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Clinical application of a lingual retractor with temporary anchorage devices (TADs) for patients with lip protrusion and anterior open bite

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A R T I C L E I N F O

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A B S T R A C T

Anterior open bite (AOB) is considered one of the most difficult malocclusions to correct and achieve successful and stable results. Various treatment approaches have been proposed for the treatment of AOB in adults. Intrusion of the entire maxillary dentition is necessary for AOB patients with severe incisor exposure. In previous reports, a labial appliance with temporary anchorage devices (TADs) implanted in various positions has been used to achieve total intrusion of the maxillary dentition. This article describes the design and biomechanics of an anteroposterior lingual retractor (APLR) to attempt retraction of anterior teeth and total intrusion of maxillary dentition after premolar extraction in patients with both lip protrusion and AOB and the functions of each component of APLR is considered. When force is applied between the anterior lever arm of the APLR and a TAD in the midpalatal area, the anterior teeth are intruded and retracted with torque control. Because the direction of the APLR force and the guide bar are not parallel, intrusive force is generated in the posterior teeth. Due to this total intrusion of the maxillary dentition, the mandible is rotated counterclockwise, improving AOB with severe incisor exposure. Various cases are presented in which APLR was applied to AOB patients, and the clinical considerations behind the treatment are explained in detail.

Introduction

Anterior open bite (AOB) is considered one of the most difficult malocclusions to correct and achieve successful and stable results because it is caused by various factors such as genetics, dental discrepancies, skeletal discrepancies, functional and soft tissue problems, and habits.[1-3] Various treatment approaches have been proposed for treating AOB in adults, including orthognathic surgery, orthodontic treatment involving extrusion of incisors, or intrusion of molars, depending on the cause.[4-7]

Extrusion of the anterior teeth is applicable in patients with AOB who have a normovergent pattern but insufficient incisal exposure when smiling.[8,9] However, extrusion is less stable than intrusion, and extrusion of incisors can ruin the smile esthetics and rotate the mandible clockwise (CW), making the mandible appear more retruded.[10-12] Therefore, intrusion of the molars using TADs has been attempted for the nonsurgical correction of patients with Class II AOB with a hyperdivergent pattern.[11,13-15] However, in open bite patients with severe incisor exposure, maxillary whole dentition intrusion may be required. In previous studies,[16-18] various temporary anchorage device (TAD) locations were applied for total intrusion of the maxillary dentition, and most of these studies used labial appliances. Although some studies have used lingual brackets to intrude the maxillary whole dentition recently, a few studies have attempted simultaneous retraction of the anterior teeth and total intrusion of the maxillary dentition using a lingual retractor in patients with lip protrusion and AOB.[19-26] No papers have detailed the use of a lingual retractor to simultaneously achieve retraction of the anterior teeth and total intrusion of the maxillary dentition in patients with lip protrusion and AOB.

Therefore, this article demonstrates biomechanical considerations for applying a lingual retractor with TADs to attempt retraction of the anterior teeth and total intrusion of the maxillary dentition after premolar extraction in patients with lip protrusion and AOB. Additionally, we aim to provide in-depth insight into the effects and clinical considerations of lingual retractors with TADs through various case reports.

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Biomechanical consideration for total intrusion of maxillary dentition

In general, intrusion of the maxillary molars is often attempted as a nonsurgical treatment plan for patients who only have an AOB; however, for the treatment of patients who have both a gummy smile and an AOB, it is recommended to attempt intrusion of the entire maxillary dentition. This will also produce a total impaction-like effect on the maxilla, which may improve the profile because of the counterclockwise rotation of the mandible. This approach can achieve a similar effect to orthognathic surgery involving total impaction of the maxilla, and the counterclockwise rotation of the mandible may make the mandible appear more protruded.[16] The amount of counterclockwise rotation of the mandible accompanying the maxillary dentition intrusion varies among individuals.[27,28]

Previous studies have described several methods and biomechanical considerations for the intrusion of the entire maxillary dentition using labial appliances. Baek et al.[16] and Tavares et al.[18] proposed a biomechanical approach to achieve intrusion of the entire maxillary dentition along with distalization of the maxillary dentition by applying two TADs on each buccal side (Fig. 1A). In a report by Baek et al.,[16] two lines of force are created by applying force to the TAD between the second premolar and first molar from the hook between the canine and first premolar and additionally applying force to the TAD between the first premolar and second premolar from the hook between the canine and lateral incisor. Distalization and intrusion of the entire dentition occur when the appliance is designed so that the center of resistance (CR) of the maxillary dentition is located between the two lines of force.[16,29] Tavares et al.[18] placed TADs between the maxillary canines and first premolars on both sides, placed TADs between the maxillary first and second molars, and applied force from these TADs to the maxillary archwire. Additionally, a transpalatal arch (TPA) was placed to prevent the crown buccal tipping toward the TAD.[18,30]

If a patient requires intrusion of the entire maxillary dentition accompanied by severe crowding or lip protrusion, orthodontic treatment, including extraction of the maxillary premolars, is required. Some previous reports have described methods to intrude the entire maxillary dentition and simultaneously retract the maxillary anterior teeth.[17,20] Wang et al.[20] and Paik et al.[17] used a maxillary archwire with an accentuated Spee curve to apply an intrusive force to the maxillary incisors and molars and an extrusive force to the premolars in orthodontic treatment, including premolar extractions (Fig. 1B). To eliminate the extrusive force in this premolar region, Wang et al.[20] applied an intrusive force between the TADs placed in the buccal alveolar bone between the second premolars and first molars on both sides and the maxillary archwire, while Paik et al.[17] applied intrusive force to the posterior teeth using TADs placed in the midpalatal area and the TPA. In both reports, retraction force was applied from the hook of the archwire between the maxillary lateral incisor and canine to the hook in the molar tube or the TADs around the molars. In this way, the entire maxillary dentition was intruded, and the maxillary incisors were retracted. However, it was non-aesthetic using labial appliances to intrude the entire maxillary dentition and retract the maxillary incisors because the appliances were highly visible, and it was disadvantageous to control the vertical position of the TADs and the length of the lever arms due to anatomical limitations.

Lingual retractor with TADs for patients with lip protrusion

In a lingual retractor, the anterior lingual arch is soldered to the attachment pads located on the lingual surface of the anterior teeth to form an anterior splint. Two lever arms of various lengths can be soldered to the attachment pads or anterior lingual arch to apply retraction force in various directions. When absolute anchorage is required, TADs are placed in the midpalatal area or palatal slope, and the anterior teeth are retracted as much as possible by activating a coil spring or power chain between the lever arm and the TADs.[21,31-34]

Retracting the anterior teeth using a lingual retractor in patients with lip protrusion has several advantages besides being less visible during treatment. First, using a lingual retractor enables the initial retraction of the anterior teeth, thereby addressing most patients' complaints about lip protrusion early on; this method minimizes round tripping by avoiding the conventional sequences of alignment and leveling followed by retraction, which often causes the anterior teeth to move into labioversion before moving posteriorly. Second, the lingual retractor encounters very little friction except for the contact between the posterior tube and the guide bar. This results in minimal resistance during the closure of extraction spaces. In conventional sliding mechanics, there is resistance to sliding between the posterior brackets, tubes, and archwire, making the closure of extraction spaces inefficient and sometimes causing unwanted movement of the posterior teeth. In this regard, using a lingual retractor can minimize the reaction in the molar region and make the closure of extraction spaces more efficient. Third, with the lingual retractor, the distance and direction between the line of force and the center of resistance can be adjusted by changing the length of the lever arm and the position of the TADs.[21,31]

The C-lingual retractor (CLR) has long lever arms (Fig. 2A), but if the line of action passes below the CR of the anterior teeth, the anterior segment may rotate clockwise (Fig. 2B), causing side effects such as anterior torque loss and canine open bite. (Figs. 2C, D).[34,35] To reduce these disadvantages, the Double J retractor with additional torque springs on the lever arms was designed.[33,36,37] These conventional lingual retractors enable torque control or vertical control of the anterior teeth by changing the length of the lever arm or the vertical position of the TADs or activating the torque spring. However, since the appliance is not attached to the posterior teeth, it is ineffective in cases where the total intrusion of the maxillary dentition is required, such as open bite patients with a gummy smile.

Design and biomechanics of antero-posterior lingual retractor for maxillary total intrusion

The APLR was designed to improve lip protrusion through anterior retraction with the total intrusion of the maxillary dentition in Class II patients with a hyperdivergent pattern.[21-26,38]

The main difference between APLR and conventional lingual retractors is that APLRs have a device attached to the posterior teeth to control them.[21-26,31] Figure 3A shows the schematic diagram of an APLR. The anterior segment of the APLR is similar to that of the conventional lingual retractor. Additionally, 0.036-in stainless steel guide bars soldered to the lever arm or front attachment pad extend posteriorly and pass through the posterior segment's posterior tube (path hole). To reinforce the anchorage, a posterior splint is generally placed on the lingual surface of the second premolar, first molar, and second molar, and a posterior tube through which the guide bars will pass is soldered to the first molar area. If needed, two tubes can be soldered on each side of a TPA. Additionally, if intrusion or torque control of the posterior teeth is required, a hook can be soldered to the TPA.[21-24,26,31]

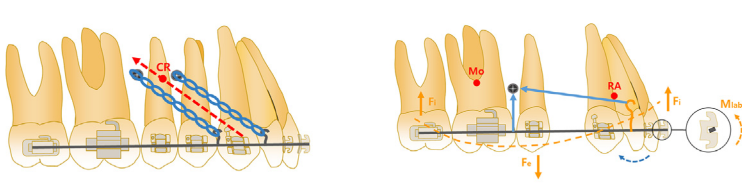

Fig. 1. Biomechanics for total intrusion of maxillary dentition using buccal appliances. A: Application of two miniscrews on each buccal side for total intrusion and distalization of the maxillary dentition in a non-extraction case, B: Application of a TAD on each buccal side and a maxillary archwire with an accentuated curve of Spee for total intrusion of the maxillary dentition and retraction of the anterior teeth in a premolar extraction case.

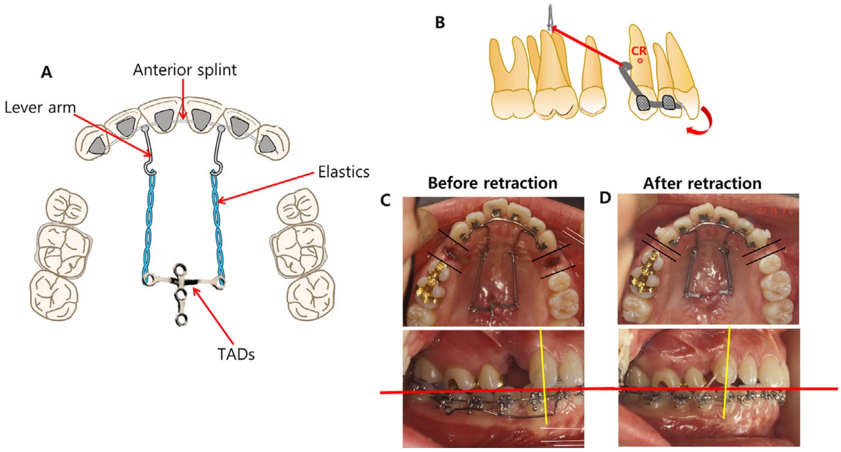

Fig. 2. A: Schematic photo of C-lingual retractor (CLR), B to D: Side effects such as anterior torque loss and canine open bite that can occur during anterior retraction using CLR. B: Schematic photo in which the line of action passes below the CR of the anterior teeth, C: Before retraction, D: After retraction.

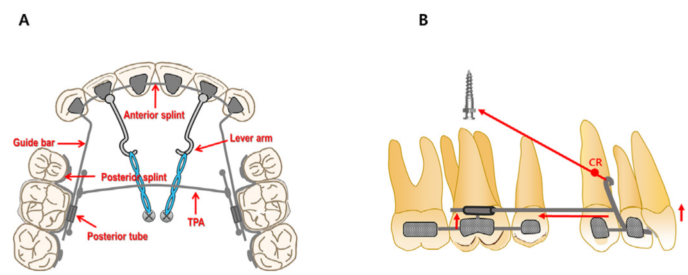

Fig. 3. A: Schematic photo of an antero-posterior lingual retractor (APLR), B: Biomechanics of the APLR.

As shown in Fig. 3B, when force is applied between the lever arm and the TADs in the midpalatal area, the anterior teeth are intruded and retracted through torque control. If the direction of the APLR force and the guide bar is not parallel, intrusive force is generated in the posterior teeth. This total intrusion of the maxillary dentition causes the mandible to rotate counterclockwise.[25,26]

As with other lingual retractors, torque and vertical movement of anterior teeth can be controlled by changing the length of the anterior lever arm of the APLR and the vertical position of the TAD.[21,22,24] In hyperdivergent Class II patients with an open bite and gummy smile, TADs should be placed higher than the hook of the anterior lever arm to achieve total intrusion of the maxillary dentition.[7,18,19] If the patients' maxillary anterior teeth require retraction with tipping movement, the line of action connecting the hook of the anterior lever arm and the TADs is designed so that it passes under their CR. However, if they require retraction with bodily movement, the line of action should be set to pass through the CR. Therefore, when anterior teeth are retracted with bodily movement, longer lever arms are needed, and TADs should be placed higher than when retracting with a tipping movement.[36,39,40]

The guide bar that is soldered to the anterior splint and passes through the posterior tube effectively controls the retraction vector to prevent anterior torque loss.[25,29] Additionally, changes in the angulation of the posterior tube control the amount of intrusion of the anterior teeth. When the posterior tube is parallel to the maxillary occlusal plane, the anterior teeth show bodily movement, but when the tube angle is distally tipped, the amount of intrusion of the maxillary anterior teeth increases. Therefore, the maxillary anterior teeth in patients with open bites and gummy smiles can be effectively controlled by changing the angulation of the tube.[25,29]

Suppose the posterior dentition is not connected as one unit when retraction and intrusion force are applied from the anterior lever arm of the APLR to the TADs. In that case, the intrusion force is applied only to the first molar to which the posterior tube is bonded (Fig. 4). Therefore, the APLR is effective when the posterior dentition is connected as one unit, so it should be designed this way. Connect the dentition as one unit by bonding buccal brackets or tubes from the canine to the posterior teeth and engage a heavy rectangular segmental archwire or by bonding a posterior splint to the buccal surface or palatal surface of the posterior teeth (Fig. 5).

Because the intrusion forces applied to posterior dentitions via an APLR are applied only to their palatal surfaces, the forces may cause some palatal tipping movements. Therefore, it is best to use a TPA to reduce tipping.[20]

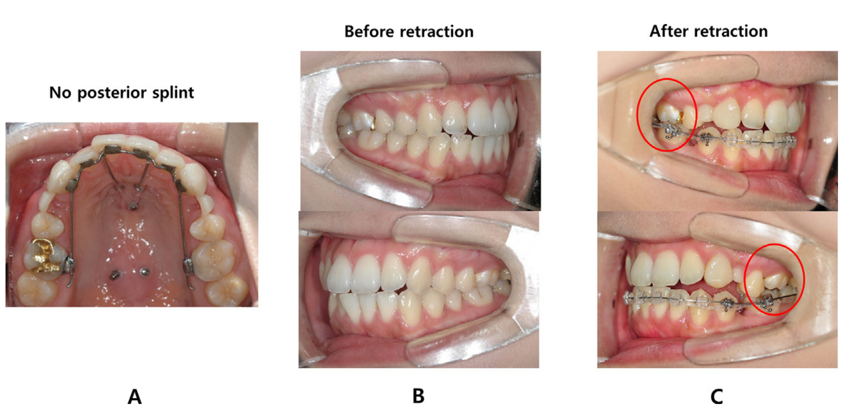

Fig. 4. A: APLR design without a posterior splint, B: Before retraction, C: After retraction.

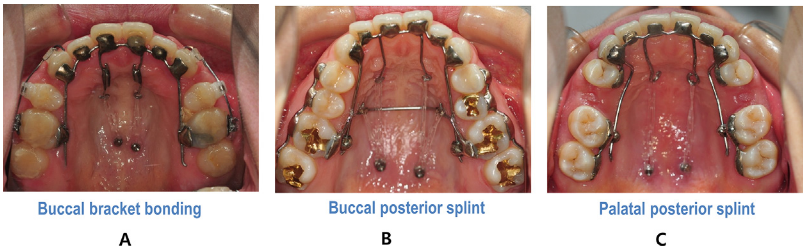

Fig. 5. The method of connecting the posterior dentition as one unit. A: bonding buccal brackets or tubes from the canine to the posterior teeth and engaging a heavy segmental rectangular archwire, B: bonding a posterior splint to the buccal surface, C: bonding a posterior splint to the palatal surface of them.

Compensatory extrusion of mandibular molars during intrusion of maxillary dentition

Previous studies[11,14] have reported that compensatory extrusion of the mandibular molars may occur during intrusion of the maxillary dentition, including the maxillary molars, which may reduce the mandible's expected amount of counterclockwise rotation. In particular, when the occlusal plane is steep or the mandibular plane angle is high, mandibular molars are prone to compensatory extrusion. Therefore, if such extrusion is expected, it is reasonable to establish a strategy to prevent it, such as implanting TADs near the mandibular posterior teeth. This should also be considered when performing total intrusion of the maxillary dentition using APLR.

Case 1. Application of APLR with long lever arms in an AOB patient with a gummy smile and a deep palatal vault

The patient was a 25-year-old woman with a chief complaint of lip protrusion and AOB. Pretreatment lateral profile photographs showed a convex profile with a retrusive chin. Smile photographs showed a gummy smile and a flat smile arc (Fig. 6A). Pretreatment intraoral photographs showed AOB and mandibular anterior crowding. The lateral cephalometric analysis showed a skeletal Class II hyperdivergent facial pattern (ANB = 7.2°, SN-GoMe = 42.9°) with a protrusive maxilla and a retrusive mandible. The maxillary incisors had a normal inclination (U1-FH = 114.1°), while the mandibular incisors were proclined (IMPA = 104.1°) (Fig. 6B). In the panoramic radiograph, it could be seen that partial endodontic treatment (pulpotomy) had been performed on both mandibular first molars, and there was a supernumerary tooth (SNT) between the mandibular right first and second premolars. The right condyle was flattened, and the left condyle had a thin bird beak pattern (Fig. 6C), but there were no TMJ symptoms.

She requested early improvement of her lip protrusion and treatment with a less visible orthodontic appliance. To improve lip protrusion, it was decided to extract first premolars from the maxilla and extract poor condition first molars and SNT from the mandible. Retraction of the anterior teeth with bodily movement and total intrusion of the maxillary dentition using APLR was planned to improve the AOB and gummy smile.

Relieving the crowding of the mandibular anterior teeth was performed by bonding brackets to the mandibular dentition, and then an APLR was bonded to the maxillary dentition 5 months later. For retraction accompanied by bodily movement of the maxillary anterior teeth, lever arms that were approximately 15 mm long were soldered to the attachment pads of both canines and guide bars were soldered to both lever arms. Palatal posterior splints were placed on the second premolars, and the first and second molars were on both sides. Two posterior tubes were soldered to each side's first molar attachment pads (Fig. 6D). The posterior tube was tipped distally at the point where the guide bar was to be inserted to increase intrusion of anterior teeth. A TPA was inserted in another posterior tube to prevent palatal tipping during posterior intrusion. TADs were placed around the midpalatal suture. The posterosuperior force applied from the lever arms to the TADs in her deep palatal vault increased the intrusion force in the maxillary dentition, and the line of force was designed to pass through the CR of the anterior teeth (Fig. 6E). Twelve months after APLR delivery, space closure was almost completed, and the finishing and detailing of both arches were carried out.

The total treatment duration was 28 months. The patient's lip protrusion, open bite, and gummy smile were completely resolved, and her smile arc was consonant (Fig. 7). Superimposition of the before and after lateral cephalograms demonstrated relatively bodily retraction (U1-FH = 112°) and intrusion of the maxillary anterior teeth (1.0 mm), intrusion of the maxillary molars (2.5 mm), controlled tipping of the mandibular anterior teeth (IMPA = 90.6°) and compensatory extrusion of the mandibular molars (1.5 mm). Despite the total intrusion of the maxillary dentition, the mandibular molars showed compensatory extrusion, so the counterclockwise rotation of the mandible was less than expected (SN-GoMe = 42.1°), and there was little change in the ANB (ANB = 6.8°) (Fig. 8).

Case 2. Application of APLR with short lever arms in an AOB patient with a gummy smile.

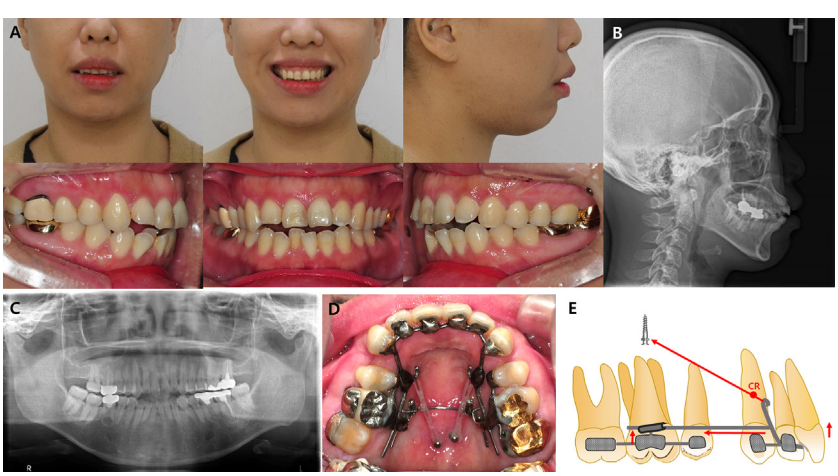

Fig. 6. Case 1. Pretreatment data. A: Facial and intraoral photographs, B: Lateral cephalogram, C: Panoramic radiography, D: Occlusal photo showing the design of the APLR, E: Biomechanics of the APLR.

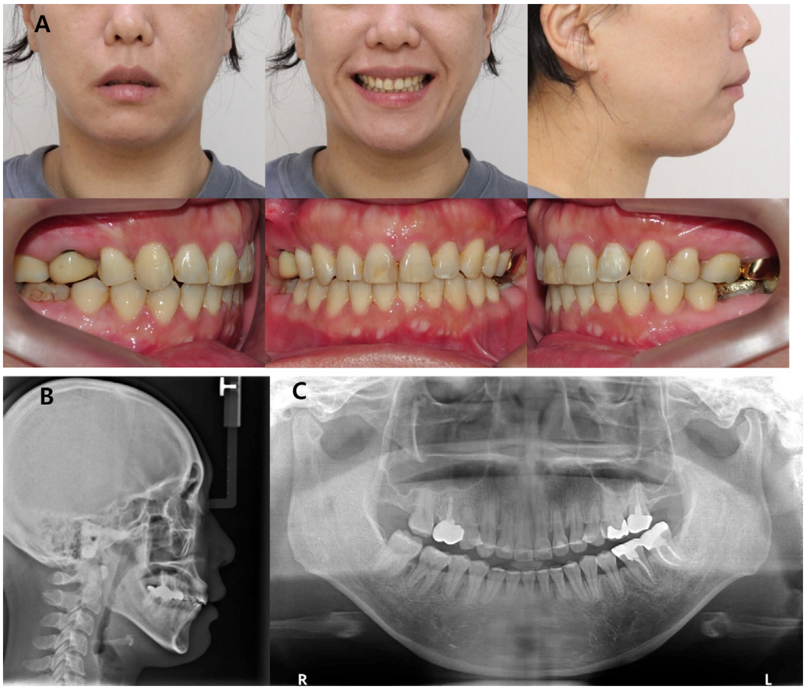

Fig. 7. Case 1. Posttreatment data. A: Facial and intraoral photographs, B: Lateral cephalogram, C: Panoramic radiograph.

A 24-year-old male patient presented with chief complaints of lip protrusion and AOB. He had a history of treatment for degenerative arthritis that was diagnosed five years earlier, but his symptoms have significantly improved over time. Pretreatment facial photographs showed a retrognathic mandible, gummy smile, flat smile arc, lip protrusion, and lip incompetency. Intraoral findings included moderate crowding in both arches with an AOB. Hiscanines and molars showed Class I relationships bilaterally (Fig. 9A).

Lateral cephalometric radiograph measurements indicated a skeletal Class II hyperdivergent pattern (ANB = 6.3°, SN-GoMe = 52.7°) with a retrusive mandible. The patient's maxillary incisors were proclined (U1-FH = 123.1°), and his mandibular incisors were also proclined (IMPA = 100.3°) (Fig. 9B). Panoramic radiographs characteristically showed condylar resorption on both sides, and the left maxillary second premolar had received endodontic treatment. The third molars were fully erupted and in occlusion (Fig. 9C).

Considering the patient's skeletal features, orthodontic treatment with surgery was proposed as the primary option to achieve an aesthetic result, but the patient declined surgery. Considering the amount of crowding and dentoalveolar protrusion, it was decided to extract the premolars, the maxillary second premolars on both sides—due to endodontic treatment of the left one—and the first premolars in the mandible to relieve the crowding and retraction of the incisors. Retraction of anterior teeth with controlled tipping movement and total intrusion of the maxillary dentition using APLR was planned to improve the lip protrusion, AOB, and gummy smile.

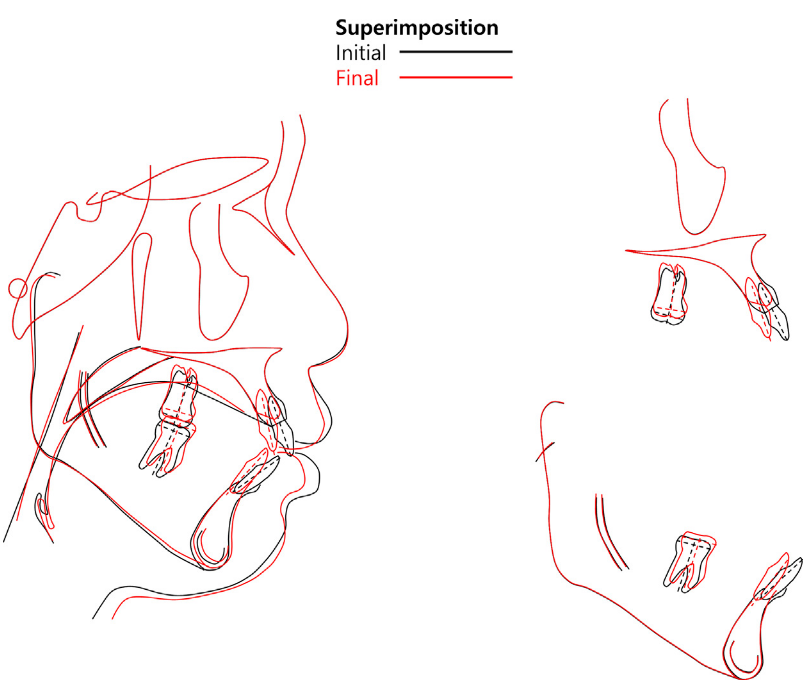

Fig. 8. Case 1. Superimposition of the lateral cephalograms before and after treatment.

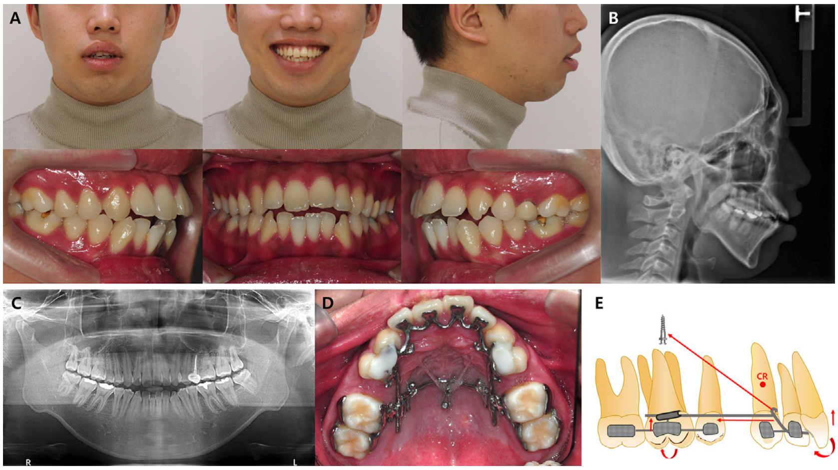

Fig. 9. Case 2. Pretreatment data. A: Facial and intraoral photographs, B: Lateral cephalogram, C: Panoramic radiograph, D: Occlusal photo showing the design of the APLR, E: Biomechanics of the APLR.

After extraction of the second premolars, an APLR was placed in the maxillary dentition. Short lever arms were soldered to the attachment pads on both canines for retraction of the maxillary anterior teeth with controlled tipping, and guide bars were soldered to the anterior splint. Buccal and palatal posterior splints were placed on the first and second molars on both sides, and the posterior tubes for the guide bars were tipped distally to increase the intrusion of the anterior teeth. A TPA was inserted in another posterior tube to prevent palatal tipping during molar intrusion, and TADs were placed in the midpalatal suture area (Fig. 9D). The posterosuperior force from the lever arms to the TADs was set so the line of force passed below the CR of the anterior teeth (Fig. 9E). Meanwhile, TADs were placed between the first and second molars in the mandible to facilitate the retraction of the mandibular incisors and to prevent compensatory extrusion of the mandibular molars. For AOB correction, which became difficult due to the large amount of intrusion of the maxillary anterior teeth, the power chain was activated between the TADs in the midpalatal suture area and the TPA to intrude the maxillary molars additionally. At 18 months into treatment, all the extraction spaces in both dentitions were almost completely closed, and finishing and detailing of both arches were completed.

The total treatment duration was 29 months, and posttreatment data showed significant improvement in lip protrusion, gummy smile, lip incompetency, and the correction of the AOB (Fig. 10A, B). His-smile arc became consonant. Fortunately, no further condylar resorption occurred in this patient despite the history of degenerative arthritis (Fig. 10C). Superimposition of the before and after lateral cephalograms demonstrated retraction with controlled tipping (U1-FH = 107.1°), intrusion of the maxillary anterior teeth (1.5 mm), intrusion of the maxillary molars (2.5 mm), controlled tipping (IMPA = 87.2°) of the mandibular anterior teeth, and no compensatory extrusion of mandibular molars. Despite the total intrusion of the maxillary dentition, there was no compensatory extrusion of the mandibular molars, so the mandible was rotated significantly counterclockwise (SN-GoMe = 50.1°), and ANB was reduced (ANB = 5.0°) (Fig. 11).

Case 3. Application of APLR with long lever arms in an AOB patient with a shallow palatal vault

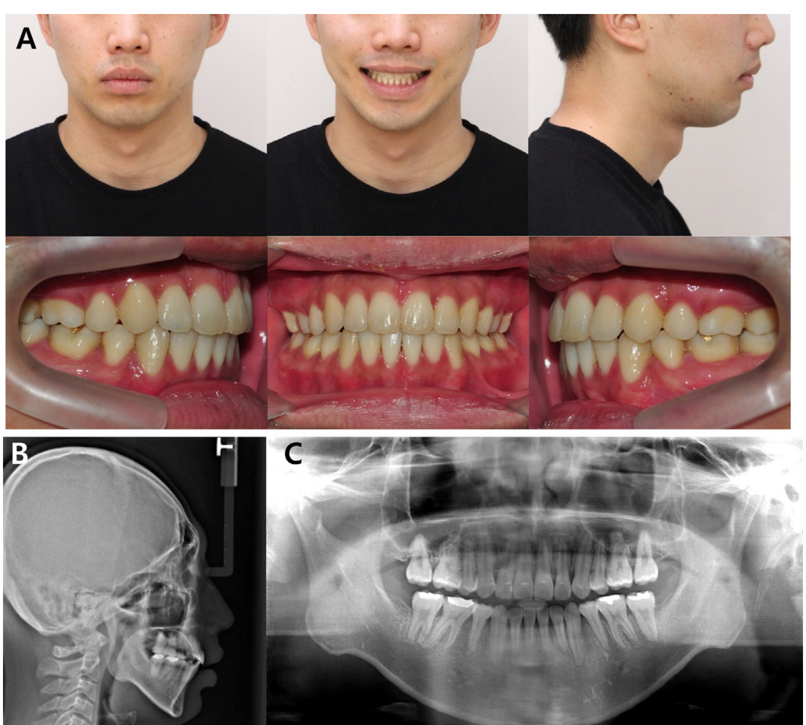

Fig. 10. Case 2. Posttreatment data. A: Facial and intraoral photographs, B: Lateral cephalogram, C: Panoramic radiograph.

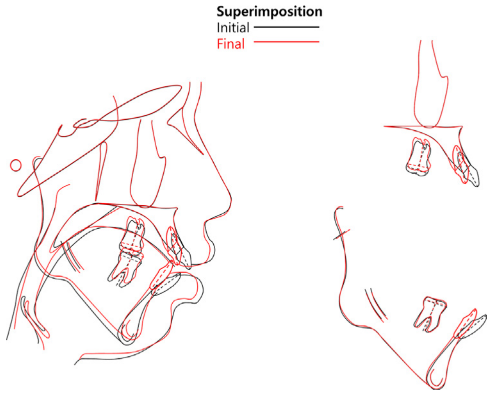

Fig. 11. Case 2. Superimposition of the lateral cephalograms before and after treatment.

A female patient presented with chief complaints of lip protrusion and AOB. She has a convex profile with a retrusive chin and lip incompetency. A slightly increased incisal exposure was observed when smiling. Intraoral photographs showed an AOB and Class II canine and molar relationships. The lateral cephalometric analysis showed a skeletal Class II hyperdivergent facial pattern (ANB = 7.0°, SN-GoMe = 43.3°) with a protrusive maxilla and retrusive mandible. The upper and lower lips showed a 4–5 mm protrusion relative to the E-line. The inclination of the maxillary incisors was normal (U1-FH = 118.0°), and the mandibular incisors were proclined (IMPA = 97.8°). Unerupted maxillary third molars and short rami were observed on the radiographs (Fig. 12A-C).

The treatment plan was to extract the premolars and address the lip protrusion through retraction of the anterior teeth. The maxillary first premolars, third molars, and mandibular second premolars were extracted to achieve a Class I molar relationship. Because she wanted early improvement of the right maxillary high canine, APLR was bonded after the alignment of the six maxillary anterior teeth. Because the patient's maxillary incisors required retraction with bodily movement, long lever arms about 17 mm were soldered between the central and lateral incisors of the anterior splint so the force would pass close to the CR of the incisors. A guide bar extending from the anterior splint was inserted into the posterior tube on the maxillary first molar. Because less intrusion of the maxillary anterior teeth was required, the posterior tube was designed parallel to the occlusal plane. One TAD was placed in the

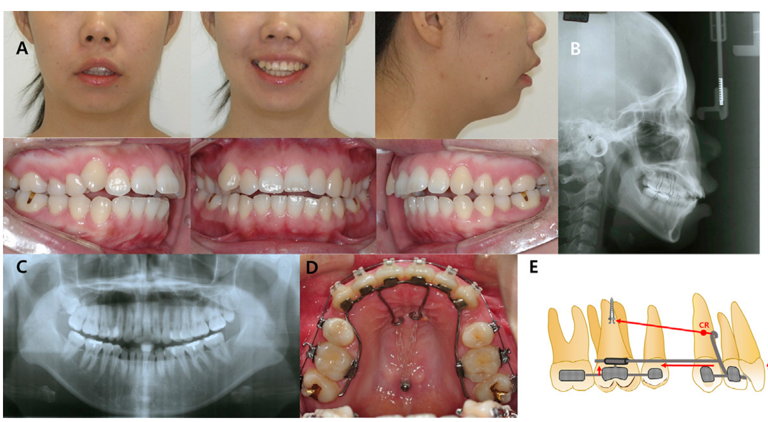

Fig. 12. Case 3. Pretreatment data. A: Facial and intraoral photographs, B: Lateral cephalogram, C: Panoramic radiograph, D: Occlusal photo showing the design of the APLR, E: Biomechanics of the APLR.

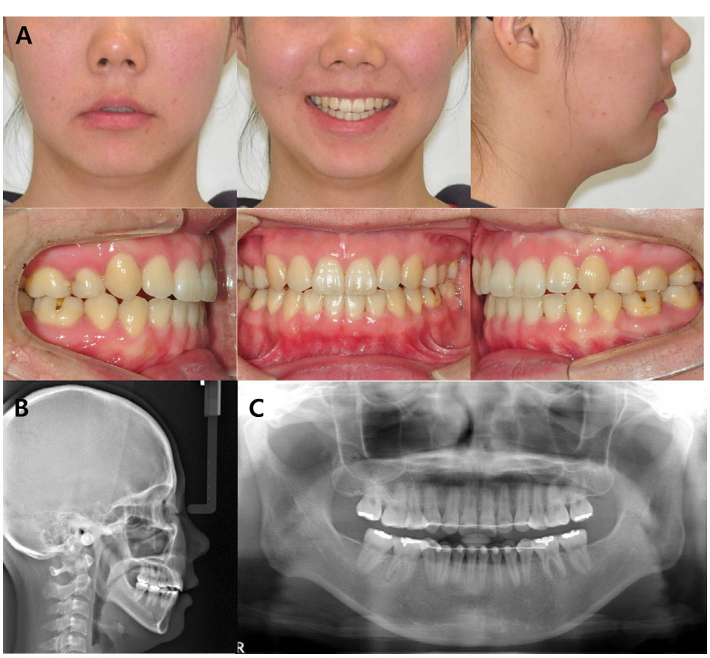

Fig. 13. Case 3. Posttreatment data. A: Facial and intraoral photographs, B: Lateral cephalogram, C: Panoramic radiograph.

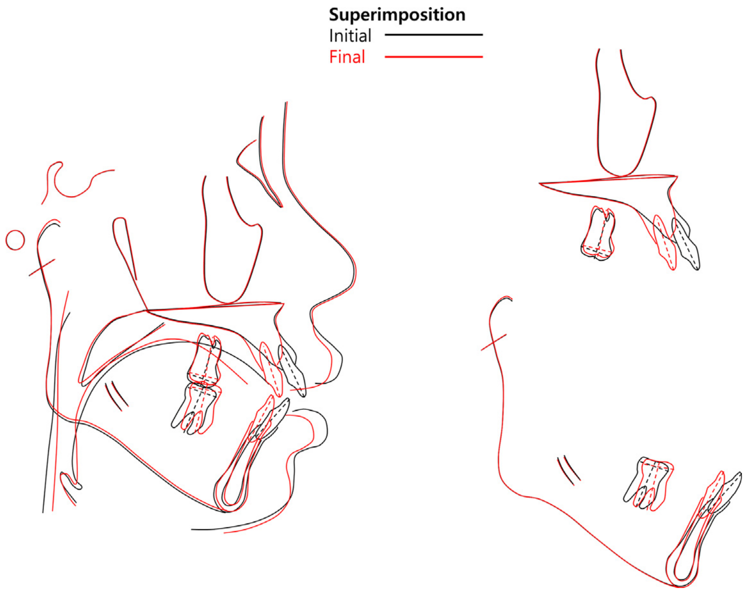

Fig. 14. Case 3. Superimposition of the lateral cephalograms before and after treatment.

midpalatal area, and the maxillary anterior teeth were retracted by activating elastomeric chains from the lever arms to the TAD (Fig. 12D). The line of force passed close to the CR of the incisors, and because the patient had a shallow palatal vault, the intrusive force in the maxillary dentition was relatively small (Fig. 12E).

After 27 months of treatment, her lip protrusion and AOB were completely resolved, and her dental relationship has improved. Her maxillary midline was in harmony with her facial midline, and the lateral profile and smile aesthetics were improved. Additionally, mentalis strain was improved (Fig. 13A-C).

Superimposition of the before and after lateral cephalograms demonstrated relatively bodily retraction (U1-FH = 113.0°) and mild intrusion of the maxillary anterior teeth (0.5 mm), intrusion of the maxillary molars (1.5 mm), controlled tipping (IMPA = 87.3°) of the mandibular anterior teeth, distal tipping and mild compensatory extrusion of mandibular molars (0.5 mm). The intrusion of the maxillary molars caused a slight counterclockwise rotation of the mandible (SN-GoMe = 42.5°), resulting in an anteriosuperior shift of the menton, a slight reduction in the lower anterior facial height with little change in the ANB (ANB = 6.3°) (Fig. 14). To achieve a greater amount of mandibular autorotation, active control of mandibular first molars extrusion was necessary.

Conclusions

For AOB patients with severe incisor exposure, intrusion of the entire maxillary dentition is necessary. APLR has the advantage of being more aesthetically pleasing than conventional labial appliances for this purpose because lip protrusion is corrected quickly. APLR minimizes roundtripping of the dentition, and the distance and direction between the line of force and center of resistance can be controlled. When applying APLR, the length of the lever arm, the vertical position of the TADs, angulation of the posterior tube, posterior splint method, use of TPA, depth of the palatal vault, and compensatory extrusion of the mandibular molars must be taken into consideration.

Patient consent

Patient consent was obtained.

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Author contributions

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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