Orthodontic Treatment Protocols for Patients with Idiopathic Condylar Resorption

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Treatment of orthodontic patients with idiopathic condylar resorption (ICR) is challenging for clinicians due to the continuous change of occlusion caused by the unstable condylar position and symptoms in the temporomandibular joint (TMJ). As an unstable condylar position can lead to confusion during orthodontic evaluation, stabilization of TMJ with splint therapy should precede orthodontic and/or orthognathic treatment. In this case report, a patient with Class II open bite and progressive condylar resorption was treated with an appropriate treatment protocol. Her condylar position was stabilized with a stabilization splint and her occlusion and facial esthetics were improved with intrusion of her maxillary posterior teeth after extraction of four premolars. Her occlusion was stable without recurrence of joint symptoms 2 years after active treatment.

Keywords; *idiopathic condylar resorption, TMD, stabilization splint*

INTRODUCTION

Idiopathic condylar resorption (ICR) is one of the most aggressive degenerative diseases of the temporomandibular joint (TMJ) that is found mostly in females in their teens or early 20s. The onset of ICR usually occurs around the time of puberty and tends to decrease after the age of 20.[1-3]

Current theories for explaining the etiology of ICR in the TMJ include a combination of chemical transduction and mechano-transduction processes. The basic concept is that destruction of the TMJ structures occur when adaptive capacity is exceeded by the functional demands.[4]

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Many studies have reported that ICR has a strikingly higher incidence in females, allowing us a logical hypothesis that sexual factors are directly involved in this disease. Estrogen is known to mediate cartilage and bone metabolism of the TMJ and reduced estrogen levels may predispose a bone degenerative process. Common bilateral patterns of condylar resorption in ICR patients indicates a genetic and hormonal nature of the etiology.[5,6]A healthy TMJ can adapt to excessive mechanical loads including parafunctional habits, trauma and orthognathic surgical procedures. However, certain individuals are susceptible to degenerative joint disease that progresses to condylar resorption when their TMJs are exposed to excessive mechanical loads. The forces produced by the stretched musculature and soft tissues which exceeded the adaptive capacity of the joints result in developing significant condylar resorption.[7-9]

ICR is a localized non-inflammatory degenerative disorder of the TMJs with lysis and repair of the articular fibrocartilage and underlying subchondral bone.[1,9-14] These changes at the condylar level result in typical clinical characteristics such as a retrognathic mandible, anterior open bite, and increased gonial angle. ICR generally occurs bilaterally, but when it occurs unilaterally, it usually causes facial asymmetry.[5] The most important aspects that attract the attention of the clinicians would be a hyperdivergent growth pattern, leading to skeletal Cl II relationships and the development of an anterior open bite with significant alteration of the occlusion.

Therapy to treat ICR usually begins with release of the temporomandibular disorder (TMD) symptoms when the disease is in the active stage. Aspirin or nonsteroidal anti-inflammatory drugs (NSAIDs) are commonly prescribed while the muscular symptoms can be treated with muscle relaxants. In addition, therapeutic exercises, oral appliances, and steroid injections in the intra-articular

 doi 10.17796/1053-4625-43.4.12

space may be applied.[14-17] However, altered occlusion and problems that affected facial esthetics should be managed with an orthodontic and/or orthognathic approach, and ICR patients need special attention because of the constantly changing occlusion caused by an unstable condylar position.

We present a case report on the treatment of a 15-year-old female with progressive condylar resorption and an anterior openbite. Based on our evaluation of her condylar stability, we suggest a treatment protocol for patients with ICR.

Case Report

A 15-year-old female patient visited with the chief complaints of lip protrusion and jaw pain with limited ability to open her mouth. She had no history of dental trauma but had prosthetic treatment on her maxillary incisors due to severe proximal caries. Pain and discomfort in the TMJ area had persisted for a year and were recently aggravated to mastication and mouth opening difficulties. She explained that her anterior openbite tendency became worse so that she could not cut noodles anymore. The patient showed lip fullness and a convex profile with a retruded chin point due to clockwise rotation of the mandible. She showed mild facial asymmetry that her chin point was deviated to the right side (Figures 1 and 2). She visited with her older sister who also presented with jaw discomfort and mandibular retrusion, but her symptoms were less significant than her sibling.

Intraoral findings confirmed her anterior openbite, mild crowding in both arches with a 7.0 mm overjet and a 1.0 mm anterior openbite. During the clinical examination, a bilateral click in her TMJ was detected with mouth opening and closing. Moderate-to-severe pain was detected with bilateral TMJ palpation in the lateral and posterior aspects of her TMJ. During this examination, the patient showed unstable dual bite which indicated a centric related occlusion (CRO) – maximal intercuspal position (MIP) discrepancy. To visualize and determine the quantitative amount of CRO-MIP discrepancies, her dental models were mounted on a semi-adjustable articulator (SAM Prazisionstechnik GmbH, Muenchen, Germany), and the mandibular position indicator (MPI) of the SAM articulator was used to evaluate the CRO – MIP discrepancies at the joint level. From the mounted model, severer Class II canine and molar relationships were found on both sides and dental midline discrepancy and an openbite tendency were revealed more significant. The MPI measurement showed a 1mm downward condylar distraction on the right side but 2mm downward on the left side (Figure 2).[18]

A panoramic radiograph showed severely flattened and backwardly inclined condylar heads on both sides. Cone-beam computed tomography (CBCT) scans showed decreased volume of both condylar heads of the mandible. The continuity of covering cortical layer of the condylar heads was not clear enough to confirm that her condylar resorption was in the repair (stable) stage (Figures 1 and 3).[5]

A lateral cephalometric analysis indicated skeletal Class II pattern (ANB, 6.0°) with a hyperdivergent growth pattern (SN-MP 34.0°). The maxillary and mandibular incisors were proclined (U1 to SN, 112.5°, IMPA, 95.0°) (Table).

Based on the diagnostic data, it was determined that the mandibular position of our patient was not in the stable position and her occlusion was not reliable to make a definitive orthodontic diagnosis. To relieve her TMD symptoms and to achieve and maintain a stable position of her mandibular condyles, a stabilization splint was prescribed with an ideal occlusal scheme of mutually protected occlusion. A stabilization splint was mounted on the SAM III articulator in a centric relation and was fabricated to make simultaneous centric contacts of mandibular buccal cusps with slight contact of the anterior teeth, then was adjusted to have suitable anterior (or canine) guidance to provide immediate disclusion of the posterior teeth in eccentric movement (Figure 4). A stabilization splint that reproduces an ideal functional occlusion could eliminate protective co-contraction of the masticatory muscles and eventually lead to an orthopedically stable joint position of the mandible.[19,20]

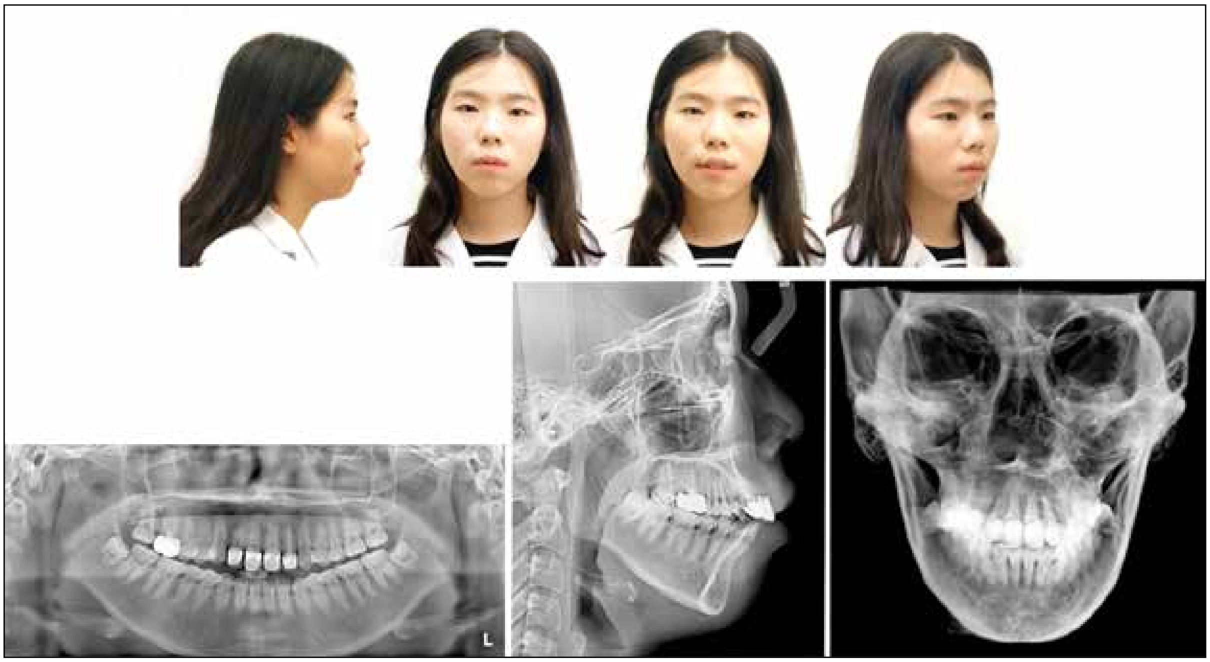
The most orthopedically stable joint position is where the condyles are located in their most superoanterior positions in the articular fossa, resting against the posterior slopes of the articular eminences.[18] With the use of a stabilization splint, the condyles gradually changed positions to this point and MPI records were taken regularly to monitor the positional change. Her pain, reduced mouth opening and other symptoms of TMJ showed gradual improvement within the first 2 months of the splint therapy, but the MPI data showed scattered distribution for more than 6 months, which indicated that the condyles were not in the stable position. After 11 months of splint therapy, the MPI data remained constant in the anterior and superior positions over time, we confirmed stabilization of the condyle by identifying a clear cortical bone continuity and no further changes in the shape of the mandibular condyles on CBCT images (Figures 5-8).[21]

After stabilization of the mandible, post-splint data were collected for definitive orthodontic diagnosis. A lateral cephalogram and superimposition with the initial cephalogram indicated that her mandible was rotated clockwise as the condyles were seated into the most forward and uppermost positions, resulting in an dramatically increased anterior open bite (11.0 mm), a more severe skeletal Class II pattern with steeper mandibular plane (ANB, 9.0° and SN-MP, 39.5°) (Figure 9 and Table).

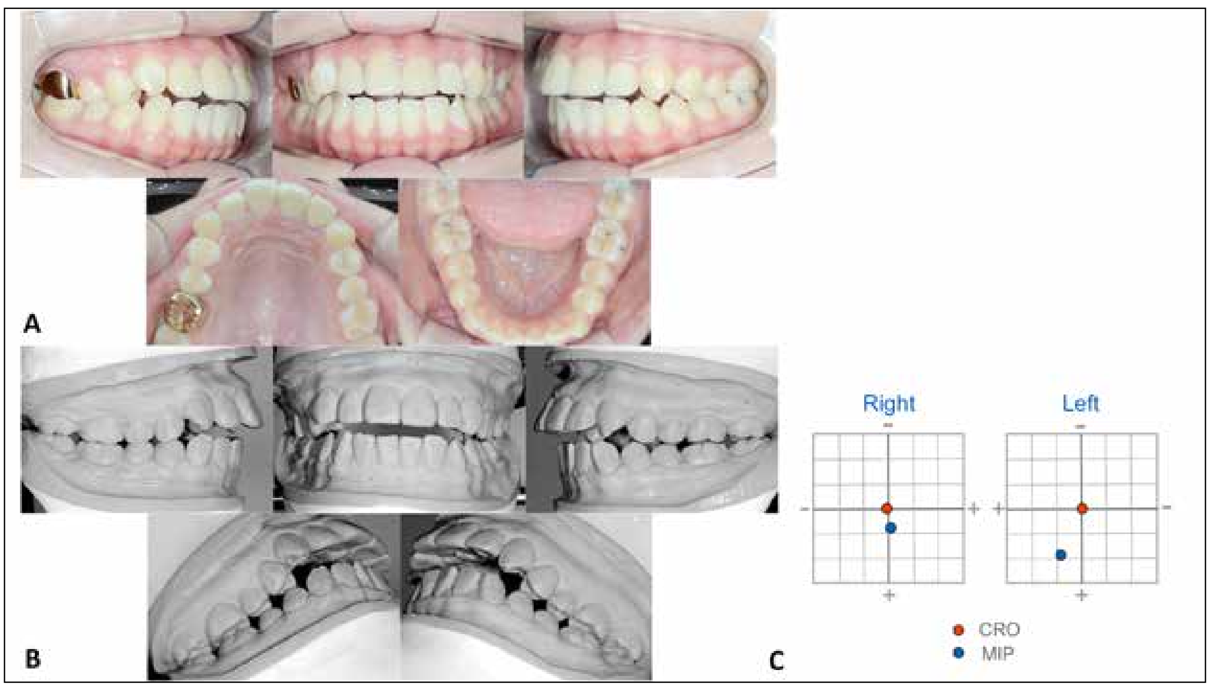
Based on the post-stabilization definitive orthodontics diagnosis, two treatment options were suggested to the patient. The first included orthognathic surgery associated with maxillary posterior impaction and mandibular advancement with maxillary and mandibular premolar extraction. This treatment option would resolve the openbite and improve facial esthetics effectively. The second option involved orthodontic camouflage treatment with extraction of the four premolars to resolve the large overjet. The intrusion of the maxillary posterior teeth was also planned to accomplish counterclockwise rotation of the mandible and resolve the anterior vertical problem using double transpalatal arch (TPA) with combination of temporary skeletal anchorage devices (TSADs). The patient chose the camouflage treatment option using TSADs.

Two TASDs (diameter, 1.4 mm; length, 8 mm; Orlus, Seoul, Korea) were placed in the buccal alveolar bone between the roots of the maxillary first and second molars and four were also placed in the palatal bone between the first premolars and molars bilaterally for intrusion of the maxillary posterior teeth. Additionally, a double transpalatal arch was placed approximately 5 mm away from the midpalatal tissue for tongue exercise and intrusion force to the posterior segments with engagement of elastomeric chains on the palatal TSADs (Figures 10 and 11).

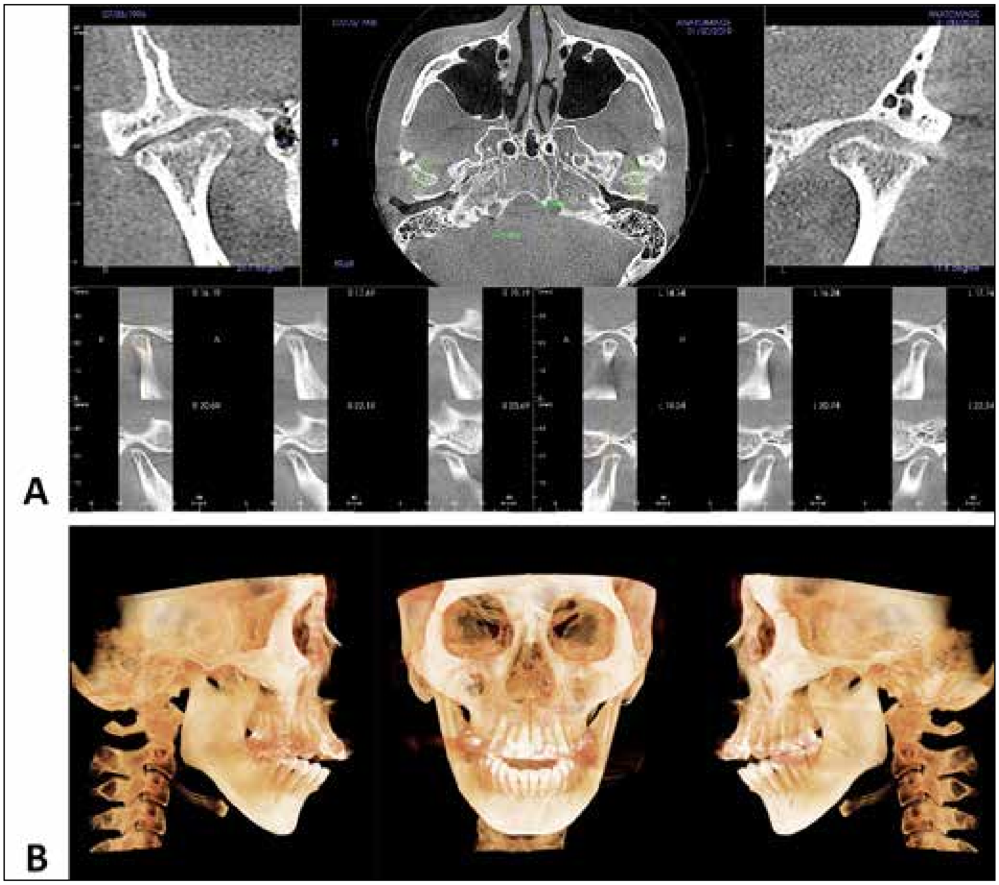
Figures 1. Pre-treatment facial photographs and radiographs.



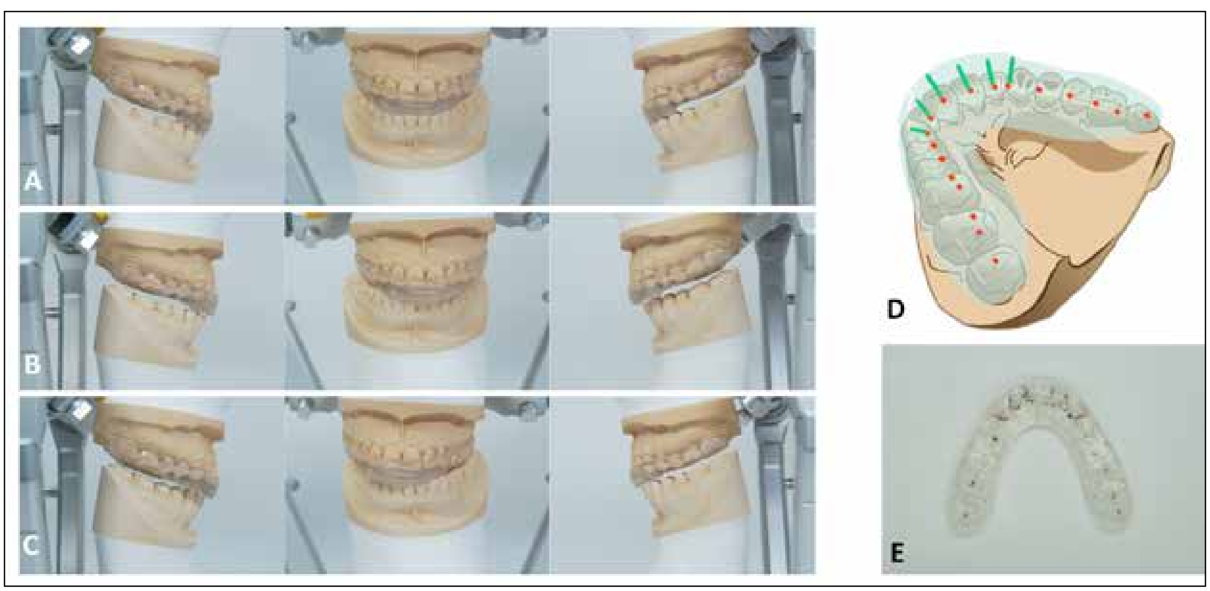
Figures 2. A, Pre-treatment intraoral photographs in maximum intercuspal position (MIP); B, pre-treatment dental casts mounted in centric related occlusion (CRO); C, mandible position indicator (MPI) data. MPI data shows centric related occlusion (CRO)–maximal intercuspal position (MIP) discrepancies at joint level. Our patient presented a downward direction of CRO-MIP condylar distraction.



Figures 3. A, Pre-treatment cross-sectional CBCT images showing condylar resorption on both sides. Loss of continuity of cortical bone and thin condylar surface are present; B, volume rendering CBCT images.



Figures 4. Fabrication and occlusal adjustment of the stabilization splint in the articulator to reproduce mutually protected occlusion: A, Posterior disclusion during the 5 mm protrusive movement; B, Posterior disclusion during the 5 mm right excursive movement; C, Posterior disclusion during the 5 mm left excursive movement; D and E, Final occlusal surface presents simultaneous centric contacts in CRO and was adjusted to provide suitable anterior guidance which provided immediate disclusion of posterior teeth in protrusive and eccentric movements.



Figures 5. Occlusion changes during the splint therapy: A, 2 months; B, 6 months; C, 8 months; D, 11 months.

Figures 6. A, Comparison of pre- and post-stabilization dental models mounted in centric related occlusion (CRO); B, changes in mandible position indicator (MPI) data during splint therapy. The MPI data shows upward seating of the condyles in the fossa from their initial positions.

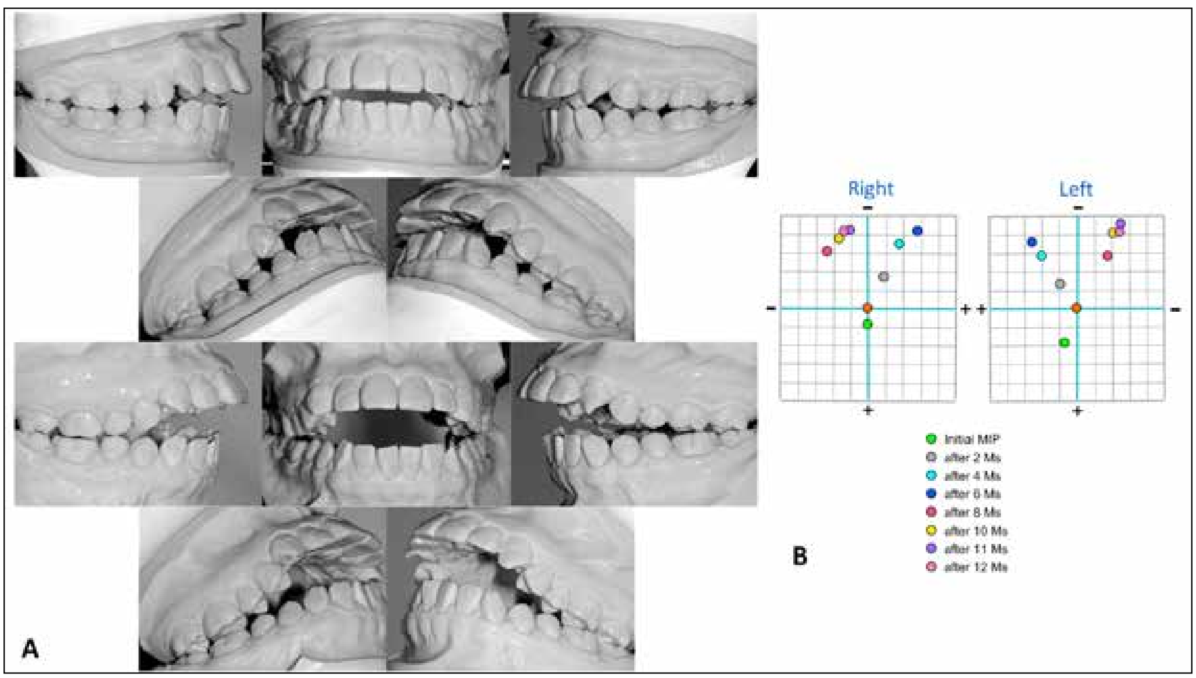
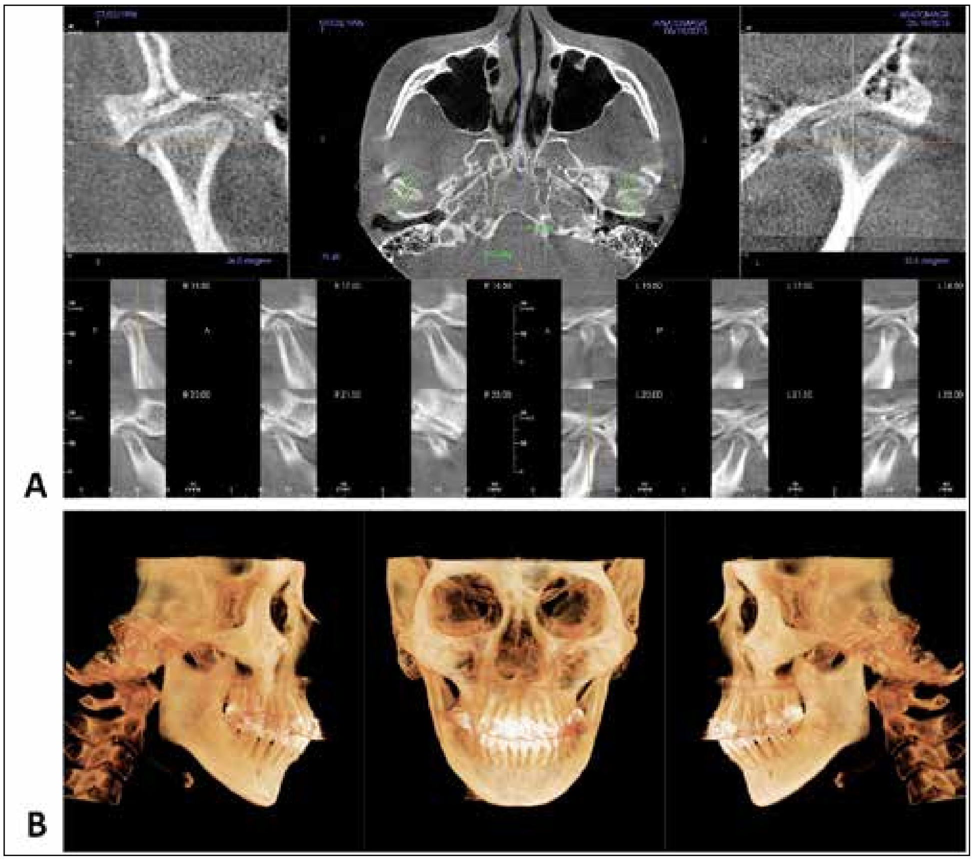
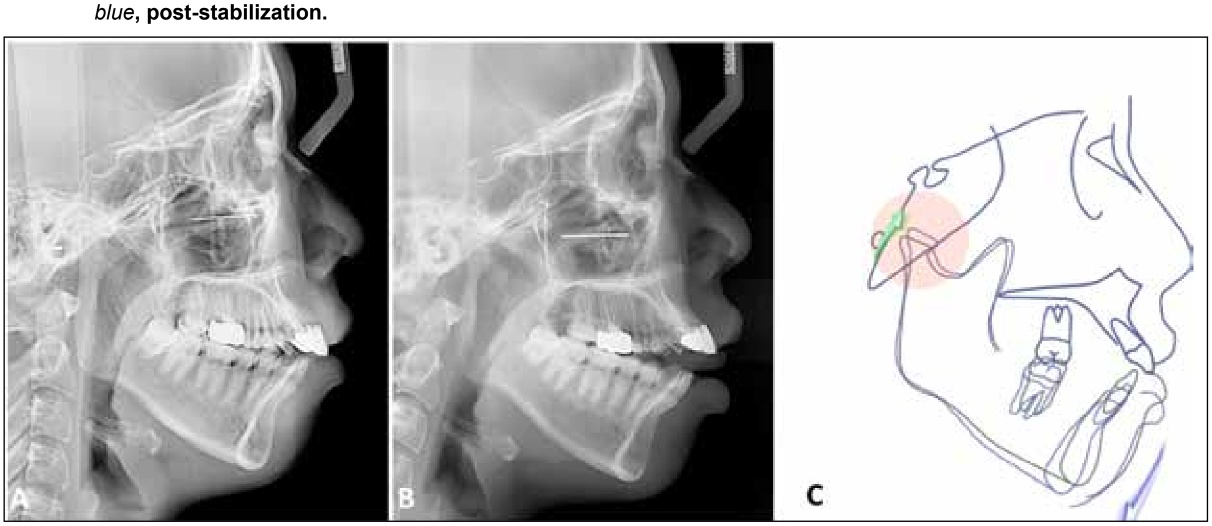


Figure 7. Post-stabilization panoramic radiograph.

Figures 8. A, Post-stabilization cross-sectional CBCT images showing the continuity of cortical bone of condylar heads; B, Volume rendering CBCT images.



Figures 9. A and B, Comparison of pre- and post-stabilization cephalogram; C, cephalometric superimposition. *black*, **pre-treatment;** *blue*, **post-stabilization.**

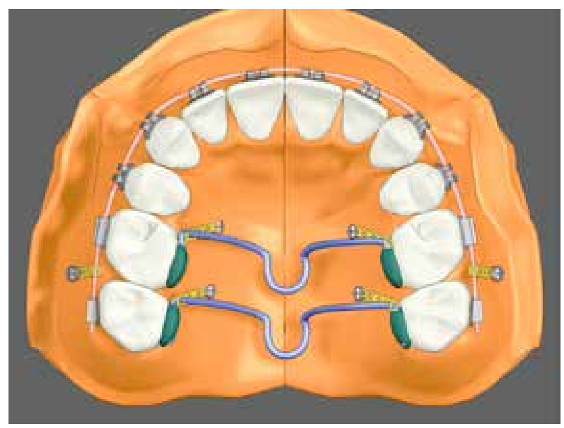


Figures 10. Treatment progress: the intrusion force was applied to the maxillary posterior teeth from TSADs and double TPA.

Table. Comparison of cephalometric measurements

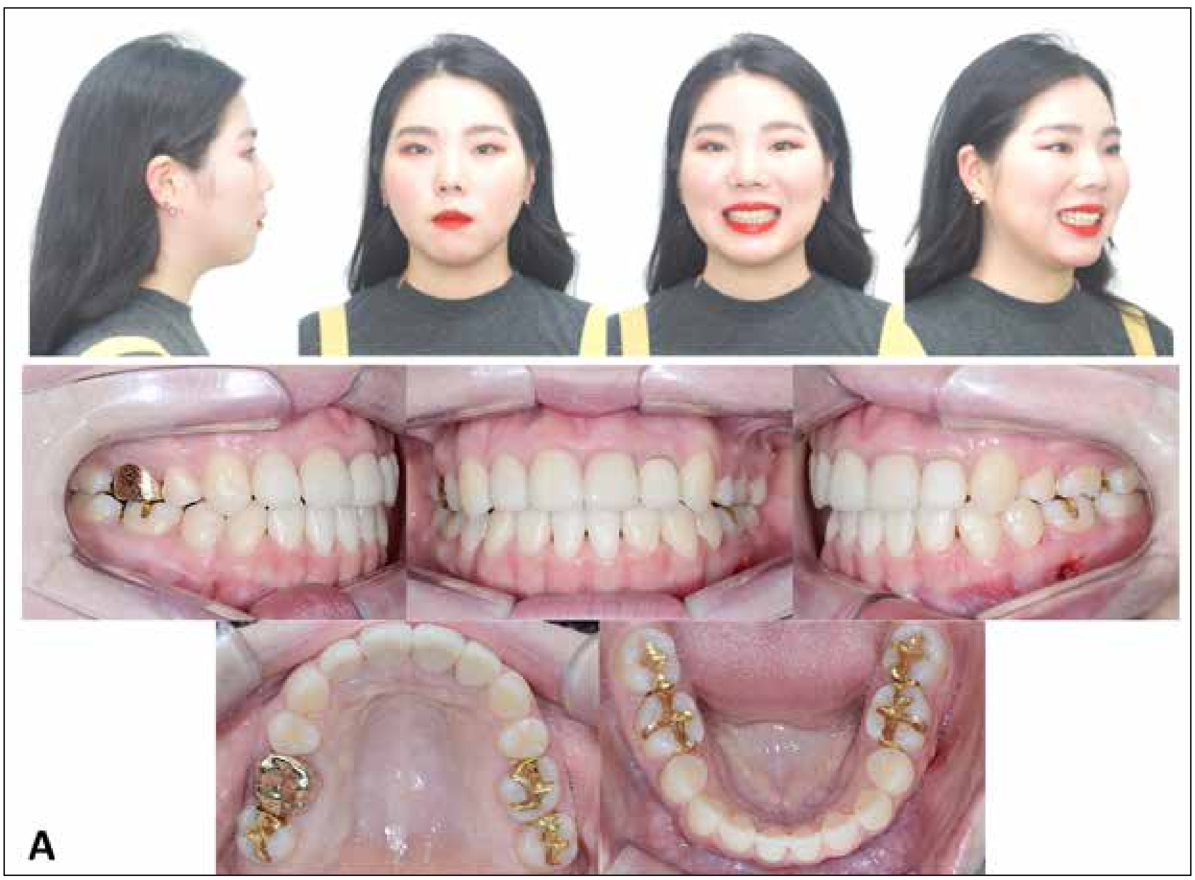
Measurement	Korean norm	Pre-treat-ment	Post-sta-bilization	Post-treat-ment
SNA (°)	82.0	82.0	82.0	82.0
SNB (°)	79.0	76.0	73.0	75.5
ANB (°)	2.5	6.0	9.0	6.5
Saddle Angle (°)	126.0	121.0	118.5	118.5
Articular Angle (°)	149.0	168.0	180.0	177.0
Gonial Angle (°)	118.5	119.0	116.0	117.0
Upper Gonial Angle (°)	45.0	38.0	33.0	36.0
Lower Gonial Angle (°)	74.0	81.0	83.0	81.0
SUM (°)	393.0	408.0	414.5	412.5
Facial Angle (Down's) (°)	89.0	85.5	83.0	84.5
Wits (mm)	-2.5	4.0	7.0	1.5
SN-MP (°)	33.5	34.0	39.5	37.0
Ramus Height (mm)	51.5	45.0	44.0	43.0
Post. FH / Ant. FH (%)	66.8	57.0	54.5	56.5
U1-SN (°)	104.0	112.5	112.5	101.0
U1-FH (°)	116.0	122.5	122.5	110.0
U1-NA (°)	22.0	30.0	30.0	17.0
U1-NA (mm)	4.0	7.5	7.5	-1.0
IMPA (°)	90.0	95.0	95.0	77.0
L1-NB (°)	25.0	33.0	38.0	18.0
L1-NB (mm)	4.0	12.0	13.0	6.0
U1/L1 (°)	124.0	109.0	103.0	137.0
Overjet (mm)	2.8	7.0	10.0	3.5
Overbite (mm)	3.0	-1.0	-11.0	3.5
Upper lip (mm)	0.0	3.5	4.0	1.0
Lower lip (mm)	0.0	6.0	9.0	2.0

Figure 11. Graphic image of the bonded double transpalatal arch (TPA) with TSADs for intrusion of maxillary posterior teeth.

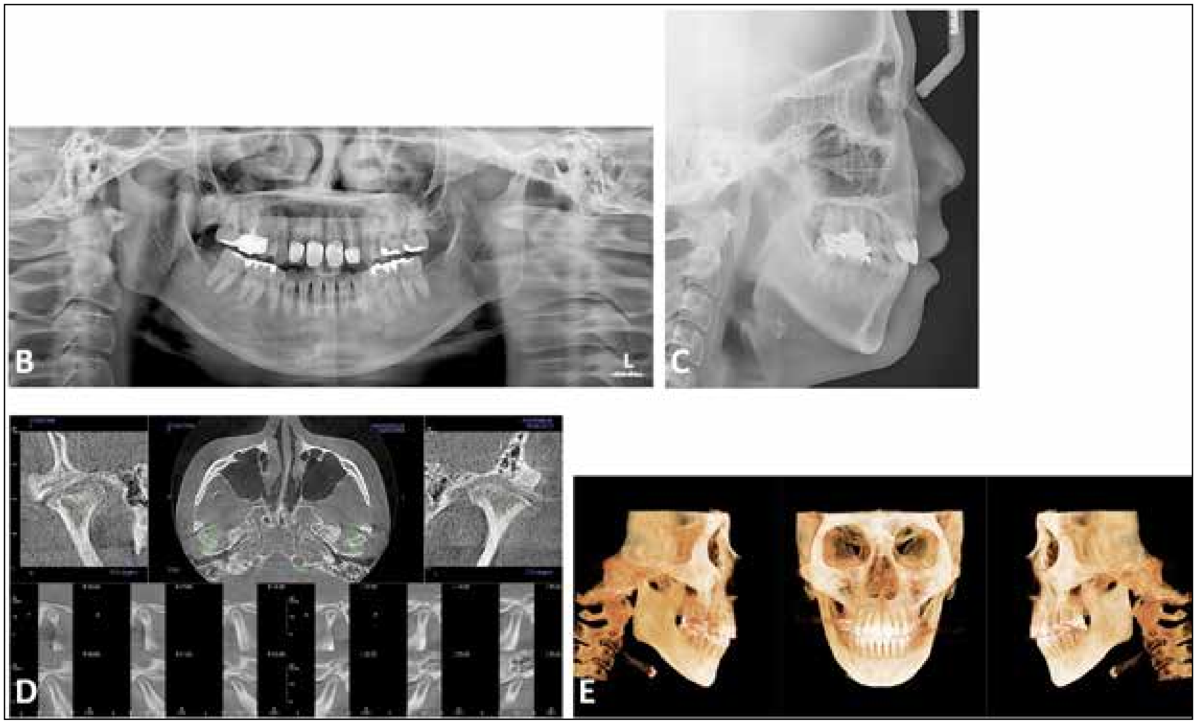


Figures 12. Intraoral photographs showing treatment progresses.

Figures 13. Post-treatment data: A, Facial and intraoral photographs.

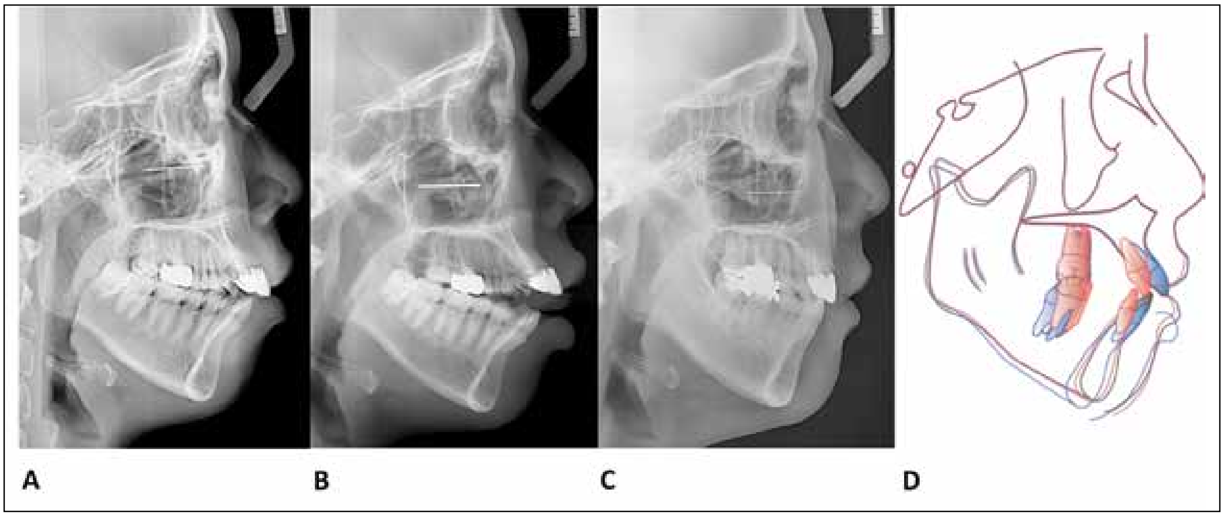


Figures 13. Post-treatment data (continued): B, panoramic radiograph; C, lateral cephalogram; D, cross-sectional view of CBCT image; E, volume-rendering CBCT image.

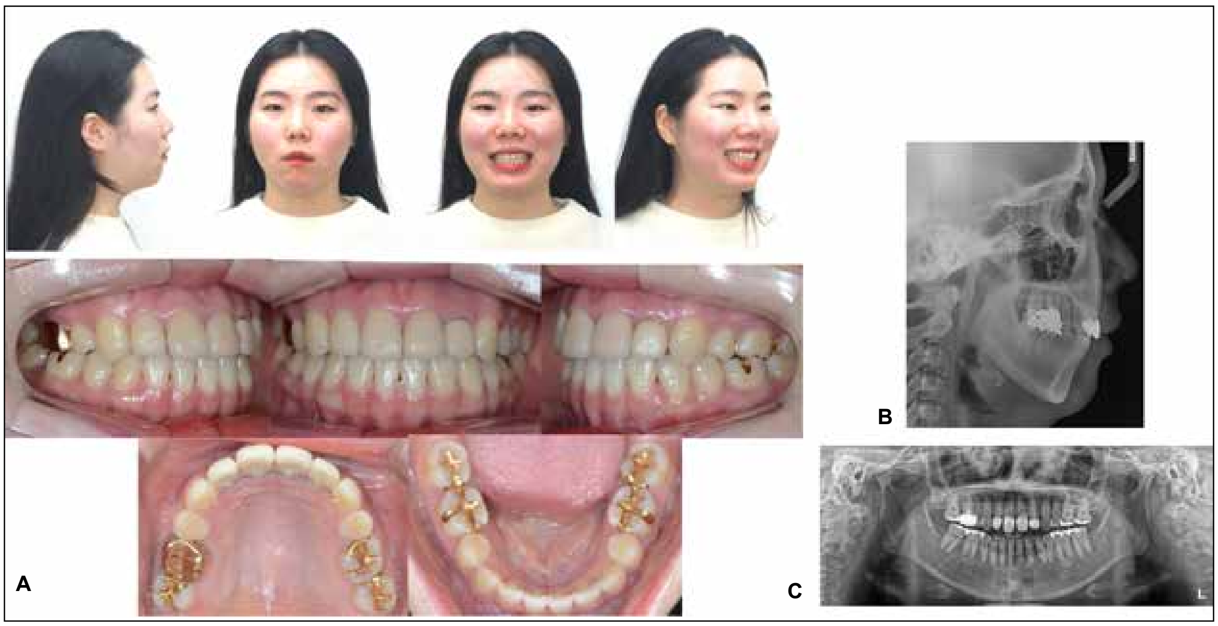


Figures 14. Comparison of intraoral photographs: A, Pre-treatment; B, Post-stabilization; C, Post-treatment.

Figures 15. Comparison of lateral cephalograms: A, Pre-treatment; B, Post-stabilization of the mandible; C, Post-treatment; D, cephalometric superimposition. *black*, pre-treatment; *blue*, post-stabilization; *red*, post-treatment.



Figures 16. Retention 24 months: A, Facial and intraoral photographs; B, Lateral cephalogram; C, Panoramic radiograph.



After 4 months of intrusive force being applied simultaneously on buccal and palatal sides, the openbite was closed from 8 mm to 3 mm, and maxillary first premolars were extracted to start a full fixed treatment and 0.022-in preadjusted edgewise orthodontic appliances (AvexOpal Orthodontics, Utah) were bonded on both arches for leveling and alignment. It was decided to postpone extraction of the mandibular premolars to check for possible changes in occlusion. Six months after the full fixed treatment, no significant occlusal change was evident so the mandibular second premolars were extracted to establish adequate overbite and overjet. Extraction spaces in the maxillary arch were closed with elastomeric chains from the posterior buccal miniscrews to hooks between the lateral incisors and canines. For the correction of Class II molar relationship, TSADs between the canines and first premolars in the mandibular arch were placed on both sides for an effective anchorage loss of the mandibular molars. Since harmful change of condylar position induced by inter-arch elastics could be detrimental to our patient, we did not apply any force that would provide extrusion force to the TMJs (Figure 12). All appliances were removed after 30 months of treatment, leaving a shallow final overbite to provide sufficient anterior guidance, due to the short crown length of the old prosthetic crowns on the maxillary incisors. Fixed lower 3-3 and upper 3-3 retainers were bonded, and wraparound removable retainers were also delivered.

Orthodontic treatment produced considerable improvement in the patient's facial esthetics, but she still had a slightly convex profile due to her retrognathic mandible. Class I canine and molar relationships with acceptable overjet and overbite were achieved. A CBCT image showed a definite cortical continuity of condylar heads and there were no significant changes in condylar morphology when compared to the post-stabilization state and the patient complained of no TMD symptoms (Figure 13-15).

At 2-year retention, treatment results were stable and there was no significant signs of any further condylar resorption (Figure 16). Condylar movement was smooth in mouth opening and closing and no recurrence of pain or other TMJ symptoms was observed.

DISCUSSION

In a previous study, it was reported that orthodontists see the incidence of ICR to be approximately 1 in 5000 patients while orthognathic surgeons have reported an incidence of 2-5%, which was far higher than the rate reported by the orthodontists.[22] This may indicate that a lot of patients with ICR are undetected by the orthodontists. Fewer than half of the patients with ICR present with TMJ pain and symptoms showing variable occlusions before developing the problem. ICR is easy to be overlooked during the clinical exams or diagnosis, but it brings about serious clinical and legal problems when it does occur during or after the treatment.

ICR is reported to appear predominantly in adolescent female teenagers; the female to male ratios range between 2:1 and 8:1. This apparent female preponderance for dysfunctional remodeling of the TMJ suggests a potential role of sex hormones as modulators of degenerative response of TMJ. Previous studies investigated that estrogen mediated cartilage and bone metabolism in the female TMJ.[3,5-7,23-25] Later studies claimed that as estrogen receptors are present in the female TMJ and estrogen can have a negative influence on joint tissues, it may predispose an exaggerated response to joint loading from parafunctional activity, trauma, orthodontics, or orthognathic surgery.[26,27]

Mechanical factors that can cause changes in condylar morphology include occlusal therapy, internal derangement, parafunction, trauma, and unstable occlusion. And when they exceed the adaptability of a patient, morphologic changes in the TMJs are accentuated when compression factors are active.[28]

It is undisputable to postpone definitive orthodontic and orthognathic treatment during the active stage of ICR. TMJs in the active phase of this disease can be influenced by various orthodontic or surgical manipulations that increase loads or functional demands on the TMJs. The progression of ICR is associated with a change in the jaw position and occlusion, and therefore may result in an unfavorable change in the orthodontic diagnosis and treatment plan.[5]

Radiographic images can be important and powerful tools for the clinical evaluation in determining the stability of ICR. In an active ICR patient, the fibrocartilage that covers the cortical layer of the mandibular condyle is observed to breakdown, and then the outer cortex of the osseous condyle starts to resorb. This is seen on the radiographic images with the disappearance of the dense outer cortical layer.[1,8] The easiest radiographic access to find an ICR is the panoramic view. The condylar mass of ICR patients is usually decreased bilaterally and the superior anterior surface of the condyle is flattened. In lateral cehalographic radiographs, it is frequently found that mandibular divergence is increased with shortened posterior facial height, and increased anterior facial height. An increase in overjet and negative overbite and sagittal measures for skeletal Class II are another characteristic findings in ICR patients. Serial lateral cephalograms can be used to identify active ICR. CBCT image can provide additional information about the pathologic phases. In the destructive or active phase, a breakdown in the anterosuperior surface integrity is seen and TMJ structures are vulnerable to biomechanical forces. At the repair or stable phase of ICR, the condyle has lost volume, but the superior surface of the condyle is corticated and smooth. Bone scan imaging techniques such as technetium-99m methylene-diphosphonate (99mTc-MDP) standard bone scans are efficient for assessing TMJ conditions, but the specificity is not sufficient to determine TMJ stability.[29,30] Even though stability of the mandibular condyles can be radiographically assessed when the size, shape, and quality of the osseous components remain constant over time, it cannot guarantee that the ICR of the patient is in the stable stage.

Therefore, clinicians need a more reliable way to confirm the stability of the TMJs. The splint therapy can be the best strategy to stabilize the TMJ before starting orthodontic treatment in patients with ICR. Stabilization of the TMJ is a therapeutic process that allows clinicians to identify the true mandibular position and make an accurate diagnosis.[19,31] Stabilization splints are often used to treat musculoskeletal disorders in TMJs and they also allow clinicians to predict patient responses to future occlusal reconstruction with an orthodontic approach.[32] As a stabilization splint eliminates the protective co-contraction by reproducing the scheme of functional occlusion, a musculoskeletally stable position of the TMJ condyles can be achieved. Even with the splint therapy, a displaced disc cannot be recaptured or repositioned to a normal position. However, the use of a stabilization splint in patients with disc displacement promotes formation of a "pseudodisc" on the posterior band of the disc.[32,33]When the condyles seat in the most forward and uppermost position in the articular fossa with the help of a stabilization splint, it can be considered that the patient's condyle is in a reproducible and reliable reference position for mandibular movement. When the joints have been stabilized, diagnostic records should be taken in the stable condylar position to make a definitive diagnosis.[32,34]

As many patients with ICR show significant changes in occlusion and mandibular position, mostly characterized by a severe openbite and retrognathic facial profile, full mouth rehabilitation such as the orthodontic and/or orthognathic approach must be followed. Even though our patient showed extreme changes in her occlusion and facial profile after the use of a stabilization splint, we decided to stay with orthodontic camouflage treatment because her venerable joints might not be able to withstand the mechanical loads produced by surgical mandibular advancement that would exceed her biological adaptability.[28,35] Conventionally, this severe openbite would be treated with orthognathic surgery, which is the most common approach, but TSADs might be indicated in some cases to facilitate the orthodontic correction.

Many studies have reported successful molar intrusion using orthodontic TSADs to improve both occlusion and facial esthetics for severe anterior openbite patients.[36-40] In our case, the patient's retrognathic profile was significantly improved by counterclockwise rotation of the mandible with the aid of multiple buccal and palatal TSADs along with a double transpalatal arch. The long-term stability after treatment for anterior openbite with TSADs has not been fully investigated yet, however, our patient had an acceptable overbite that remained stable for 2 years of retention.

CONCLUSIONS

In the treatment of ICR patients, TMD symptoms and the constantly changing occlusion caused by an unstable condylar position disrupt reliable orthodontic diagnosis and assigning criteria for orthodontic evaluation. Therefore, the TMJ structures should be stabilized prior to active tooth movement to identify and maintain the true mandibular position. Mechanics to prevent TMJ structures from unbearable mechanical loads are also recommended for orthodontic treatment of patients with ICR.

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