Case Report

Torque control of maxillary anterior teeth with the double J retractor and palatal miniscrews during en masse retraction: *A case report*

Johnny Liaw[a]; Greg Huang[b]; Fang-Fang Tsai[c]; Shin-Huei Wang[c]; Wendy Liao[c]

ABSTRACT
A double J retractor (DJR) and palatal miniscrews were used to retract maxillary anterior teeth after failure of buccal posterior miniscrews. The line of action passing through the center of resistance of the maxillary anterior teeth and the moment generated by the palatal miniscrews via torquing springs successfully controlled the overbite and incisor torque during space closure. The DJR and palatal miniscrews work well with labial fixed appliances to address bimaxillary protrusion. (*Angle Orthod.* 2022;92:562–572.)

KEY WORDS: Protrusion; Mini-implant anchorage; TSADs; Torque control; Double J retractor

INTRODUCTION

Protrusion is a common problem in Asian patients seeking orthodontic treatment. Skeletal anchorage is a powerful tool to reduce protrusion. With temporary skeletal anchorage devices (TSADs), profile reduction can be achieved reliably.[1–5]

Upper posterior TSADs at the infrazygomatic crest are used by the authors for maximal retraction in protrusion cases regularly. However, some cases lack sufficient bone support in this area. Palatal miniscrews could be considered as a backup. Various designs of palatal appliances had previously been tried with palatal TSADs.[4,6–9] The double J retractor (DJR) is a modified lingual retractor, which aims to retract incisors with a translational movement via lever arm mechanics.[10,11] In this case, a DJR with torquing springs was bonded on the lingual surfaces of upper anterior teeth for en masse retraction.

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Diagnosis and Etiology

A 23-year-old female patient visited the clinic with a chief complaint of dentoalveolar protrusion. Clinical examination showed a convex facial profile with a retruded chin. In addition to the acute nasolabial angle, the labiomental fold was deep. Facial asymmetry was noted, with the right half of the face slightly larger than the left. The chin point deviated to the right about 2.5 mm. The upper dental midline shifted to the right 1.5 mm in comparison to the facial midline. The lower dental midline was off to the right by 2.5 mm.

Both arches were fairly well aligned with symmetrical ovoid arch forms and mild arch length discrepancies: 2.5 mm in the upper arch and 2 mm in the lower arch. Canine relationships were Class IIish on the right and Class I on the left, while molar relationships were Class I bilaterally (Figures 1 and 2). Overjet and overbite were both 1 mm.

The panoramic radiograph showed horizontal impaction of the mandibular right third molar and mesioangular impaction of the mandibular left third molar (Figure 3). The UL maxillary first molar was endodontically treated and had a crown restoration. The periodontal condition was healthy with a thick soft tissue type. Cephalometric measurements (Table 1) revealed Class II skeletal relationships (SNA, 84°; SNB, 74°; ANB, 10°) and a high mandibular plane angle (SN-MP, 38.7°). The axial inclination of the upper incisors was normal (U1-SN, 102.5°). The lower incisors showed typical dental compensation for the skeletal Class II relationship (L1-MP, 115.5°).

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Figure 1. Pretreatment facial and intraoral photographs.

Treatment Objectives

The treatment objectives included alignment and leveling of both arches, ideal overjet and overbite, Class I dental relationships, and maximal retraction of upper and lower incisors for profile improvement. To maximize the profile improvement in this patient with thick soft tissues, anchorage would be reinforced to achieve maximal retraction. Care would be taken to control the vertical dimension to improve the chin projection during space closure.

Treatment Alternatives

The ideal treatment plan for this patient was orthognathic surgery combined with orthodontic treatment. Four premolar extractions along with anterior subapical osteotomies for profile reduction and bilateral sagittal split osteotomy for mandibular advancement to correct the skeletal Class II relationship were suggested. A genioplasty might be considered to improve the chin projection and correct the chin point to be coincident with the facial midline. However, the patient declined the surgical approach.

The selected alternative plan was four-first premolar extractions and space closure to reduce the protrusion. The patient was informed of possibly insufficient profile improvement in consideration of less soft tissue response because of her thicker lips. TSADs would be considered for anchorage reinforcement to maximize incisor retraction and profile reduction. The patient accepted the use of TSADs and understood the limitations of orthodontic treatment without orthognathic surgery.

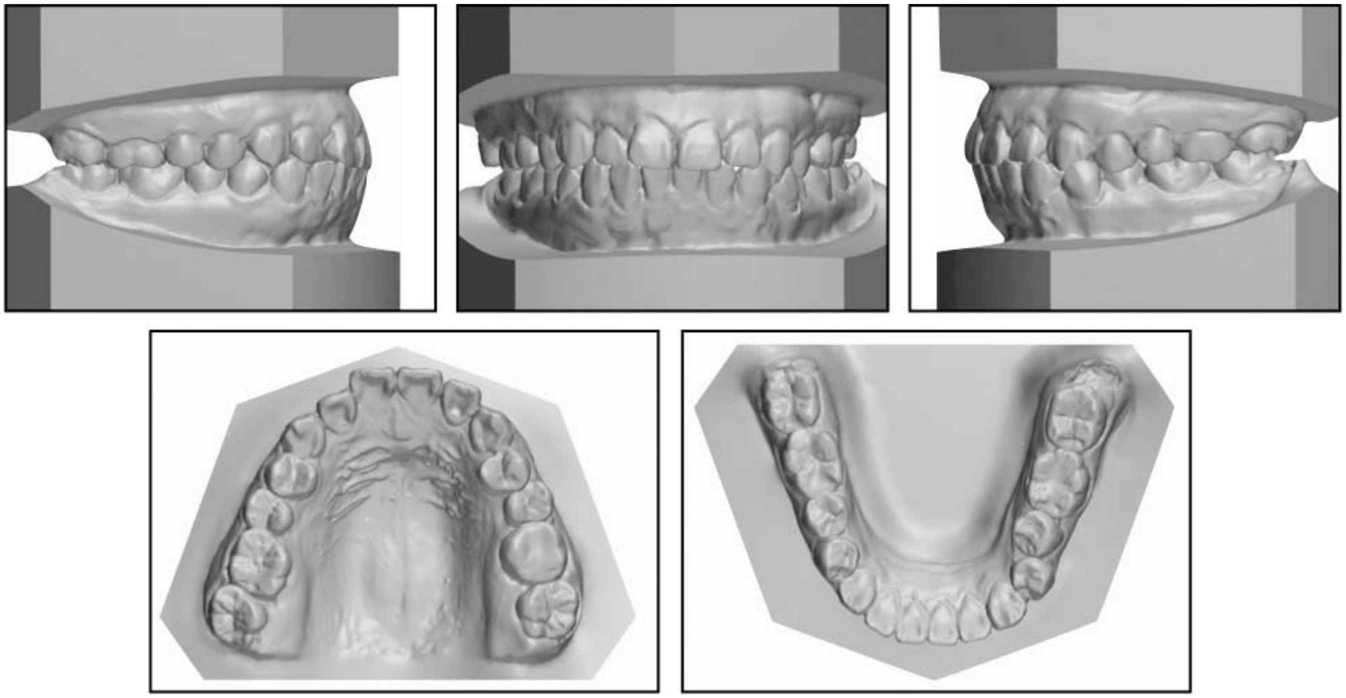

Figure 2. Pretreatment study models.

Treatment Progress

After initial bonding, two miniscrews (A1-P, 2 × 10 mm; Bioray Biotech Corporation, Taipei, Taiwan) were installed in the upper posterior areas (infrazygomatic crest) for maximal retraction. Two weeks later, lower brackets were bonded and an initial wire of 0.016-inch nickel titanium was placed (Figure 4). Unfortunately, the miniscrews failed shortly after installation. It was decided to fabricate a DJR and place miniscrews in the palate between the upper second premolars and first molars (Figure 5).

Space closure was started after bonding the DJR and installation of palatal miniscrews in the fourth month. At that time, both arches were in 0.016 × 0.022-inch stainless steel archwire. Typical sliding mechanics was performed by using elastic chains on the buccal appliances. Space closure was augmented by attaching elastic chains from the palatal miniscrews to the lever arm hooks of the DJR. Space closure was completed in the 22nd month (Figures 6 and 7). The DJR was continued for 5 more months to maximize the retraction. It was then removed for final detailing and finishing. All of the appliances were removed after 33 months of active treatment (Figures 8 through 10).

Table 1. Cephalometric Measurements

Analysis	Taiwanese Norms	Pretreatment	Posttreatment
Skeletal			
SNA (°)	81.5 ± 3.5	84.0	84.0
SNB (°)	77.7 ± 3.2	74.0	76.0
ANB (°)	4.0 ± 1.8	10.0	8.0
SN-MP (°)	33.0 ± 1.8	38.7	34.0
Dental			
U1 to NA (mm)	3.9 ± 2.1	2.5	−1.5
U1 to SN (°)	108.2 ± 5.4	102.5	103.8
L1 to NB (mm)	6.6 ± 2.8	14.5	6.5
L1 to MP (°)	96.8 ± 6.4	115.5	97.7
Facial			
E-Line UL (mm)	−1.1 ± 2.2	3.0	1.0
E-Line LL (mm)	0.5 ± 2.5	8.5	3.0

* ± Indicates mean ± standard deviation in norms

Treatment Results

Bilateral molar and canine Class I relationships were achieved. Protrusion was reduced, and chin projection improved considerably. The patient was satisfied with the treatment results.

The cephalometric superimpositions (Figure 11) showed upper incisor retraction of 5.0 mm and upper incisor intrusion of 2.8 mm. Upper first molars were moved mesially 1 mm on the right and 1.9 mm on the left. The upper first molars were intruded 2.7 mm. Lower incisors were retracted 7.2 mm and intruded 4.3 mm. The total arch intrusion of the maxillary arch was achieved with skeletal anchorage. The lower right first molars were moved mesially 2.4 mm on the right and 1.0 mm on the left. The mandibular plane angle was reduced by 4.7°, from 38.7° to 34°. B point moved forward slightly by the closing rotation of the mandible.

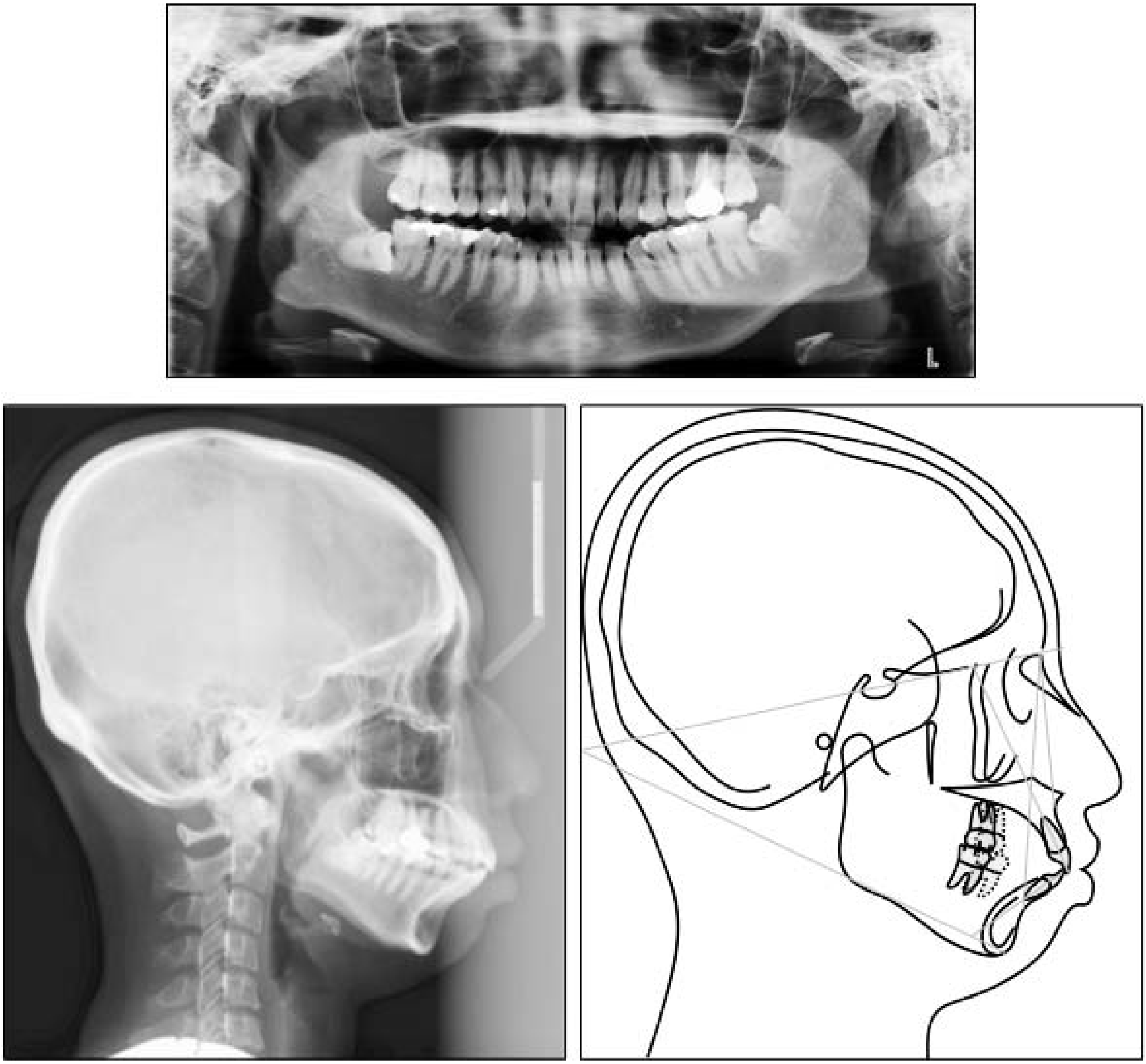

Figure 3. Pretreatment panoramic radiograph, lateral cephalogram, and cephalometric tracings.

ANB was reduced by 2°, from 10° to 8°. Pogonion was moved forward by 4.4 mm and upward by 3.1 mm. The lower anterior facial height was reduced 3.0 mm. The axial inclination of the lower incisors uprighted from 115.5° to 97.7°. The torque of upper incisors was well controlled (U1-SN, from 102.5° to 103.8°).

DISCUSSION

Extractions and maximum anchorage during space closure are often used in treatment of protrusion cases. Incisor torque control is critical during maximum anterior retraction. The incisor torque is controlled by the moment/force ratio (M/F ratio) of the anterior segment.[12,13]

Light retraction forces and third-order bends in the archwire to apply palatal root torque are common methods for incisor torque control during space closure with a continuous archwire.[14] A segmented arch approach using a beta-titanium (TMA) T-loop with angulations in the second order to generate a relatively constant force with a high countermoment is another way to control the M/F ratio and in turn control the pattern of tooth movement.[15–17] However, it takes time and experience to master the segmented technique. The use of T-loops in a continuous

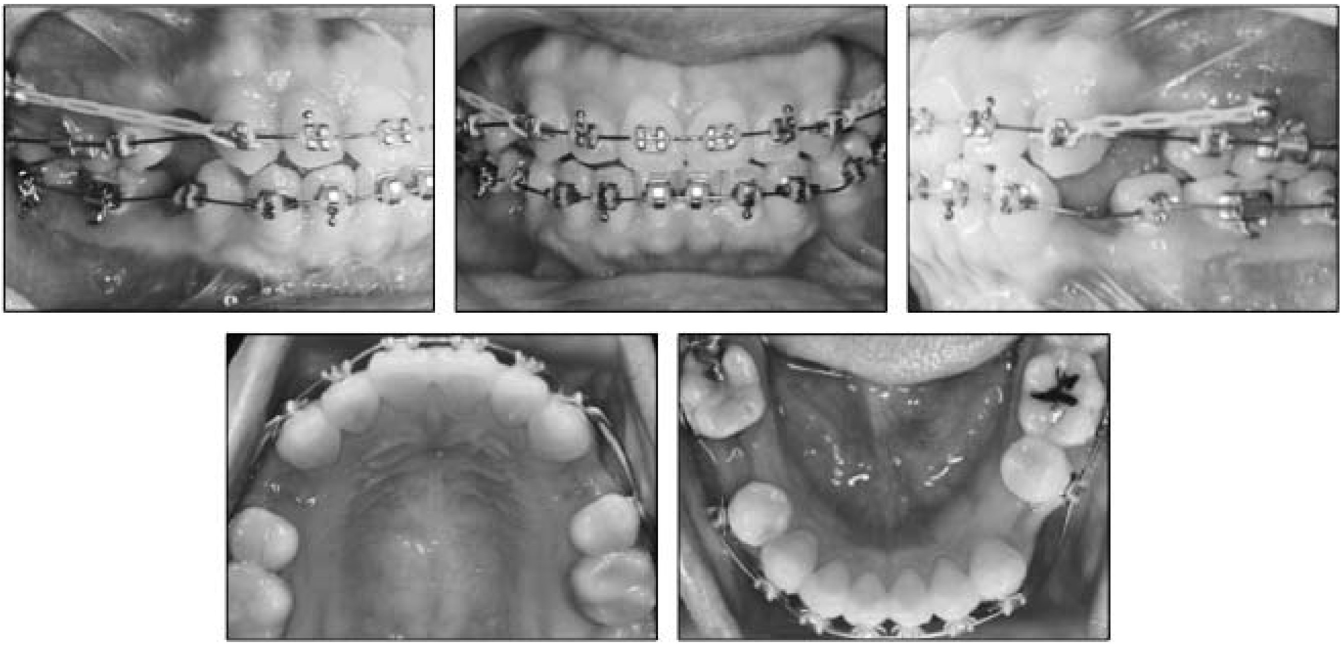

Figure 4. Miniscrews were installed in the upper posterior area for anchorage the first month of treatment. However, both miniscrews failed and were removed right away.

archwire cannot provide the desired M/F ratio as in the segmented arch technique. The moment and force on the reaction units need careful planning to prevent adverse events.

The moment created by third-order bends in archwires is limited by the short distance of the bracket slot. The moment may drop suddenly after tooth movement begins.[18] The use of a TMA archwire is preferred for higher stored energy. The Warren torquing spring, Burstone torquing arch, and intrusion arch are some other possible appliances to control incisor torque.[19,20] With the radius of the Warren torquing spring, the moment is increased to some extent in comparison with the third-order bends on the archwire. It is still

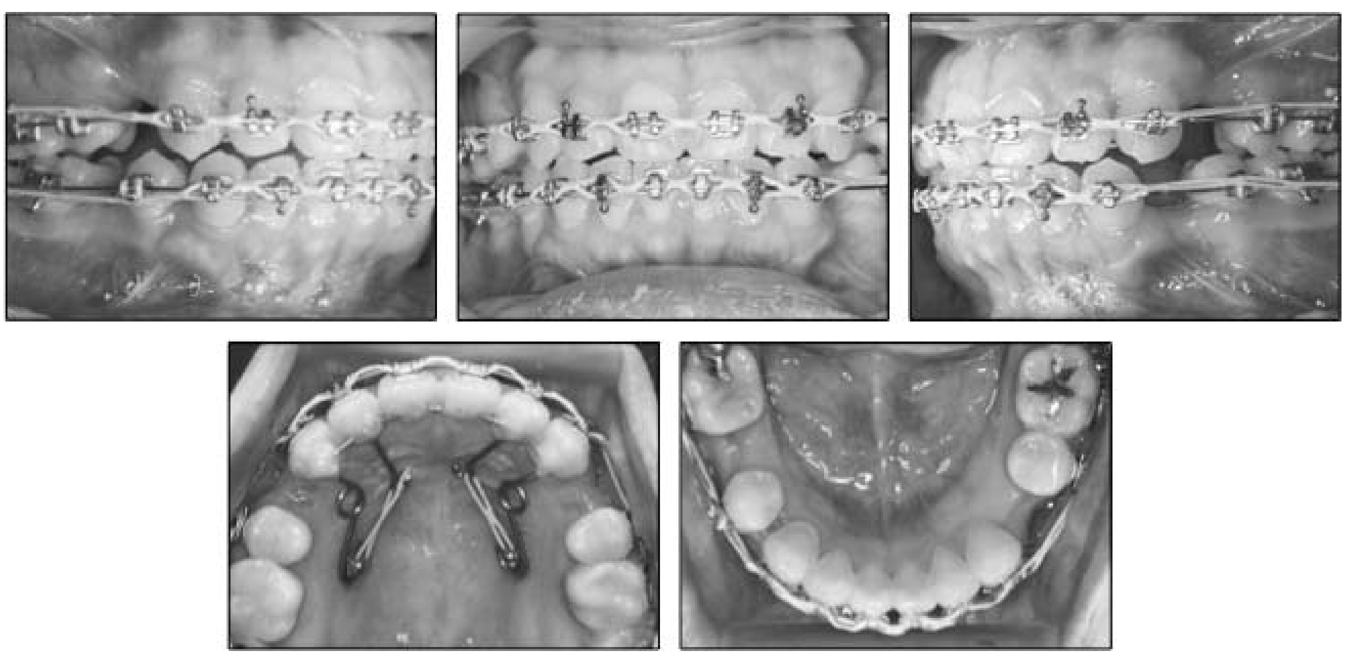

Figure 5. A DJR was bonded with flowable composite resin in the fourth month of treatment. Typical labial sliding mechanics were applied on both arches for space closure with palatal elastic chains from retraction hooks of lever arms to palatal miniscrews for anchorage reinforcement.

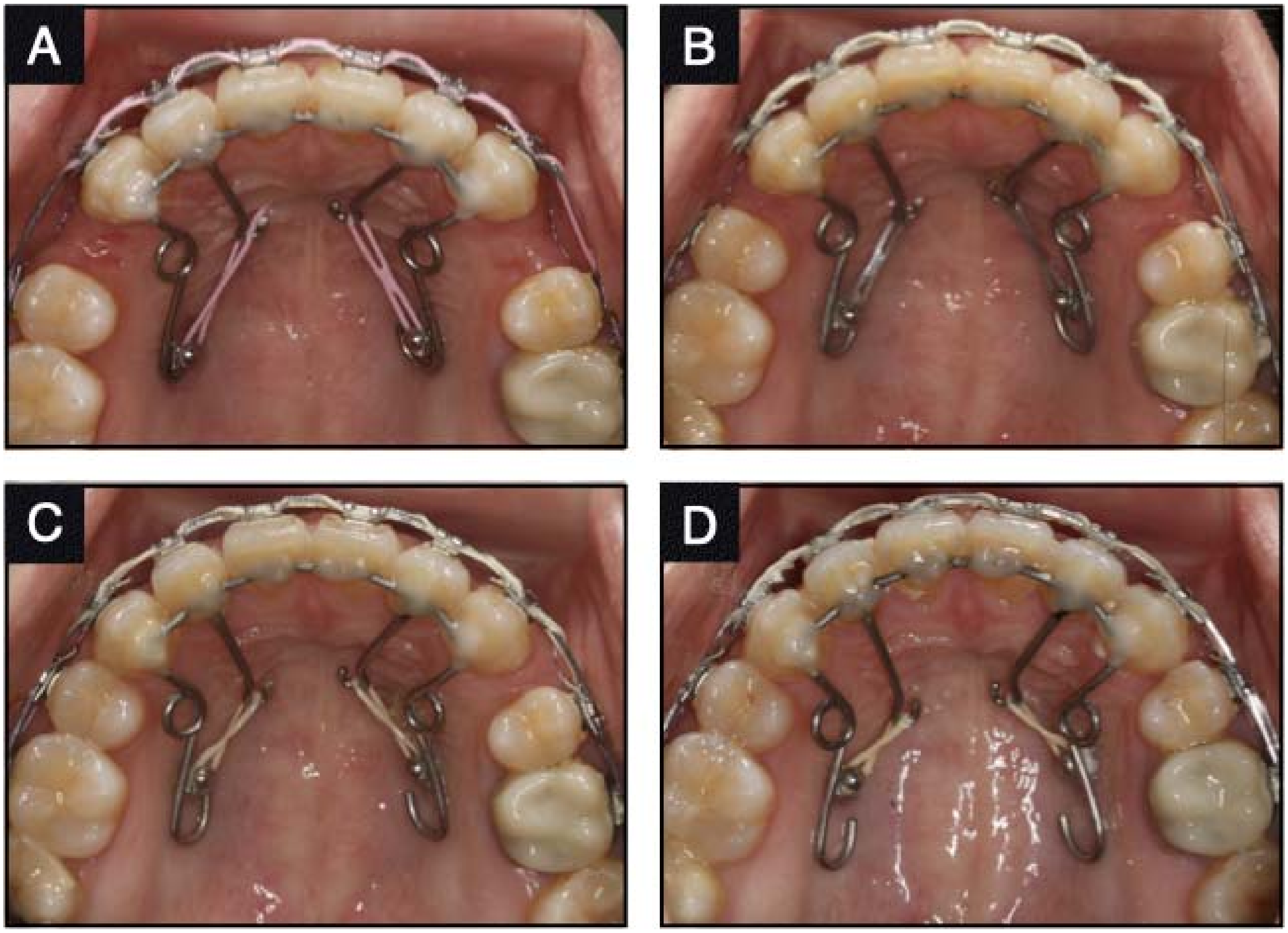

Figure 6. Space closure proceeded smoothly: (A) 4 months, when space closure started; (B) 13 months; (C) 19 months; and (D) 22 months, when all the spaces were closed. Please note the line of action was changed following retraction and torque change of the maxillary incisors.

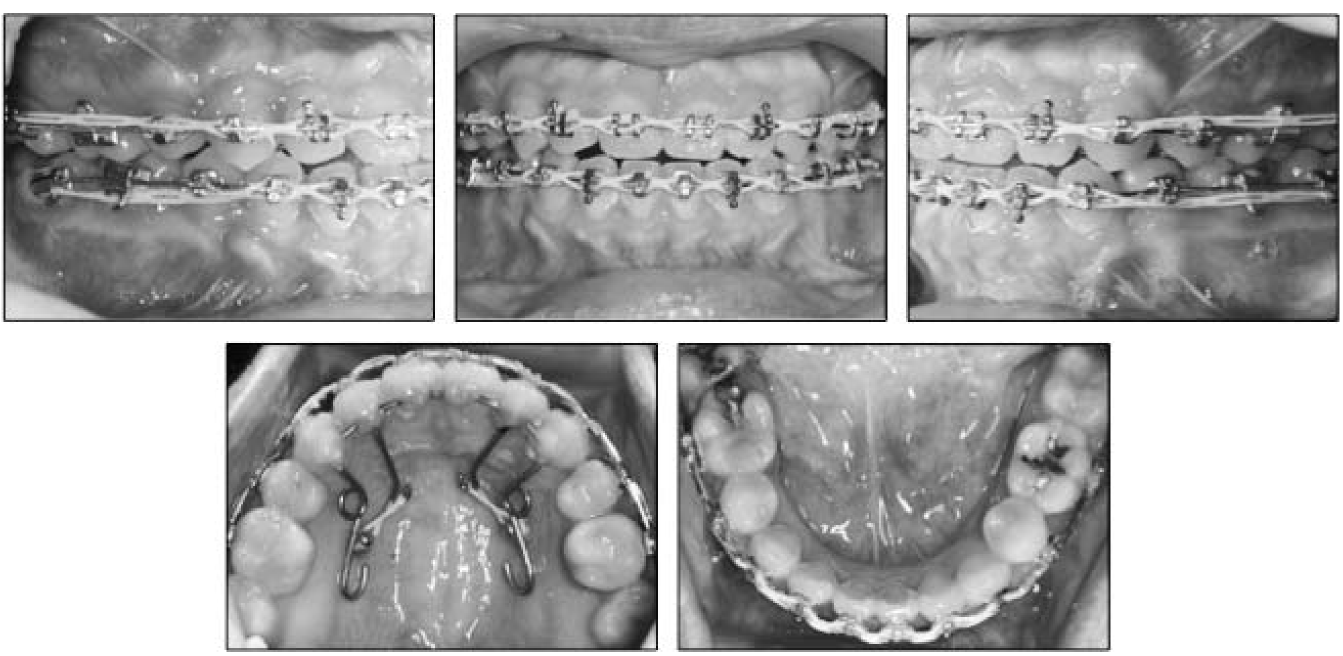

Figure 7. Intraoral photographs after complete space closure at 22 months of treatment.

Figure 8. Posttreatment facial and intraoral photographs.

much less than the moment created by the Burstone torquing arch. The Burstone torquing arch (as well as a Burstone intrusion arch) will produce countermoments in the posterior segments and vertical forces at both ends, leading to possible adverse events that need to be controlled with care. With the advent of skeletal anchorage, the application of miniscrews might be a good choice to avoid possible adverse events on the dentition.

In addition, lever arm mechanics have also been reported to assist in controlling the torque of the upper incisors during retraction.[6,7,10,11,21–24] In terms of lever arm mechanics, the lingual lever arm is superior to the labial lever arm for anatomical reasons. Although some authors tried to use a labial lever arm in the anterior segment to direct the line of action through the center of resistance, anatomical limitations often result in soft tissue impingement over the buccal mucosa.[24] The position of a palatal miniscrew can be higher than the buccal miniscrew so that the line of action of the lingual lever arm more readily passes through the center of resistance of maxillary anterior teeth than that of the labial lever arm.

When the usual upper posterior buccal anchorage screws failed because of anatomical limitations, a backup plan was necessary to achieve the treatment goals. Various appliance designs were proposed in conjunction with the direct or indirect use of palatal TSADs. Modified lingual arches have been suggested previously in conjunction with palatal miniscrews or palatal plates.[4,6,7] Various designs of molar distalizers, such as the TSAD-supported pendulum or distal-jet appliances, also can be considered to assist with space closure.[8,9]

Among a wide range of palatal appliances in conjunction with TSADs, the DJR is a modified lingual

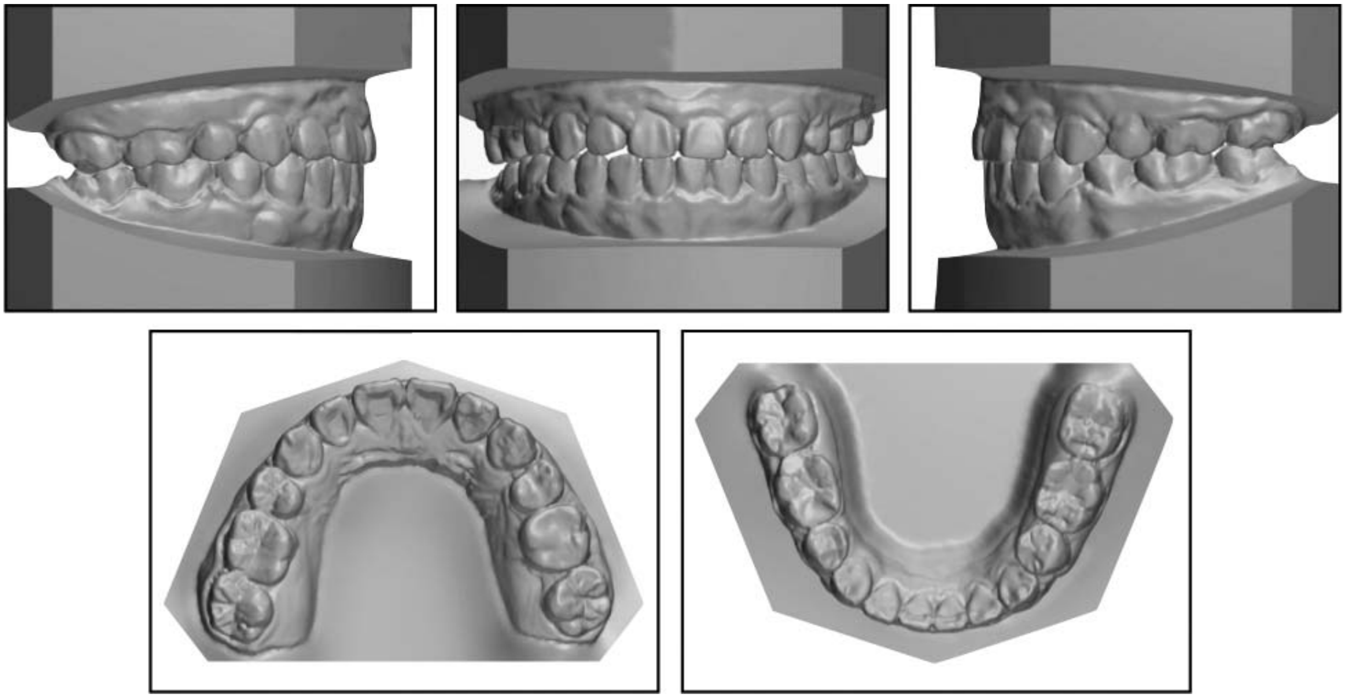

Figure 9. Posttreatment study models.

retractor that aims to retract incisors with a translational movement via lever arm mechanics.[10,11,21] The lingual lever arm mechanics have been reported to assist in controlling the torque of the upper incisors during retraction. In 2010, Jang et al. located the center of resistance of the six maxillary anterior teeth retracted with the DJR and found the optimal position of palatal miniscrews in a finite element study.[21] They suggested that the center of resistance of the six maxillary anterior teeth was 12.2 mm apical to the incisal edge and that the implant position should be 8 mm from the cervical line of the first molar. Torquing springs with helices are designed to slide along the palatal miniscrews, counteracting the retroclination of the incisors when space is closed.

The fabrication of the DJR is relatively simple (Figure 12). A 0.036-inch stainless steel wire is used, with the lingual arch first adapted to the lingual surface of the upper six teeth and then bent at the canines to form helical torquing springs extending to the first molar area. They are designed to rest on the occlusal side of the palatal miniscrews, thus preventing the anterior teeth from retroclining during retraction. Two lever arms are bent to adapt to the palatal slope, at approximately the height of the center of resistance of the maxillary incisors, and then soldered to the lingual arch at the center of the lateral incisors. The appliance is sandblasted before bonding at the center of the lingual surfaces of the maxillary anterior teeth.

Two palatal miniscrews are installed just gingival to the helical torquing springs (around 8 mm to the gingival line) between the upper second premolars and first molars. As the tip of the miniscrew is inserted, it displaces the torquing spring slightly to the occlusal, which generates a slight intrusive force and torquing moment on the anterior segment (Figure 13). The elastic chains are attached from the head of palatal miniscrews to the lever arm retraction hooks, with a line of action passing close to the center of resistance of the anterior segment.

Although the height of the lever arm could be fabricated according to the estimation of the center of resistance of the maxillary anterior teeth, torque control seemed to be less predictable in case reports using similar lingual retractors.[23] The first reason was that the center of resistance could not be confirmed exactly. The second reason was that the relationship between the retraction force and the center of resistance would be changed during space closure while the upper incisors were being intruded and retracted.[22]

A second mechanism, with the torquing springs resting on the palatal miniscrews, reinforces control of incisor torque during maxillary anterior tooth retraction. It is believed that the combined setup provides a better chance for torque control of the maxillary anterior teeth by passing the retraction force through the center of resistance and using the torquing springs supported with palatal miniscrews to prevent the anterior teeth from tipping and dumping at the same time.

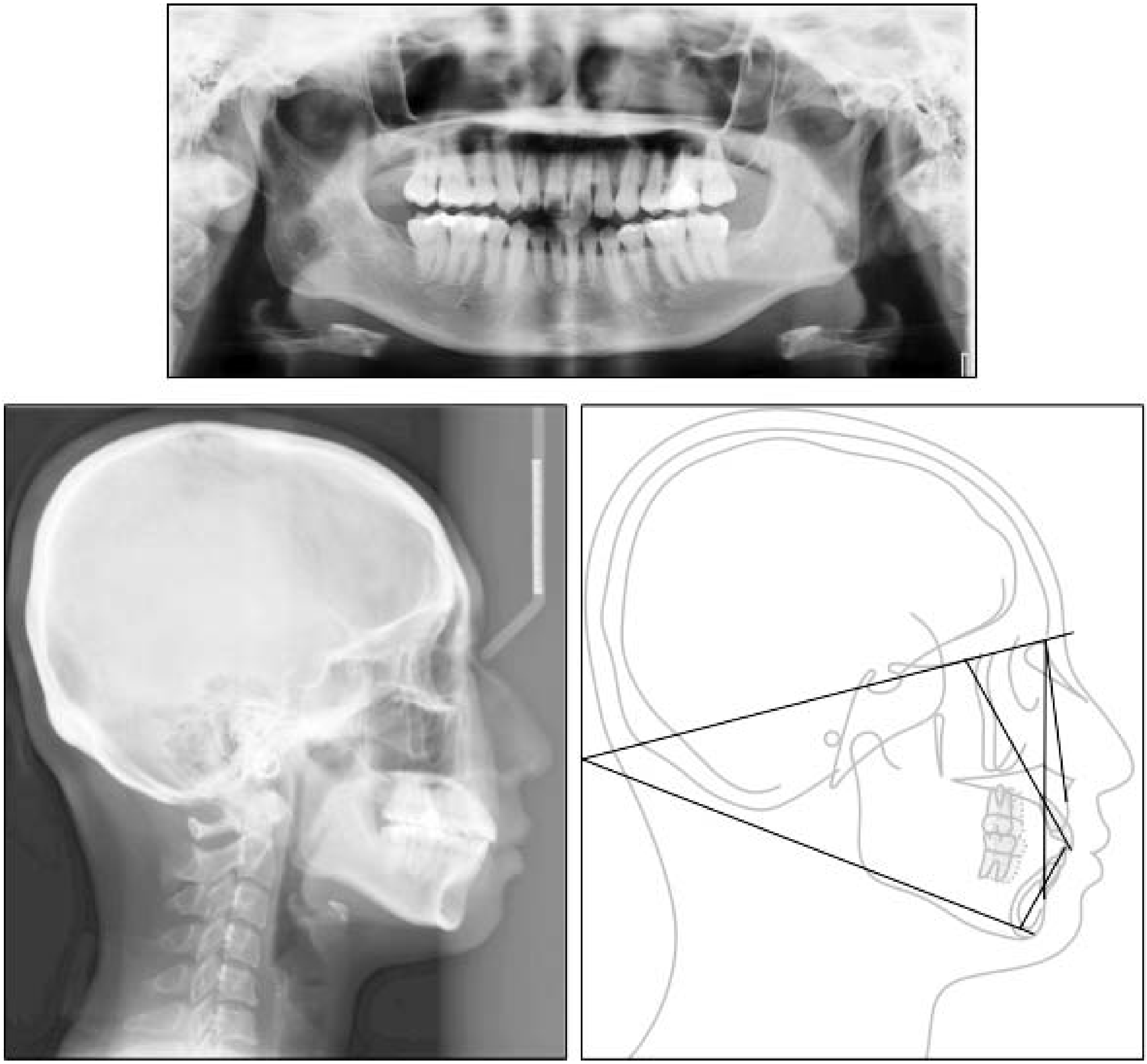

Figure 10. Posttreatment panoramic radiograph, lateral cephalogram, and cephalometric tracings.

As the anterior segment is retracted, the geometry of the helical torquing spring will continue to further exert a slight downward force on the torquing springs, thereby continuing to control the torque and vertical position of the anterior teeth. The palatal miniscrews act as stable anchorage for the retraction of the anterior teeth. Along with the intrusion and retraction of upper anterior teeth, simultaneous intrusive force via the labial archwire over the upper posterior segment may lead to a counterclockwise rotation of the maxillary occlusal plane and in turn a counterclockwise rotation of the mandible, which is especially beneficial for protrusion patients with Class II, hyperdivergent skeletal patterns (Figure 13).

On the contrary, if the initial incisor show is insufficient, the combined use of the DJR and palatal miniscrews might be contraindicated, as the upper incisors may be intruded during retraction. In this scenario, a torquing arch with extrusive force anteriorly would be a better choice. However, the use of the torquing arch may not be as compatible with space closure as the design of the DJR. It may need a second stage of incisor torque regaining with a torquing arch after space closure. The disadvantages of the DJR and palatal miniscrews used in this case report may include

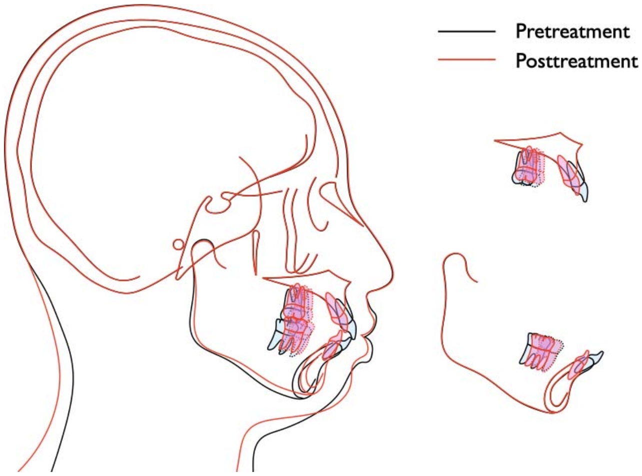

Figure 11. Superimposed tracings showed maximal retraction of anteriors in both arches. Total arch intrusion with temporary skeletal anchorage devices in the upper arch resulted in closing rotation of the mandible, which is beneficial for the posttreatment profile of Class II cases.

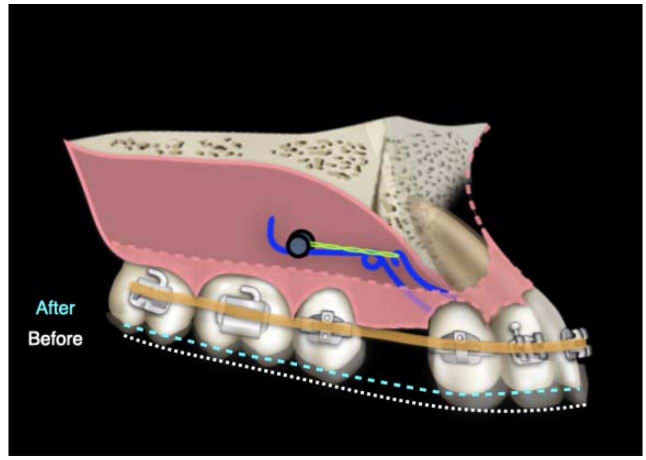

Figure 13. Along with the intrusion and retraction of upper anterior teeth, simultaneous intrusive force via the labial archwire over the upper posterior segment may lead to upward movement of the maxillary occlusal plane and, consequently, a counterclockwise rotation of the mandible.

extra costs of miniscrews, extra visits, extra laboratory fees, and the risk of miniscrew failure.

CONCLUSION

- The use of the DJR with palatal miniscrews in a protrusion case was illustrated. It is possible to use the DJR and palatal miniscrews in conjunction with conventional labial brackets. With the long lever arms extended to the level of the estimated center of resistance and the miniscrews on the palatal slope posteriorly, the maxillary incisors were intruded and retracted with excellent torque and anchorage control using the DJR.

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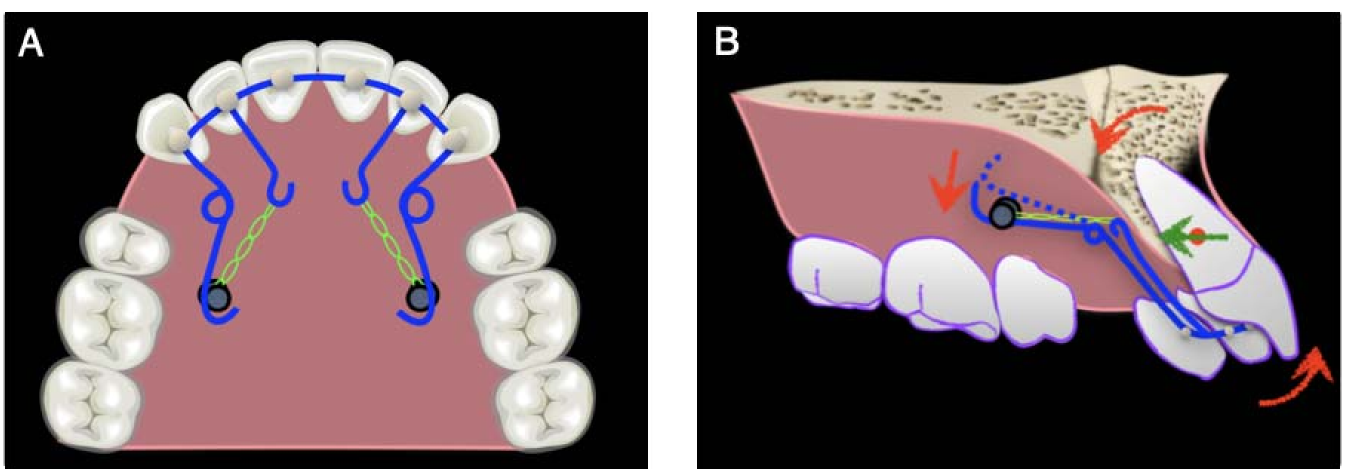

Figure 12. (A) The components of appliance design: (1) main lingual arch from canine to canine, (2) helical torquing spring, (3) lever-arm retraction hook, and (4) palatal miniscrews. (B) Line of action passes through the center of resistance of maxillary anterior teeth to retract the anterior teeth bodily. A torquing moment on the anterior teeth was created consequently. The helical torquing springs rested along the palatal miniscrews located around 8 mm from the gingival lines of upper first molars. A gentle downward force was generated by the miniscrews when the helical torquing spring slides along the palatal miniscrew during anterior retraction.

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