right canine to a miniscrew in the left alveolar bone and one from the first molar bracket tube to a steel ligature connected to the miniscrew head in the retromolar area. The arrows point to the steel ligature.

Figure 6. Posttreatment facial and intraoral photographs.

0.016 × 0.022-inch TMA wires, and the patient was debonded after 25 months. Lingual fixed retainers and a Hawley removable retainer were provided to secure the stability of the arches.

Treatment Results

The posttreatment records showed that the treatment goals were achieved. Dental esthetics were improved, with interdental spaces closed, the mandibular dentition retracted, and the dental midline aligned with the patient's facial midline. The patient's smile esthetics were significantly improved, although the facial asymmetry remained, showing the initial chin deviation. Favorable interdigitation and Class I canine and molar relationships were established. Transverse dental compensation of the posterior teeth and intermolar width were well maintained during treatment (Figures 6 and 7).

The final lateral cephalometric analysis showed that the inclination of both the maxillary and mandibular incisors were preserved within $<1°$ difference (U-1 to SN, from 108.7° to 109.2°; IMPA, from 76.0° to 75.2°) during treatment (Figure 8; Table 1). The 2-year follow-up radiographs and the cephalometric superimpositions showed that the result remained stable (Figures 9 and 10).

DISCUSSION

For adult patients with Class III malocclusion, the options to treat using orthodontics alone or in combination with orthognathic surgery have been discussed for many years. Previous studies indicated that the Wits appraisal, gonial angle, existing temporomandibular disorders, and amount of chin deviation, especially for patients with facial asymmetry, were indicators than can help determine the

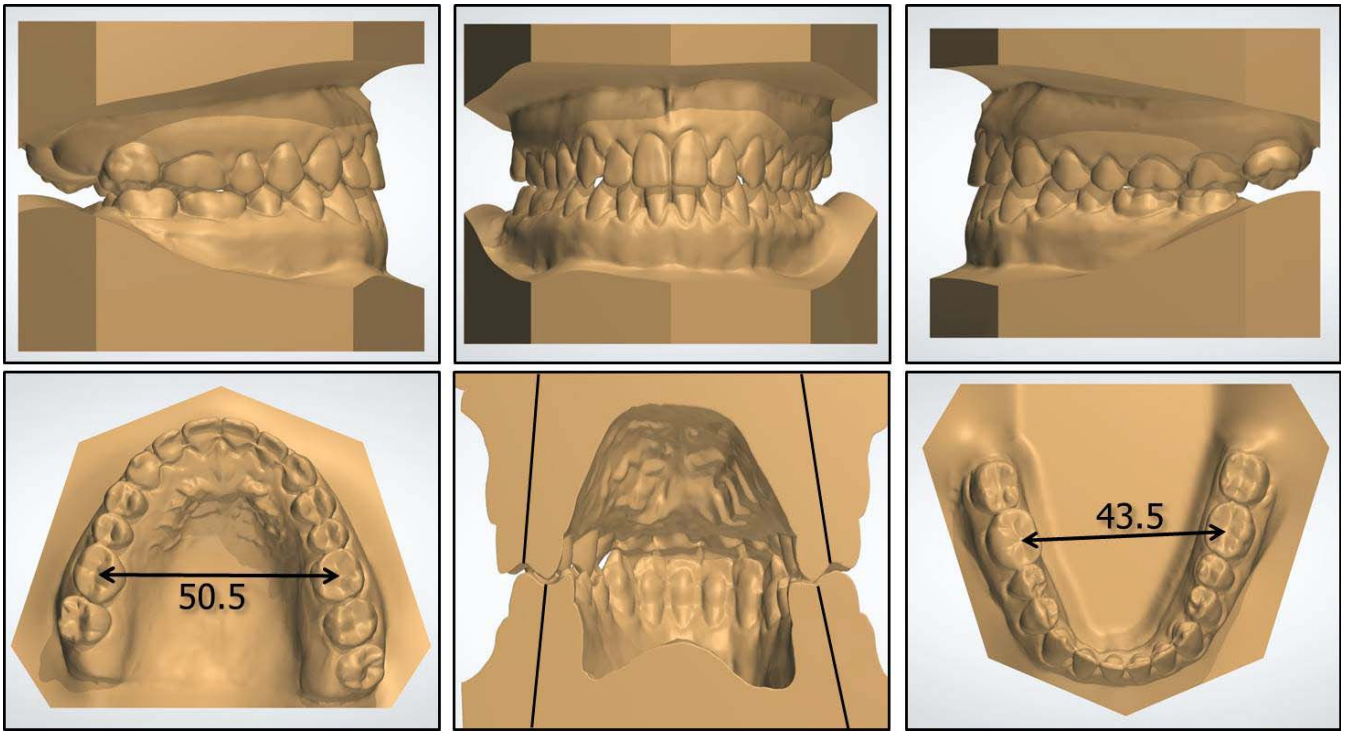

Figure 7. Posttreatment models. Solid line, axis of the first molars.

treatment plan.[7] Additionally, it is necessary to consider the patient's willingness to undergo specific procedures, the patient's expectations, and facial esthetics. The initial skeletal parameters of this patient, such as lower Wits appraisal (–18.9 mm), greater gonial angle (124.8°), maxilla/mandible transverse discrepancy, and mandibular asymmetry (4 mm) indicated that surgical intervention was theoretically an appropriate treatment plan. However, the patient refused the surgical approach because of the associated surgical risks. Therefore, the patient was informed that mandibular prognathism and chin deviation would not be corrected by the orthodontic treatment chosen.

Before camouflage treatment was decided upon for the patient, she was also examined to determine if she exhibited any temporomandibular joint symptoms. Skeletal asymmetry develops suboptimal occlusion, which can cause temporomandibular disorder (TMD) and encourage disc displacement.[8] Accordingly, patients with asymmetric mandibular prognathism have a higher prevalence of TMD symptoms, such as joint pain, joint clicking, and headache, compared with patients with only a protruded mandibular jaw.[9] Thus, orthognathic surgery is strongly recommended for patients with preexisting TMD. Although TMD may not be cured completely, good improvement of TMD symptoms after surgery has been reported.[9] Considering that the patient did not show any signs of TMD, and the function of her posterior occlusion was acceptable, camouflage treatment with preservation of the original compensated posterior occlusion was planned.

Occlusion with mandibular asymmetry tends to display different inclinations between deviated and nondeviated sides.[10] The conventional preadjusted bracket can correct the compensated dentition, which results in a successful outcome for the surgical approach. However, in the case of camouflage treatment, decompensation could be undesirable, especially if the patient shows favorable posterior occlusion despite the mandibular asymmetry, as in the case presented here. In this condition, to preserve the compensated dentition more efficiently throughout treatment, a virtual setup technique and CAD/CAM customized bracket system were applied.

Stability is one of the concerns associated with camouflage treatment because the skeletal discrepancy cannot be changed by orthodontic treatment alone.[11] Graber et al.[12] presented theories of posttreatment stability; for instance, to establish proper functional occlusion and to maintain the original mandibular arch form, the bone and adjacent tissues must be allowed to reorganize around newly positioned teeth. Accordingly, both the well-maintained dentition and

Figure 8. Posttreatment radiographs: (A) lateral cephalogram; (B) posteroanterior cephalogram; (C) panoramic.

unaltered arch form represented a stable treatment outcome for the patient reported here. Superimposition of posttreatment and retention images showed good retention within minimal relapse in the maxilla; however, more discrepancies were observed in the mandibular right dentition, which may have been due to the extensive distalization used to correct the midline (Figure 11A,B). Additionally, after 18 months of retention, the occlusal force and contact area of the patient were evaluated using a pressure-sensitive sheet (Dental Prescale 50H, typeR, Fuji Film Corp, Tokyo, Japan). This patient's occlusal force and contact area were within the acceptable range based on patients with normal occlusion.[13] The occlusal force was also quite even between the right and left sides (R:L = 5.6 : 4.4). Based on the functional occlusion, adequate occlusal force. and contact area of this patient, it is expected that the treatment outcome is stable (Figure 11C).

Discrepancies between actual treatment outcomes and planned occlusion must be considered when using a CAD/CAM bracket system. Previous studies have noted major factors that can affect the final treatment outcome of customized bracket systems, such as accuracy of intraoral scanning, the digital model, and the indirect bonding method, including the bond strength of the customized bracket.[14–16] Wire bending may be required to overcome the discrepancies between the ideal and actual situation, and the clinician must attend carefully to each step of the digital workflow to improve final outcomes. In this case, one of the lower incisor brackets was rebonded to reduce a

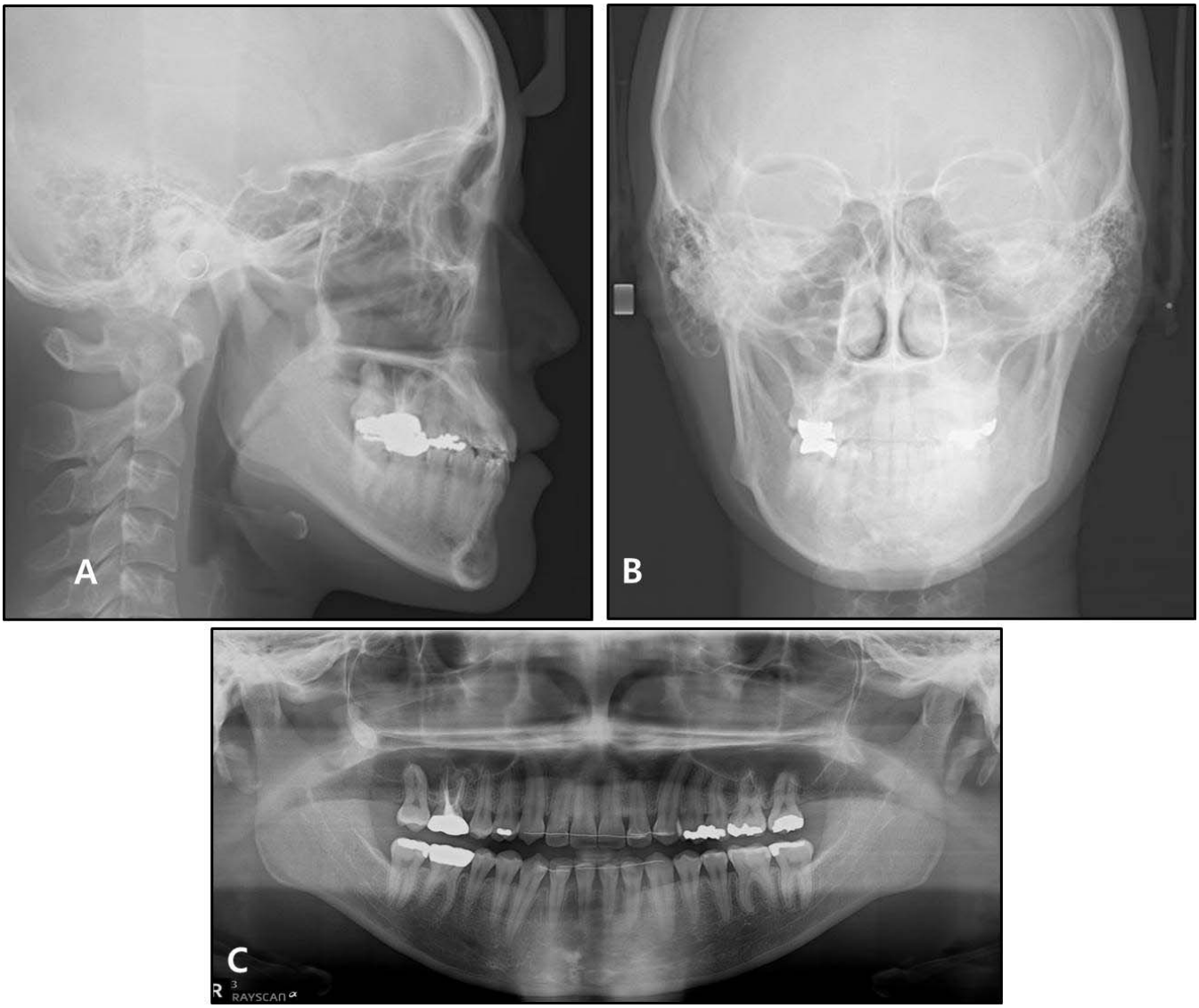

Figure 9. Retention radiographs: (A) lateral cephalogram; (B) posteroanterior cephalogram; (C) panoramic.

discrepancy of the marginal ridge between incisors, and the wire was bent to correct the improper angulation of lower second molars during the finishing stage. In addition, additional labial torque was added in the incisor area of the lower wire during total tooth movement to prevent lingual inclination of the incisors. Even though the individual prescription was built into the brackets, play between the wire and slot was inevitable. Thus, the biomechanics for proper tooth movement should be considered even though ideal occlusion was planned by the virtual simulation software. Ultimately, clinicians must closely monitor the tooth movement and occlusion throughout treatment to improve the effectiveness of the customized brackets.

CONCLUSIONS

- In the malocclusion described, for which an orthognathic surgical approach was rejected, camouflage treatment was applied successfully to improve the occlusal relationship.
- A virtual setup model provides detailed information that can be used to estimate the outcome of camouflage treatment and, for the patient detailed, a customized bracket enabled achievement of a desirable treatment result.

ACKNOWLEDGMENTS

We thank Mr Jae-Hun Yu for his digital imaging technical support.

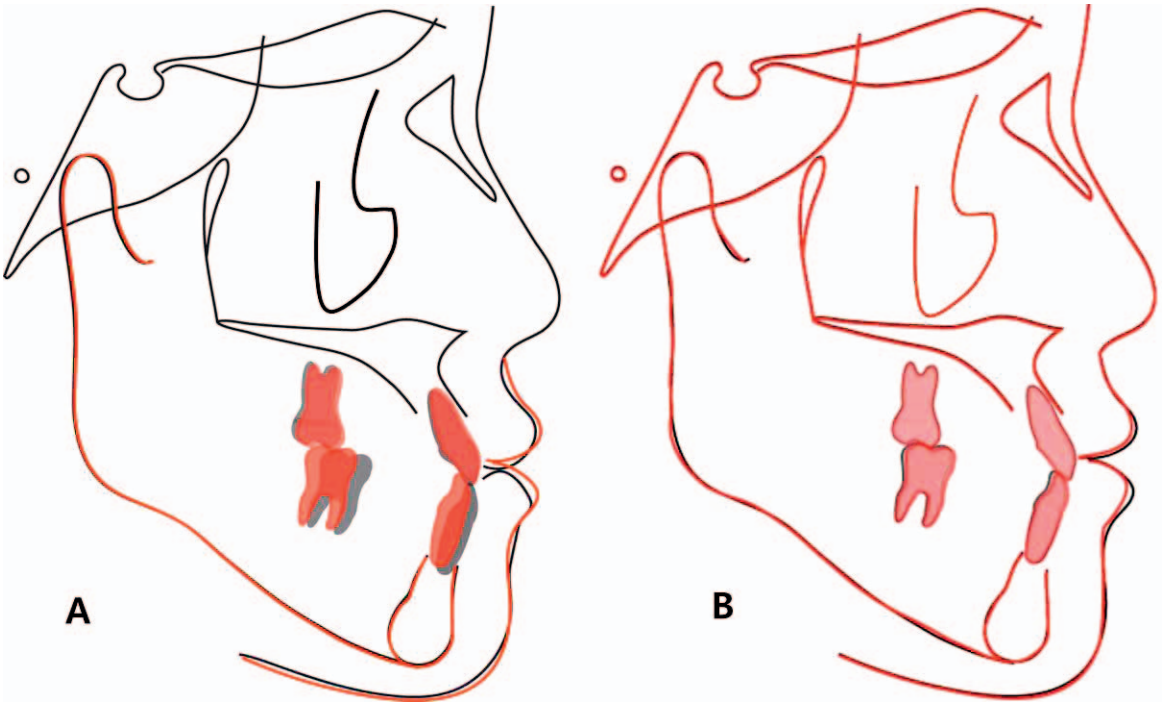

Figure 10. Cephalometric superimposition. (A) pretreatment and posttreatment. Black, pretreatment; red, posttreatment; (B) posttreatment and retention. Black, posttreatment; red, retention.

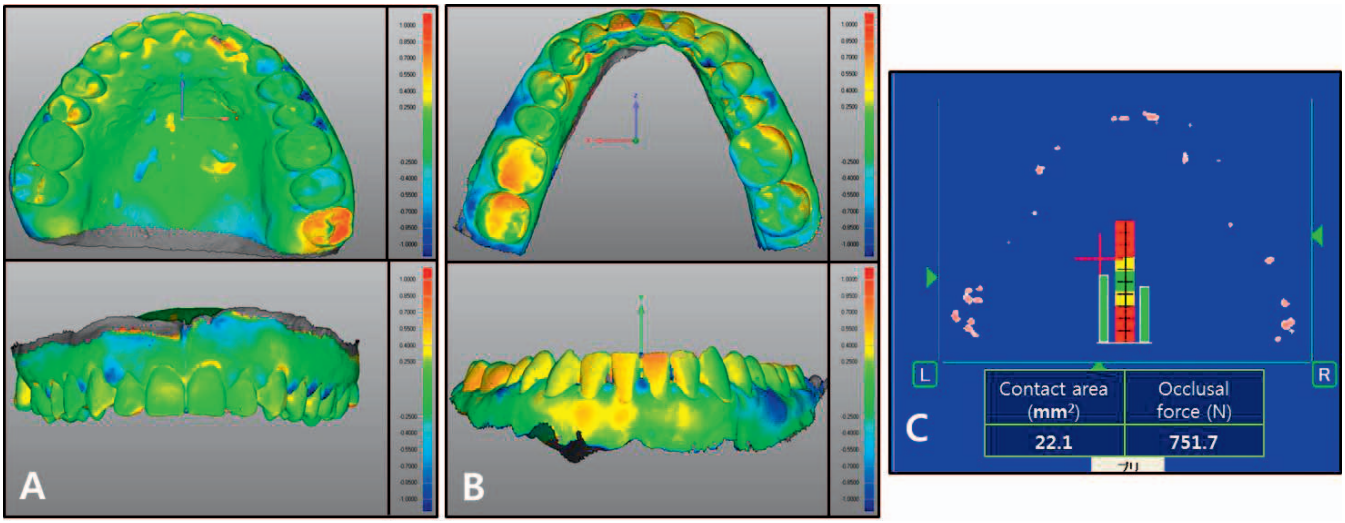

Figure 11. (A, B) Superimposition of debonding and retention model images. (C) Occlusal force (N) and contact area (mm^2) result at 18 months of retention.

This paper was supported by the Advanced Technology Center Program funded by the MOTIE, Korea. (10077316, Integrated System for Dental Diagnosis, Treatment Simulation & PSI Design)

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