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POSTERIOR IMPACTION WITH ORTHODONTIC MINISCREWS FOR OPEN-BITE CLOSURE AND IMPROVEMENT OF FACIAL PROFILE

Skeletal anterior open bite is often caused by posterior dentoalveolar excess and downward and backward mandibular rotation. Orthodontic miniscrews can successfully impact the posterior dentition, allowing for open-bite correction through upward and forward mandibular autorotation. An Asian male, 27 years of age, with a Class II skeletal relationship, dolichocephalic facial type, high mandibular plane angle, 4.0-mm anterior open bite, and convex soft-tissue profile was treated with 4 dentoalveolar orthodontic miniscrews. The maxillary first and second molars were impacted 1.4 mm, resulting in open-bite closure, 2.1 degrees of upward and forward mandibular autorotation, 2.0-mm advancement of pogonion, 3.5-degree reduction in soft-tissue facial convexity, and 2.6-mm increase in anteroposterior pharyngeal dimension on the lateral cephalogram. This case report demonstrates successful treatment with orthodontic miniscrews in open-bite closure with Class II correction, without extraction or surgically positioned miniplates. Miniscrew-supported posterior impaction and mandibular autorotation may become a viable treatment alternative to surgery in patients desiring improvement in their excessive dentofacial vertical dimension and facial esthetics. World J Orthod 2007;8:157–166.

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The etiology of anterior open bite is multifactorial.[1] Skeletal anterior open bite demonstrates a morphologic pattern of increased vertical dimension, adenoid-facies, and excessive eruption of the posterior maxillary dentoalveolus resulting in an opening rotation of the mandible.[1–5] Traditional treatment of anterior open bite in adult patients includes premolar or molar extraction to close the palatomandibular wedge,[6,7] mandibular incisor extraction,[8] multiple-loop edgewise archwire (MEAW) therapy,[1] intermaxillary or box elastics on nitinol wire,[9] high-pull headgear or facemask,[10] or maxillomandibular surgery.[11] Many adults may resist extraction or surgical treatment options,[11] increasing the difficulty of maintaining proper overbite and vertical control.

Orthodontic miniscrews offer an alternative for treating anterior open bite by providing skeletal anchorage to intrude the posterior teeth. Extensive literature exists on the efficacy of posterior impaction with miniscrew anchorage in adult patients with anterior open bite; however, these reports describe treatment with premolar extraction[11,12] or surgically positioned maxillary or mandibular miniplates.[13–15] The purpose of this case report is to describe nonsurgical, nonextraction open-bite correction of an adult patient with 4 orthodontic miniscrews, resulting in significant improvement of soft-tissue esthetics.

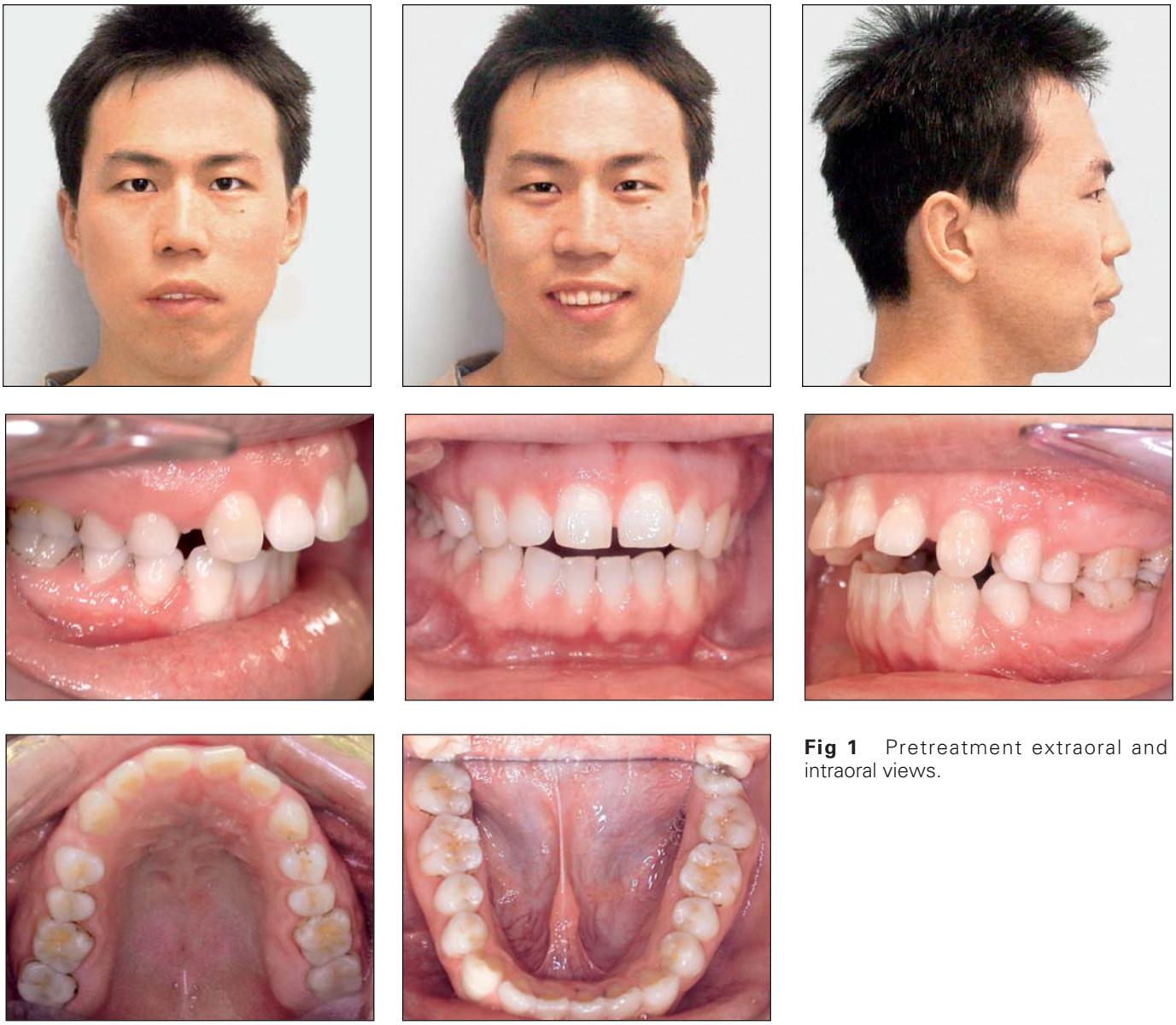

Fig 1 Pretreatment extraoral and intraoral views.

CASE HISTORY

An Asian male, 27 years of age, came to the University of Illinois, Department of Orthodontics, with the chief concern of disliking the space between his teeth and his facial appearance. The patient's medical history and past dental history were noncontributory, with no recalled history of asthma, nasopharyngeal obstruction, digit habit, tongue thrust, or facial trauma.

DIAGNOSIS AND ETIOLOGY

Clinical examination revealed a symmetric, dolichocephalic facial pattern with a convex soft-tissue profile, maxillary and mandibular lip protrusion, acute mentolabial angle, and mentalis strain upon closure. Study cast analysis showed a Class II, Division 1 malocclusion, 4.0-mm open bite, and 8.9-mm overjet, with 4.5 mm of maxillary spacing, mongoloid incisors, and generalized posterior

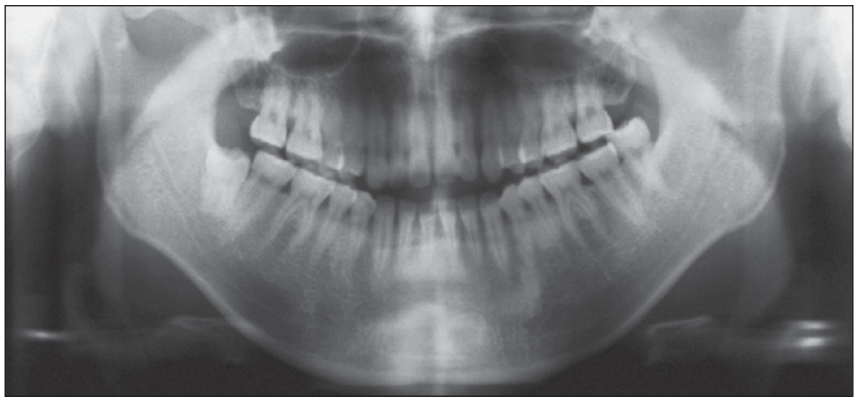

Fig 2 *(above)* Pretreatment panoramic radiograph.

Fig 3 *(right)* Pretreatment cephalogram.

occlusal wear. The maxillary midline was coincident with the facial midline, and the mandibular midline deviated 3 mm to the right of the maxillary midline (Fig 1). Panoramic radiography revealed partial bony eruption of the mandibular right third molar, supra-eruption of the mandibular left third molar, agenesis of the maxillary third molars, and adequate root lengths (Fig 2).

Cephalometric analysis (Table 1) showed a Class II skeletal pattern with mild mandibular retrognathism (SNA, 83.0 degrees; SNB, 76.0 degrees). The patient displayed excessive vertical growth (SN-GoGn, 43.7 mm), with a steep mandibular plane angle (FMA, 38.3 degrees), and a retrusive chin (Pog-N perpendicular, −11.2 mm). Dentally, the interincisal angle was acute (U1-L1, 120.0 degrees), with both maxillary incisors (U1-APo, 12.9 mm) and mandibular incisors (L1-APo, 3.7 mm) protruded but well angulated relative to the skeletal bases (Fig 3).

TREATMENT OBJECTIVES

1. *Soft-tissue facial esthetics:* Improve the nose-lip-chin relationship, reduce maxillary lip protrusion, mentalis strain, and soft-tissue facial convexity.
2. *Skeletal:* Autorotate the mandible closed, improve anterior position of pogonion, and reduce lower facial height.
3. *Occlusion:* Achieve Class I molar, Class I canine occlusion. Improve dental asymmetry, reduce overjet, achieve overbite, and establish canine-supported occlusion.
4. *Maxillary dentition:* Level and align, intrude the maxillary posterior segment, consolidate spacing, retract and retrocline maxillary incisors.
5. *Mandibular dentition:* Level and align, intrude, or maintain the vertical position of the mandibular posterior segment.

TREATMENT ALTERNATIVES

The patient was presented with the following treatment alternatives: *(1)* retraction and retroclination of the maxillary incisors, and Class I molar malocclusion achieved with elastics or a mandibular positioning device; *(2)* premolar extraction with molar protraction; *(3)* advancement genioplasty; or *(4)* maxillary posterior impaction with mandibular advancement and genioplasty. Incisor retraction and Class II elastic wear risked further increasing the vertical dimension, exacerbating facial convexity and increasing the difficulty of open-bite closure. The patient refused both tooth extraction and orthognathic surgery.

The treatment plan agreed upon was to use 4 orthodontic miniscrews, placed bilaterally in the maxillary and mandibu-

Fig 4 **(a)** Four self-drilling orthodontic miniscrews (Dual-Top; Rocky Mountain Orthodontics) were placed mesial to the maxillary first molars and mandibular right molar, and distal to the mandibular left molar. Activation from the miniscrew head to archwire (as shown) will limit intrusion of the second molar, and should be avoided. **(b)** 567 Triangle. Acute angulation of the miniscrew during insertion positioned the miniscrew head too close to the cementoenamel junction of the molar, limiting the amount of intrusion. Notice the development of a cant due to faster intrusion on the left side. Right-side–only active intrusion was continued for 2 months to level the horizontal plane. **(c)** Occlusal cant leveled with improved mandibular autorotation and midline approximation.

lar buccal dentoalveolus, to provide skeletal anchorage for posterior dental intrusion and accompanying mandibular autorotation. Closing rotation of the mandible would aid open-bite correction without overextruding the maxillary incisors, assist Class II molar correction while providing vertical control, and improve soft-tissue facial esthetics by strengthening soft-tissue pogonion without orthognathic surgery.

TREATMENT PROGRESS

Maxillary and mandibular first and second molars were banded with Wilson attachments soldered to the gingival aspect of the maxillary and mandibular first molar bands. A passive maxillary transpalatal bar and mandibular lingual holding arch were placed. Maxillary and mandibular 0.018 × 0.022-inch MBT (3M Unitek, St Paul, MN, USA) appliances

Fig 5 Class II closing bite elastics connected to the mandibular miniscrew to prevent eruption of the mandibular molars.

and maxillary canine lingual cleats were indirect bonded. After leveling and aligning, the canines were retracted with 100-g NiTi coil (GAC, Bohemia, NY, USA). The maxillary incisors were retracted with a 0.016 × 0.022-inch reverse-curve T-loop TMA (Ormco, Orange, CA, USA) to provide vertical control and palatal root torque. Due to the posterior occlusal wear, the maxillary first molar bands were removed and reinserted with Gosh-Garian attachments to allow better clearance for the transpalatal bar. A continuous 0.016 × 0.022-inch stainless steel wire was placed in the maxillary and mandibular arch, in preparation for miniscrew insertion. Prior to posterior impaction, the patient was referred to the oral surgeon for extraction of both mandibular third molars; however, due to financial limitations, only the mandibular left third molar was extracted. Maxillary and mandibular second premolars, and first and second molars were actively intruded with orthodontic miniscrews for 6 months. After the sixth month of intrusion, a slight cant of the occlusal plane was detected. For 2 months, molar intrusion was continued on the right side only to level the horizontal plane (Fig 4). Class II elastics from the maxillary canine to the mandibular miniscrews aided mandibular rotation and minimized mandibular molar extrusion (Fig 5). The patient was retained with a mandibular fixed 3-3 retainer and toothpositioner to help preserve posterior impaction and bite deepening. The patient was referred back to the oral surgeon for extraction of the mandibular right third molar.

ORTHODONTIC MINISCREW PLACEMENT AND TECHNIQUE

Four self-drilling miniscrews (Dual Top Miniscrew System; Rocky Mountain Orthodontics, Denver, CO, USA), 8 mm long and 1.6 mm diameter, were placed in the maxillary and mandibular posterior buccal dentoalveolus under local anesthetic in the Department of Orthodontics at the University of Illinois at Chicago. The maxillary miniscrews were placed between the second premolar and first molar. The right mandibular miniscrew was placed between the second premolar and first molar; the left mandibular miniscrew was placed between the first and second molars. All 4 miniscrews were inserted at the level of the mucogingival junction, at a 30-degree angle from the occlusal plane.

Miniscrew insertion technique

Posterior interradicular placement of orthodontic miniscrews can be particularly challenging due to the limited visibility (particularly in patients with limited mouth opening or tight musculature), risk of root proximity or sinus involvement, and limited attached gingiva. Miniscrews should be placed in the region of the greatest bone availability and bone density, and ideally within attached tissue, at a location appropriate for treatment mechanics. At times, the clinician must compromise placing the miniscrew in the ideal biomechanical location for an alter-

Fig 6 (a) Wilson transpalatal bar set-up in preparation for maxillary posterior impaction. The transpalatal bar was placed 3 to 5 mm off the palatal slope and midpalate to provide adequate intrusion space. Buccal root torque activation was incorporated into the Wilson extensions. The transpalatal bar extended onto the occlusal surface of the second molars to aid intrusion. **(b)** Resting tongue pressure against the transpalatal bar aided intrusion forces.

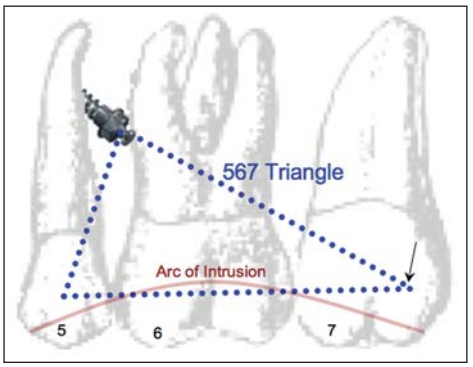

Fig 7 567 Triangle. Blue triangle represents elastic chain or NiTi coil. Extending the triangle under and around the second molar significantly aids in molar intrusion in comparison to wrapping the elastic around the archwire. The red line represents the arc of intrusion, with greatest intrusion at the first molar and less intrusion at the second premolar and second molar.

ative location of greater safety and simplified insertion technique.

The greatest amount of posterior interradicular bone is mesial to the first molar in the maxilla, and mesial or distal for the first molar in the mandible.[16,17] Upon insertion, a miniscrew should have at least 0.5 to 0.75 mm of available bone[18] around its shaft circumference. Therefore, a 1.6-mm miniscrew should be placed with a minimum interradicular space of 3 mm. Liou et al recommend 2 mm of bone on either side of miniscrew shaft, for a minimum interradicular space of 5.5 to 6 mm, due to the tendency for the miniscrew to tip, extrude, and migrate during activation.[19]

Alternatively, to overcome limited interradicular bone availability, a clinician could have diverged the roots and inserted the miniscrew at a more obtuse angle, placed zygomatic or buccal shelf miniplates, inserted the miniscrew in the palate or placed the miniscrew gingivally in the alveolar mucosa above the roots.

To maximize soft-tissue health, miniscrews should be placed within attached gingival tissue, away from the buccal frenum. Placement in loose alveolar mucosa increases the risk of aphthus ulceration, soft-tissue irritation, and gingival overgrowth, which can reduce implant stability.[19,20] The mucogingival junction decreases in height posteriorly, and the clinician may have to accept placing the miniscrew in alveolar tissue to maintain proper vertical positioning and to avoid root proximity, particularly in the posterior mandible.

Proper angle of insertion should be 45 to 90 degrees from the occlusal plane in the maxilla and 30 to 45 degrees from the occlusal plane in the mandible.[21] Maxillary miniscrews can be placed perpendicular to the occlusal plane under the maxillary sinus in posterior edentulous spaces.[21] Mandibular miniscrews should maintain a steeper angulation to provide greater surface contact with cortical bone. Attempting an angulation steeper than 30 degrees risks the miniscrew slipping down the bony slope under the tissue, rather than engaging cortical bone. Due to the limited amount of interradicular bone present in this patient, the maxillary miniscrew was

placed at a steeper angle of insertion to avoid root proximity. The disadvantage of placing a posterior interradicular miniscrew at an angle of insertion less than 45 degrees from the occlusal plane is that the miniscrew head may become too close to the teeth, minimizing the amount of achievable intrusion.

Posterior impaction set-up

Intraoral setup for posterior impaction with buccal miniscrew-anchorage consisted of banded maxillary and mandibular first and second molars, a removable transpalatal bar and mandibular lingual holding arch, and maxillary and mandibular continuous 0.016 × 0.022-inch stainless steel wires extended 2 to 3 mm beyond the second molar band. Placement of a removable transpalatal bar provided buccal root torque to allow for intrusive translation during posterior impaction. Without buccal root activation, molar intrusion from buccal dentoalveolar miniscrews would result in buccal crown tipping.

The transpalatal bar was placed 3 to 5 mm away from the palate, which created sufficient room to accommodate posterior impaction. Furthermore, resting tongue pressure against the palatal bar aided intrusive forces. The mandibular lingual holding arch provided buccal root torque during mandibular posterior impaction. When possible, occlusal arms extending from the transpalatal bar or mandibular lingual holding arch to the second molar should be maintained during active intrusion (Fig 6).

Activation technique: The 567 triangle

Successful posterior impaction for anterior open-bite correction must activate intrusion of the second molar in addition to the first molar. Simply activating around the first molar tube or intruding from the archwire between the first and second molars will fail to significantly intrude the second molar. As a result, the second molar will remain behind as the first molar intrudes, preventing autorotation and open-bite closure.

A suggested activation technique for posterior impaction is to wrap an elastic chain or NiTi coil spring around the second premolar, first molar, and second molar tubes—creating a 567 triangle with the apex at the miniscrew (Fig 7). A NiTi coil spring is preferable, with 200- to 300-g[5,15] intrusive force per side in the maxilla, and 200- to 400-g[14] intrusive force per side in the mandible. Leaving the archwire 2- to 3-mm long prevents the elastic chain or coil spring from slipping off the second molar tube. The maxillary first molar intrudes at a rate of 0.5 to 1.0 mm per month.[12] However, simultaneous intrusion of the first and second molar will reduce the rate of intrusion by approximately half.[22,23] Mandibular molar intrusion may require greater activation force due to the greater cortical bone thickness in the posterior mandible.

TREATMENT RESULTS

After 16 months of orthodontic treatment and 8 months of posterior intrusion, Class I canine and molar relationships were obtained, with ideal overbite and overjet and a significant reduction in facial convexity (Fig 8). Anterior open-bite correction was achieved through maxillary posterior dentoalveolar impaction, mandibular autorotation, and eruption and retroclination of the maxillary incisors. The maxillary molars were intruded 1.4 mm, with reference to the palatal plane. There was no change in the vertical position of the mandibular molars. The mandibular plane showed 2.1 degrees of cephalometric counterclockwise autorotation, with 2.0-mm advancement in skeletal pogonion. Mandibular autorotation accounted for the 1.5-degree reduction in ANB (Fig 9). Soft-tissue facial convexity was reduced 3.5 degrees and anteroposterior pharyngeal space increased 2.6 mm, significantly improving soft-tissue esthetics (Fig 10, Table 1).

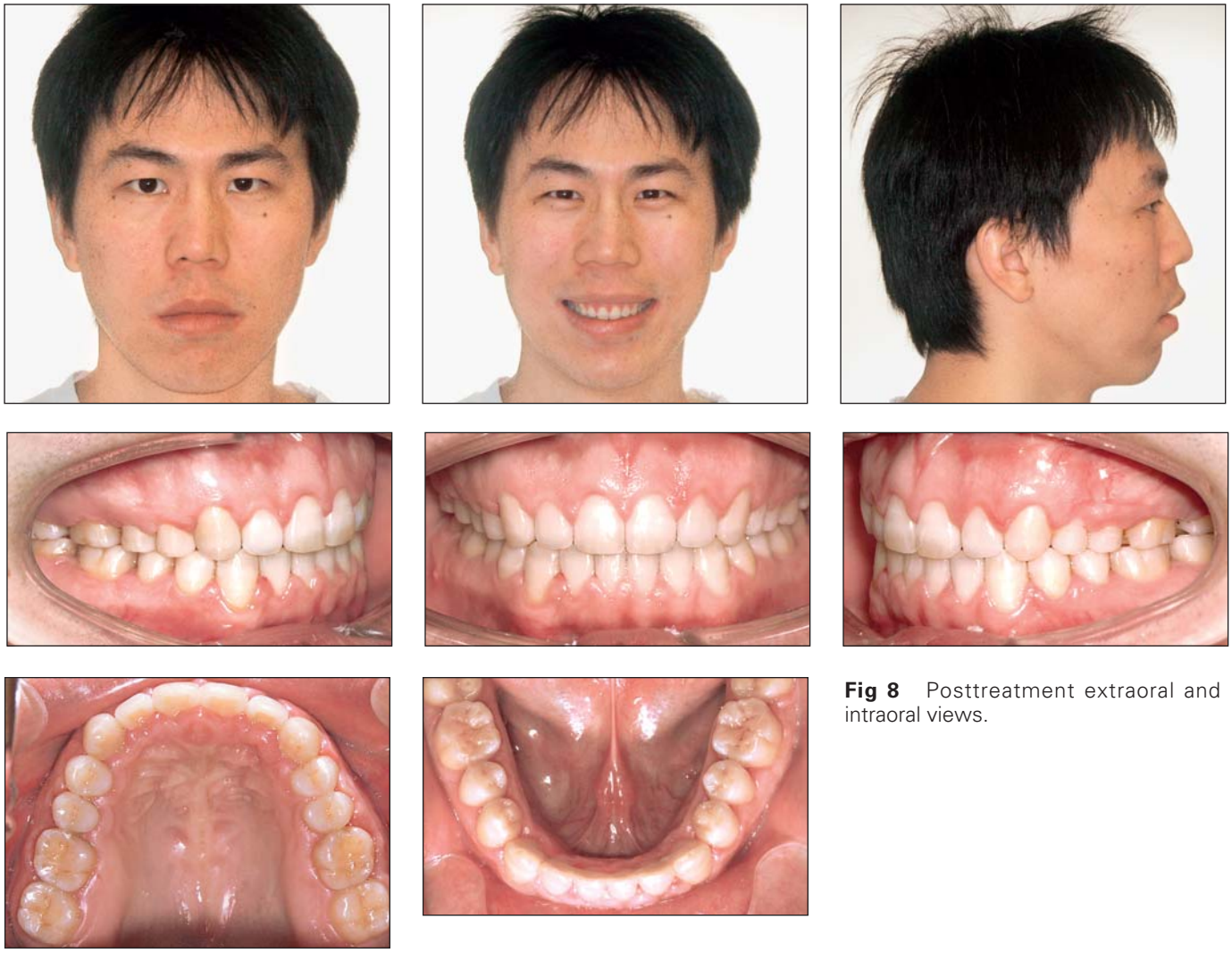

Fig 8 Posttreatment extraoral and intraoral views.

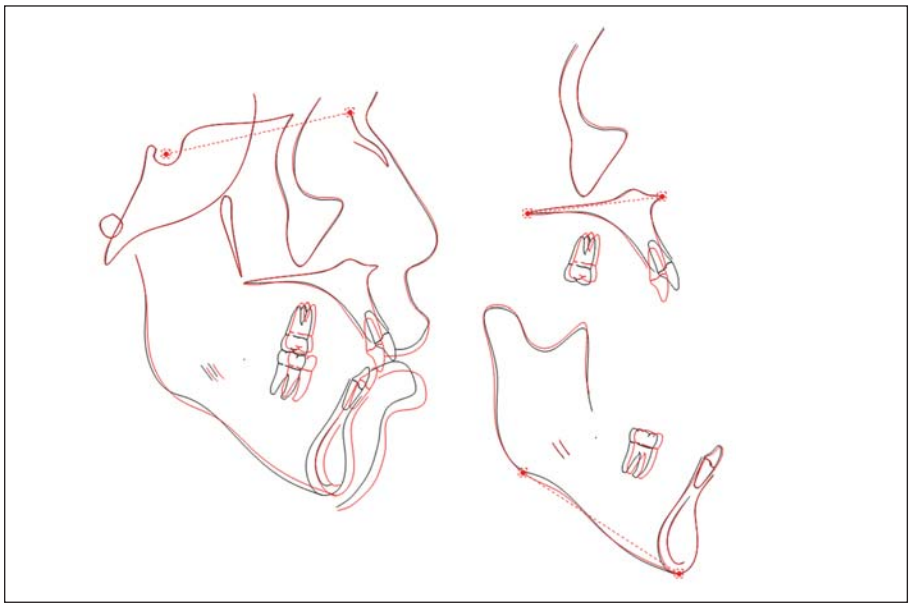

Fig 9 Superimposition of cephalometric tracings.

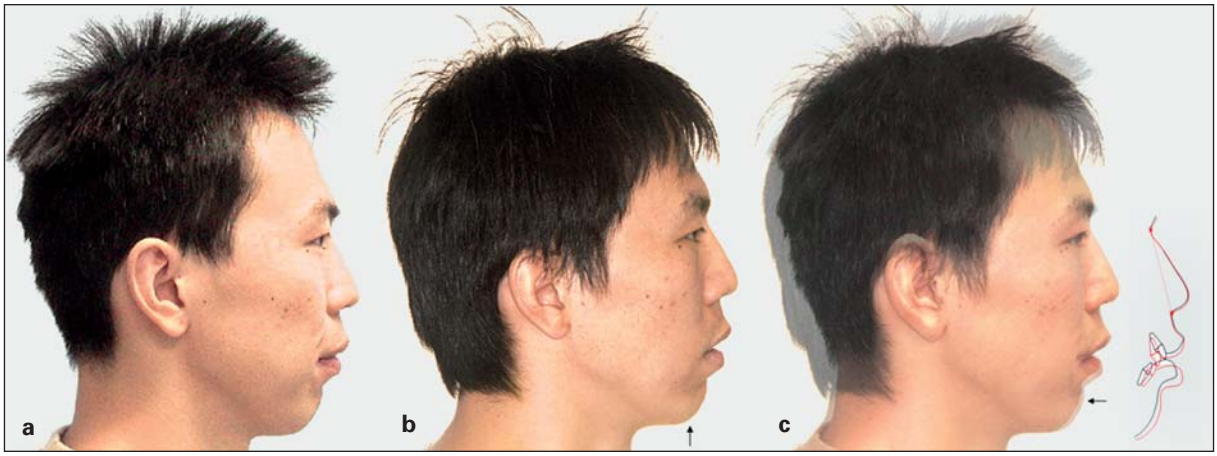

Fig 10 **(a,b)** Notice the dramatic change in soft-tissue appearance, chin prominence, increase in throat length, and reduction of mentalis strain. **(c)** Soft-tissue overlay of images **a** and **b** with soft-tissue superimposition. Notice the increase in soft-tissue pogonion.

Table 1 Cephalometric analysis

Measurement	Initial	Final	Norm	SD
Skeletal				
SNA (degrees)	83.0	83.0	82.0	3.5
SNB (degrees)	76.0	77.5	77.7	3.2
ANB (degrees)	7.0	5.6	4.0	1.8
SN-GoGn (degrees)	43.7	39.7	32.9	5.2
FMA (degrees)	38.3	36.2	26.9	4.5
Pog-N perpendicular (mm)	−11.2	−9.2	−5.0	8.0
Dental				
Interincisal angle (U1-L1, degrees)	120.9	135.2	135.0	6.0
Maxillary incisor angulation (U1-SN, degrees)	106.0	90.1	108.2	5.4
Maxillary incisor protrusion (U1-APo, mm)	12.6	7.1	6.0	2.2
Mandibular incisor angulation (L1-MP, degrees)	86.0	90.3	96.8	6.4
Mandibular incisor protrusion (L1-APo, mm)	3.7	5.5	2.7	1.7
U6-PP (mm)	28.0	26.5	—	2.0
L6-MP (mm)	38.0	38.0	—	3.0
Overbite (mm)	−4.0	2.0	2.3	2.0
Overjet (mm)	8.9	1.8	2.3	2.5
Soft tissue				
Facial convexity (G'-Sn-Po', degrees)	19.7	16.2	9.7	4.9
Throat length (mm)	38.9	41.5	57.0	6.0

SD, standard deviation.

DISCUSSION

In the case report presented, maxillary dentoalveolar miniscrews allowed for successful intrusion of the maxillary first and second molars. Placement of mandibular miniscrews prevented extrusion of the mandibular molars. The maxillary miniscrews were inserted at an acute angle to minimize the risk of root contact; however, the proximity of the miniscrew head to the first molar cementoenamel junction limited the extent of intrusion. If maxillary dentoalveolar miniscrews are to be used as an alternative to zygomatic miniplates, the miniscrew head should be inserted as far gingival as possible, which may necessitate placement within the alveolar mucosa. During posterior impaction, the clinician should check for development of a cant at each visit, by having the patient bite on a tongue depressor, as well as noting deviations in the midline. Though numerous cephalometric studies and case reports have documented successful molar intrusion

with skeletal anchorage in patients with anterior open bite, long-term follow-up studies are needed to determine the stability of posterior dentoalveolar impaction.

CONCLUSIONS

Correction and maintenance of anterior open bite can be a great challenge to the orthodontist. Treatment is further complicated in adult patients with a retrognathic mandible, dolichocephalic facial type, and convex soft-tissue profile. Patients who resist extraction or orthognathic surgery risk a further increase of vertical dimension and facial convexity. Orthodontic miniscrews, in the absence of surgically positioned miniplates or tooth extraction, can impact the posterior dentoalveolus and autorotate the mandible. In the near future, miniscrew-supported posterior impaction may become a routine alternative to orthognathic surgery in patients desiring improvement of facial esthetics.

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