Treatment of a severe Class II Division 1 malocclusion combined with surgical miniscrew anchorage

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This article reports the camouflage treatment of a female patient, aged 15 years 2 months, who had a Class II Division 1 malocclusion with severe anterior protrusion and deep incisor overbite. The camouflage treatment plan included bilateral extraction of the maxillary first premolars combined with the use of temporary anchorage devices (TADs) and tension coil springs to retract canines into the extraction spaces and then the 4 incisors. The treatment included use of a mandibular fixed labial arch with minimal use of Class II elastics to correct mild mandibular spacing and level the curve of Spee. Ideal overjet and overbite relationships were established, and the final result was well balanced and esthetically pleasing. The molars were finished in a Class II relationship. Total treatment time was 2 years 6 months. Cephalometric superimpositions revealed that mandibular molars were not disturbed by the limited use of Class II elastics. Surgical miniscrews in canine and incisor retraction in Class II Division 1 malocclusion are an alternate type of temporary anchorage that reduce or remove reliance on conventional intermaxillary anchorage. (Am J Orthod Dentofacial Orthop 2019;155:572-83)

Anchorage preservation is considered one of the most important elements of successful orthodontic treatment. Orthodontists have used a variety of anchorage devices.[1] To reinforce anchorage, there have been many auxiliary devices, such as extraoral headgear, fixed functional orthopedic appliances, lingual arch, transpalatal arch, holding arch, and conventional fixed appliances with intermaxillary elastics, and almost all have some limitations.[2,3] However, the use of most of these appliances needs the patient's cooperation to be effective, especially in the type of treatment of Class II Division 1 that depends on providing maximum dentoalveolar anchorage as a consequence of the reaction forces applied to move teeth. Orthodontic treatment of patients with Class II malocclusion who show poor compliance with conventional treatment modalities can be challenging.

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For the younger growing patient, nonextraction with growth modification may be the treatment of choice. Modification of growth is usually done with the use of functional appliances, either removable or fixed. However, Ruf and Pancherz[4] reported using a Herbst fixed functional appliance for Class II correction in a young adult who was determined by means of hand-wrist radiography to be at the end of the postpubertal growth period. The mean pretreatment age was 16.5 years. Fixed functional appliances are claimed to correct Class II skeletal problems by repositioning the mandible and the mandibular arch in an anterior direction. The displacement resulting from their fixed functional therapy was predominantly dentoalveolar in nature. Forward and downward displacement of mandibular incisors were the most pronounced dentoalveolar effect, followed by mandibular molar displacement.[5] Fixed functional appliances are effective in the management of Class II malocclusion.

Upadhyay et al[6] compared the treatment effects between mini-implants versus fixed functional appliance for treatment of a young adult Class II female patient and found that the 2 treatment protocols provided adequate dental compensation for the Class II malocclusion but did not correct the skeletal discrepancy.

Management of Class II Division 1 malocclusion can be treated in many ways, according to the individual

case, such as the amount of skeletal discrepancy, the age of the patient, patient's attitude to more or fewer treatment compromises, and compliance.

Since the introduction of dental implantology in the late 1960s,[7,8] skeletal or bone anchorage has become increasingly used in clinical orthodontic treatment. In 1997, Kanomi[9] reported the use of osseointegrated dental implants as anchorage during orthodontic tooth movements. The scope of orthodontic treatment has expanded with new treatment planning strategies enabling more predictable tooth movements in all 3 spatial planes; particularly with the use of bone implant anchorage.[10,11]

Surgical miniscrews as bone anchorage present many advantages. One advantage is that bone implants can enhance orthodontic treatment by providing a source of absolute orthodontic anchorage.[12,13] Introduction of surgical miniscrews has enabled predictable tooth movements and eliminated undesirable reciprocal movement on the teeth that otherwise would have been used as anchorage. These screws can be located in alveolar bone according to force vectors required for specific tooth movements. The small screw size allows easy insertion and removal compared with osseointegrated implants. Prevention of infection depends on the high level of patient care of the screw site. The financial cost of screw is much less compared with osseointegrated implants.

Classification of "extradontal" intraoral orthodontic anchorage is according to origin[14]: (1) developed from osseointegrated dental implants, eg, palatal implant, onplant, retromolar implant; and (2) developed from a surgical screw, with a smooth surface not enabling osseointegration or, potentially, immediate orthodontic loading.

Miniscrew anchorage with nickel-titanium closed coil spring for retraction of anterior teeth has become a new strategy for treating skeletal Class II patients as a replacement for closing loop retraction mechanics, which often requires maximum anchorage with headgear and transpalatal arch. Several authors[15-17] have reported that treatment with miniscrew anchorage is simpler, with less anchorage loss of the maxillary first molar, and provides a more significant improvement of the sagittal upper lip position than traditional anchorage mechanics. Miniscrews can serve as comfortable treatment without the need for patient compliance.[13,18,19]

Abundant case reports have mentioned the use of the titanium miniscrew to resolve orthodontic problem in Class II cases such as camouflage treatment of adult patients by means of distalization,[2] canine retraction, and then anterior retraction,[3,18,20] molar intrusion mechanics combined with incisor retraction, and anterior open bite correction.[21,22]

In a prospective split-mouth study, Thiruvenkatachari et al[23] studied anchorage loss during bilateral canine retraction in 10 patients in whom one side of the mouth received treatment using titanium miniscrew implant with closed coil spring compared with conventional molar anchorage on the other side. The canines were retracted in 4-6 months, with no anterior molar movement on the implant side but with 1-2 mm of movement on the molar anchorage side.

Using conventional methods, tooth movement during canine retraction has been reported to be ~1 mm/month. The teeth move at slow rate, taking ~5-8 months to retract the canine.[24,25]

DIAGNOSIS

The Thai female patient was 15 years 2 months old and presented to the Orthodontic Clinic at the Faculty of Dentistry, Khon Kaen University, with a complaint that her teeth were sticking out and she was unhappy with her appearance. She was healthy with no contributing medical history. The pretreatment extraoral clinical photographs (Fig 1) showed a convex lateral profile, with potential lip trap, and a Class II Division 1 incisor relationship. She had incompetent lips and increased upper incisor show at rest.

The pretreatment intraoral photographs (Fig 1) showed severe maxillary protrusion with a large overjet and deep overbite dental arches. The pretreatment dental casts (Fig 2) showed mild crowding in the upper arch and spacing 2.5 mm in the lower arch, large overjet of 9 mm, overbite 7 mm and severe deep curve of Spee 4 mm.

All permanent teeth up to the second permanent molars had erupted, and 4 third molars were developing in the root-forming stage, as shown in the panoramic radiograph (Fig 3).

The pretreatment cephalometric radiograph (Fig 3) and analysis (Table) demonstrated a moderate skeletal type II (ANB angle 6°, Wits appraisal 3 mm). The SNA angle of 81.5° indicated an orthognathic maxilla compared with cranial base, and the SNB angle of 75.5° reflected a retrognathic mandible compared with cranial base. Her MP-PP angle of 22° revealed acceptable vertical skeletal relationships.

Regarding growth status, lateral cephalometric radiographs (Fig 3) were taken before treatment, and cervical vertebral maturation[27] demonstrated skeletal growth completed to stage CS5, which indicated that only a small amount of growth could be expected in the following year during treatment.

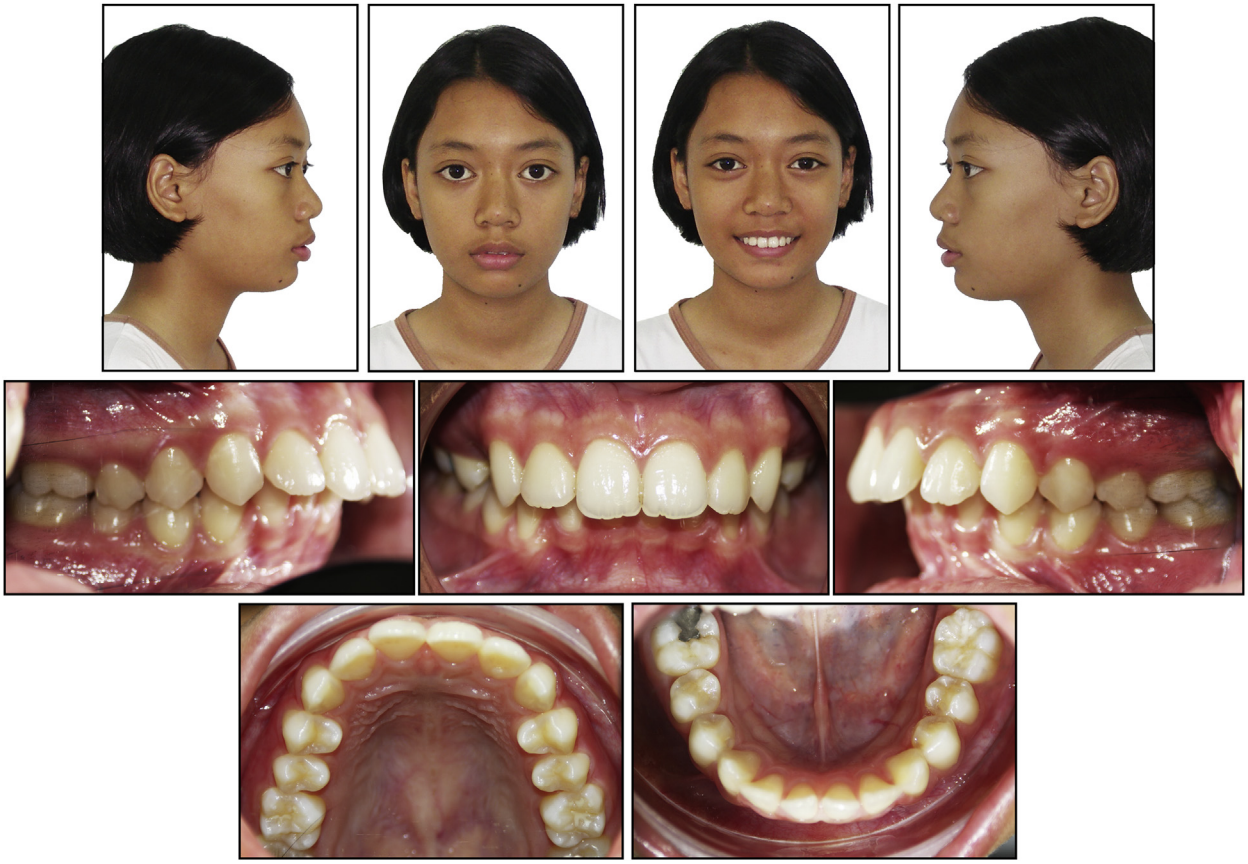

Fig 1. Pretreatment extraoral and intraoral photographs of the patient.

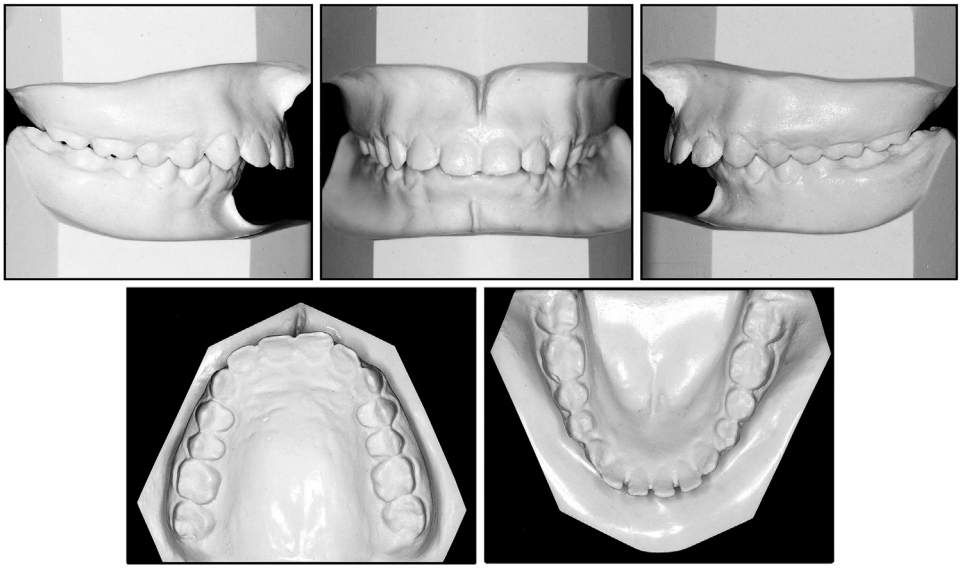

Fig 2. Pretreatment dental casts.

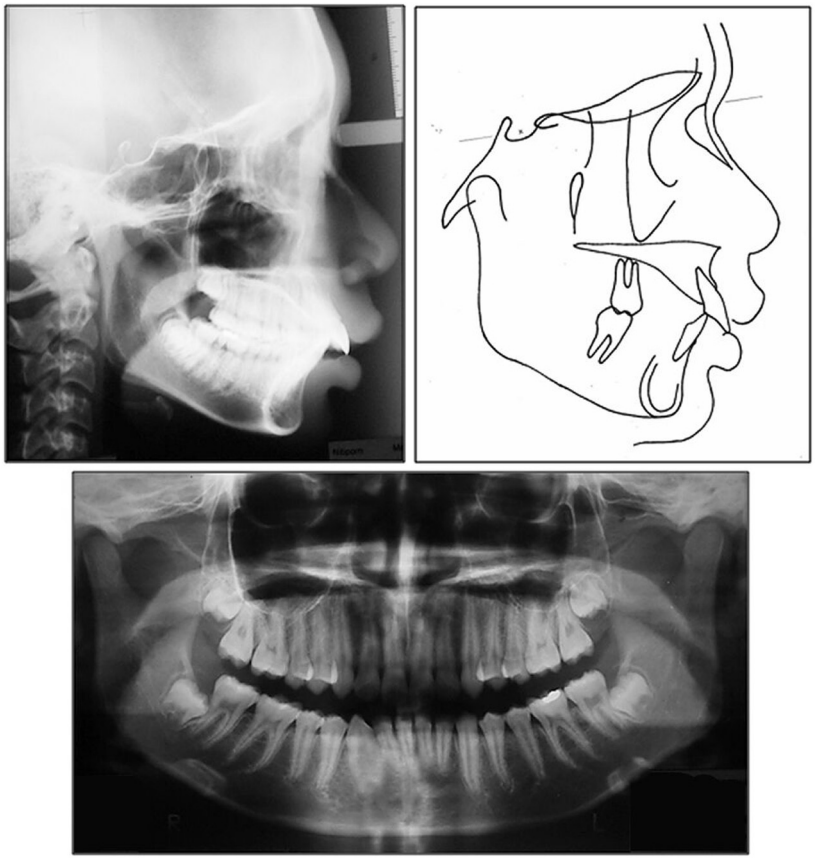

Fig 3. Pretreatment cephalometric radiograph, cephalometric tracing, and panoramic radiograph.

Table. Cephalometric comparisons

Location	Measurement	Thai norm[26]		Before treatment	After treatment	Change
		Mean	SD			
Skeletal						
Cranial base	NS-FH (°)	7	2.58	9.5	9	−0.5
	NS-Ba (°)	128	5.09	135.5	135	−0.5
Maxilla to cranial base	SNA (°)	84	3.58	81.5	81	−0.5
	SN-PP (°)	9	3.03	9	6	−3
Mandible to cranial base	SNB (°)	81	3.59	75.5	77	1.5
	SN-MP (°)	30	5.61	31	26.5	−4.5
Maxillomandibular	ANB (°)	3	2.50	6	4	−2
	Wits (mm)	−2	3.49	3	4	1
	MP-PP (°)	20.9	5.25	22	20.5	−1.5
Dental						
Maxillary dentition	U1 to NA (°)	22	5.94	23.5	13	−10.5
	U1 to NA (mm)	5	2.13	6.5	3	−3.5
	U1 to SN (°)	108	6.13	106.5	94.5	−12
Mandibular dentition	L1 to NB (°)	30	5.61	32.5	27.5	−5
	L1 to NB (mm)	7	2.22	8	6	−2
	L1 to MP (°)	97	5.97	105	103	−2
Soft tissue						
	Nasolabial angle (°)	91	7.98	90	107	17
	H-angle (°)	14	3.83	20	11.5	−8.5
	L lip to E-plane (mm)	2	2.03	3.5	2	−1.5

Objectives of treatment

The treatment objectives to deal with the patient's complaints were: (1) to create a more balanced esthetic face by reducing the apparent intermaxillary anteroposterior discrepancy and reducing the patient's convex facial profile with improved smile esthetics; and (2) to achieve ideal intermaxillary incisor overbite and overjet relationships as well as to reduce the curve of Spee with alignment and leveling of the teeth in both arches to establish good intercuspation.

Alternate treatment options

To accomplish the treatment objectives, we identified 5 treatment options. The patient's chief complaint was her upper teeth protrusion and she wanted complete retraction of the anterior teeth to make her smile more beautiful. Because she was a nongrowing patient, treatment options for correction of her Class II malocclusions could include orthognathic surgery for a severe case or selective removal of permanent teeth with subsequent orthodontic camouflage to mask skeletal discrepancies.

Thus, the first option was to correct the Class II molar/bicuspid malocclusion with a combination of orthognathic surgery and orthodontics and suggestion of a genioplasty to enhance esthetic profile improvement. If the patient accepted such treatment, there was the advantage of a rapid result.

However, this option was declined by the patient's parents, owing to perceived risks with surgery and high cost of treatment even though this option could provide a better esthetic treatment result. The following nonmaxillofacial surgery options based on orthodontic camouflage were then presented to the patient.

(1) Use high-pull headgear as a maximum anchorage device for the retraction of the anterior teeth, with or without maxillary second molar extractions for maxillary molar distalization and biteplate. The disadvantage of this was the orthodontic anchorage requirement of using headgear, which is dependent on the patient's cooperation. However, the patient refused extraoral appliances such as headgear for anchorage owing to esthetic and social reasons.

(2) Extract the maxillary and mandibular first bicuspids. This would require maximum posterior maxillary and mandibular dentoalveolar anchorage combined with Class II intermaxillary elastics correcting the excessive maxillary anterior overjet and leveling of the mandibular arch curve of Spee.

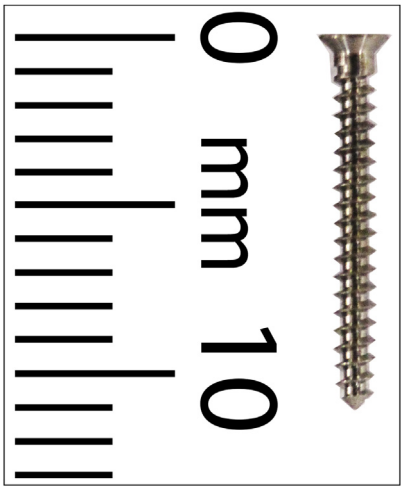

Fig 4. Osteomed microscrew.

(3) Use fixed functional appliances with nonextraction by encouraging any remaining mandibular growth and by eliciting dentoalveolar effects. This appliance treatment can be used with a noncompliant young adult patient.

(4) Extract the maxillary first bicuspids and use surgical miniscrews to provide absolute anchorage for intrusion and retraction of the maxillary incisors. Aligning the mandibular teeth and leveling the curve of Spee with some mandibular incisor intrusion would be achieved through use of a mandibular fixed labial appliance and some limited use of intermaxillary Class II elastics.

After extensive discussion, the patient and parents chose the fourth option of extraction of the maxillary first bicuspids associated with surgical miniscrews.

The overall treatment plan was then formulated as follows: (1) general dental care: oral hygiene instruction, scaling, and polishing full mouth and additional fluoride mouth rinse and super floss daily; (2) extractions: upper first bicuspid to retract incisors; (3) anchorage: maxilla: absolute and reinforced anchorage with miniscrews between the second bicuspid and first molar on both sides for anterior teeth retraction and intrusion; mandible: moderate anchorage preparation for later use of Class II elastics, together with dental arch leveling to reduce the curve of Spee; (4) appliances: 0.022 × 0.028-inch slot preadjusted edgewise brackets; (5) finishing and detailing: short-term intermaxillary elastics to correct deep bite and assist overcorrection of overjet; and (6) retention: removable wraparound retainers.

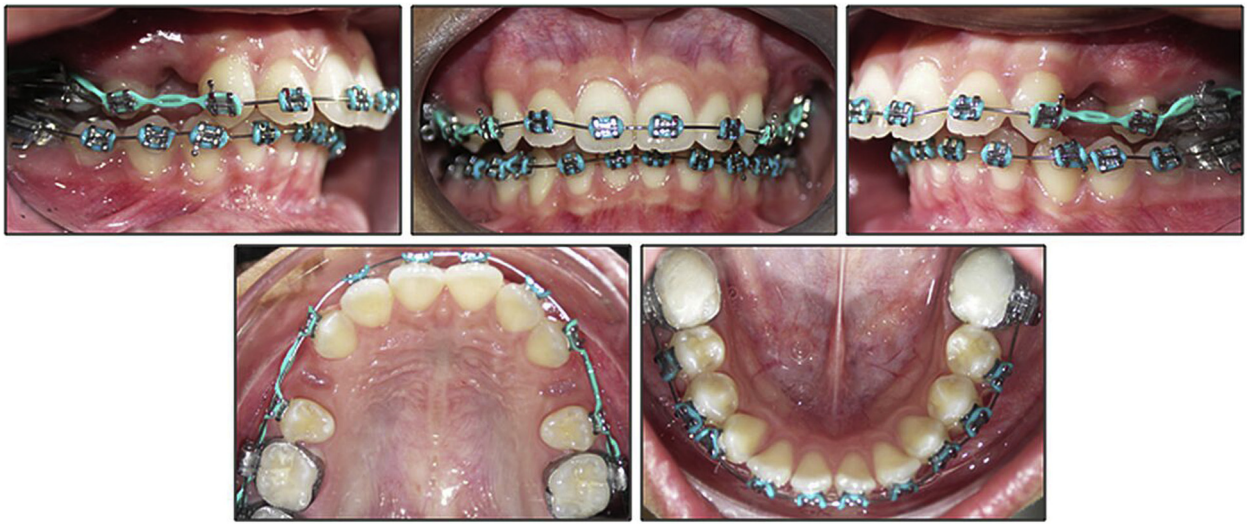

Fig 5. Treatment photographs: leveling and aligning phase.

Treatment start and progress

The patient was referred to an oral surgeon for placement of the surgical miniscrews at bilateral maxillary sites in the buccal interdental alveolar bone in the maxilla between the second bicuspid and the first molar as located with the use of panoramic radiographs and periapical films. The detailed surgical procedure and aftercare was as described by Viwattanatipa et al.[28] The diameter of the titanium surgical miniscrews (Osteomed, Dallas, Texas; Fig 4) was 1.2 mm, the screw thread length 8 mm, and total length 11 mm.

A 0.022 × 0.028-inch slot straight wire appliance (MBT Prescription; 3M Unitek, Monrovia, California) was placed in both arches. Leveling and aligning were then commenced with the use of round 0.014-inch wire (AJ Wilcock Australian Wire; Fig 5).

Simultaneously with the surgical miniscrew placements, the patient was referred for extraction of maxillary first bicuspids. After 1 month, the patient was referred for punching to expose the heads of the screws. Along with change to 0.016 × 0.022-inch stainless steel archwires in the movement phase (Fig 6), both upper canines were retracted with the use of NiTi closed coil springs (Ormco, Kerr, Italy) linked to the surgical miniscrews; also, in the mandibular arch leveling and aligning and bite opening with reverse curve of Spee continued.

Figure 7 shows the bilateral maxillary inverted L-loop configurations of 0.017 × 0.025-inch stainless steel wires bent anterior to the maxillary canines to form a maxillary closing loop archwire for intruding the maxillary incisor with simultaneous retraction with NiTi closed coil spring. The inverted L-loop were used as anterior hooks for engaging the coil springs. Maxillary incisor retraction was commenced with the use of miniscrew combined with 175 g per side of NiTi closed coil spring. Intrusion of the lower anterior teeth was continued with mandibular 0.5 mm stepdown bends in the 0.016 × 0.022-inch stainless steel archwire from tooth 32 to 42, and from tooth 33 to 43 another 0.5 mm supported by Class II elastics (3/16″, 3.5 oz.; Ormco Corp, Mexico) used from mandibular second molars to maxillary canines for mandibular arch leveling and incisor intrusion.

The patient was referred to remove the surgical miniscrews when maxillary canines and incisors were fully retracted and all spaces closed (Fig 8). Some maxillary canine rotation that happened during retraction was corrected with lingual buttons bonded to the canines and linked to the maxillary molars by power chain.

Once the orthodontic objectives had been achieved, the fixed appliances were removed and wraparound retainers inserted. The patient was instructed to wear the retainers 24 hours per day (except during meals and brushing periods) for 1 year, then gradually decreasing the wearing time. She was informed about the need for a periodic check-up and oral hygiene control.

TREATMENT RESULTS

The posttreatment facial photographs showed improvement in the facial profile (Fig 8). The intraoral photographs (Fig 8) and dental casts (Fig 9) showed satisfactory dental alignment, bilateral Class I canine relationships, and ideal overjet and overbite. Good buccal

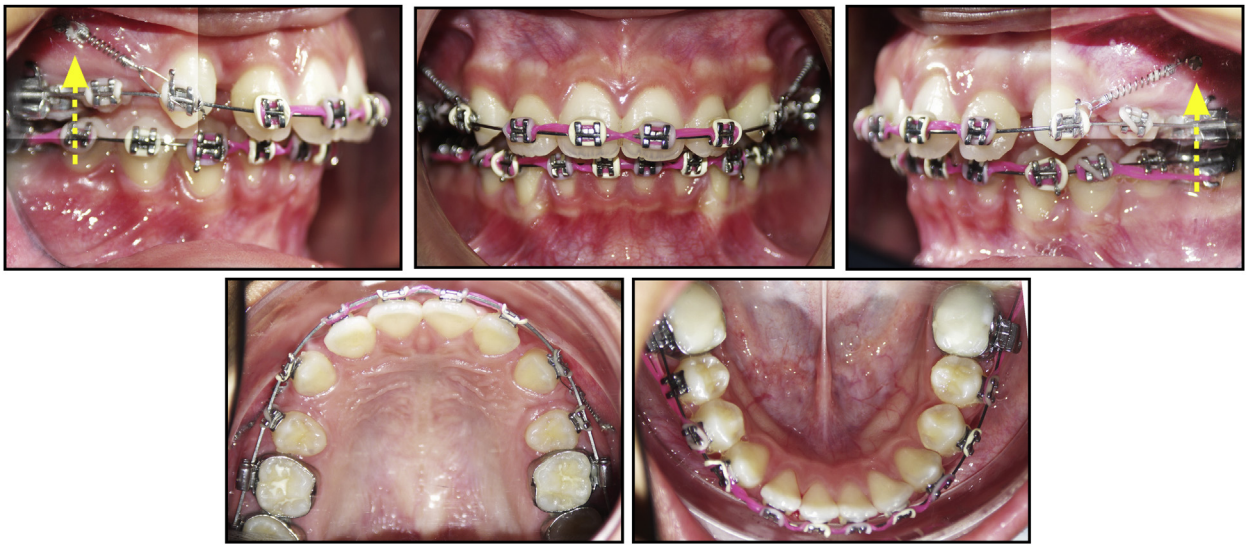

Fig 6. Treatment photographs: canine retraction with the use of closed coil spring.

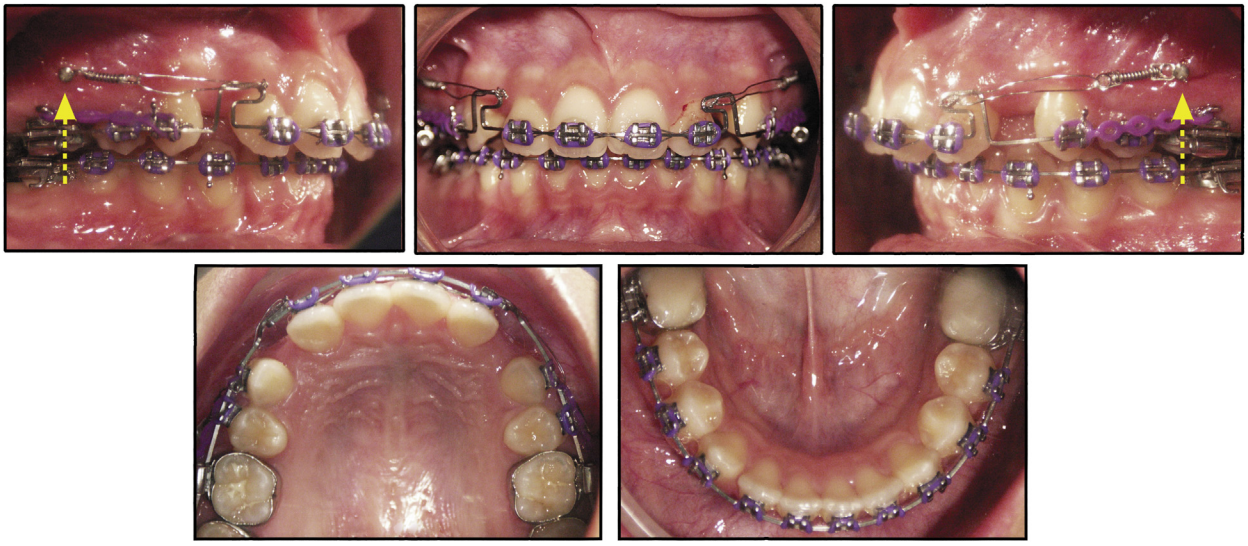

Fig 7. Treatment photographs: retraction of maxillary incisors.

interdigitation was achieved. Mandibular alignment was completed and dental midlines coincided and matched the facial midline.

Canine guidance was present on the left and right during lateral excursions, and incisal guidance was present on protrusion. There were no nonworking side interferences during functional movements. The cephalometric analysis between pretreatment and posttreatment cephalometric radiographs in the Table showed that sagittal skeletal relationship type II was changed to type I (ANB was reduced from 6° to 4°) and the maxillary incisors were retroclined and positioned backward (U1-NA was retracted from 23.5° and 6.5 mm to 13° and 3 mm; U1-SN was decreased from 106.5° to 94.5°). In terms of soft tissue changes, an acceptable facial profile was achieved with H angle decreased from 20° to 11.5° and nasolabial angle increased from 90° to 107°. All represented the changes from a skeletal Class II pattern to a skeletal Class I pattern.

Fig 8. Posttreatment extraoral and intraoral photographs of the patient.

The panoramic radiograph (Fig 10) showed that all extraction spaces were closed, and the roots had been paralleled.

The treatment time was 2 years 6 months. Upper and lower wraparound retainers were used to maintain alignment. The retention period was designed for 1 year full time and then gradually decreased. The patient was periodically recalled for retainer recheck.

Lateral cephalometric superimposition (Fig 11, *A*) showed intrusion of upper and lower anterior teeth and extrusion of lower posterior teeth as well as correction of the original large curve of Spee. Backward movement of upper anterior teeth corrected protrusion of the maxillary anterior teeth.

Overall superimposition of pre- and posttreatment cephalometric radiographs (Fig 11, *A*), registered on the best fit of anterior wall of sella turcica, greater wing of sphenoid bone, and Walker point, where the contour of the anterior clinoid crosses the anterior wall of sella turcica, revealed that the maxillary anterior apical base was moved backward 3 mm at the A point and the mandible was moved backward 0.5 mm at the B point. The facial convexity and upper lip protrusion were reduced. The nasolabial angle was more obtuse. There was harmonization of upper and lower lip, and improving lip incompetence.

Maxillary superimposition of pre- and posttreatment cephalometric radiographs (Fig 11, *B*) along the palatal plane registered on the best fit of internal palatal structure, lingual contour of oral part of palate, and at the pterygomaxillary fissure, revealed the forward movement at the A point of 3 mm in results from the treatment effect of the change in upper anterior teeth inclination. The upper first molars were moved forward ~2 mm and intruded ~3 mm. The upper incisors were tipped palatally and intruded as the incisal edge moved backward 11 mm and upward 4 mm.

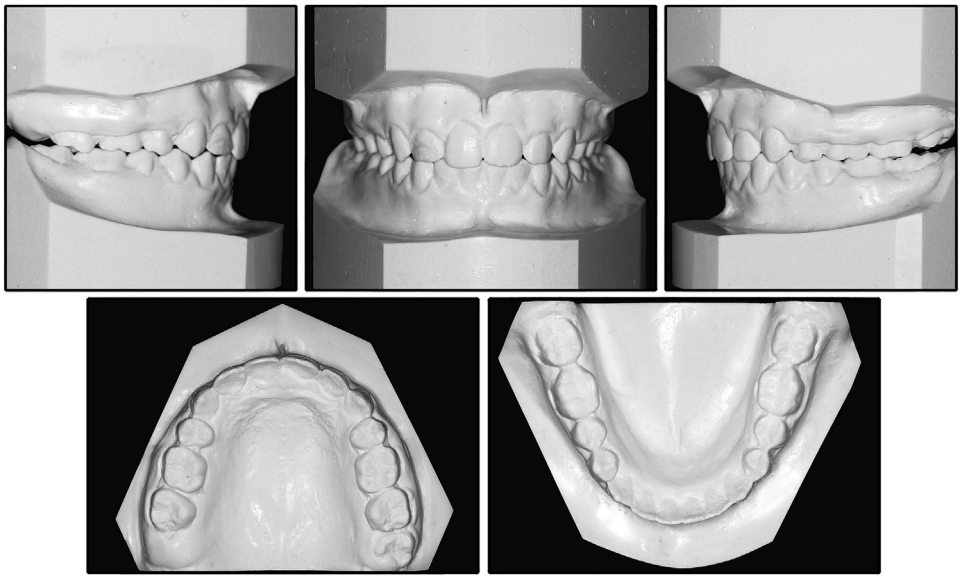

Fig 9. Posttreatment dental casts.

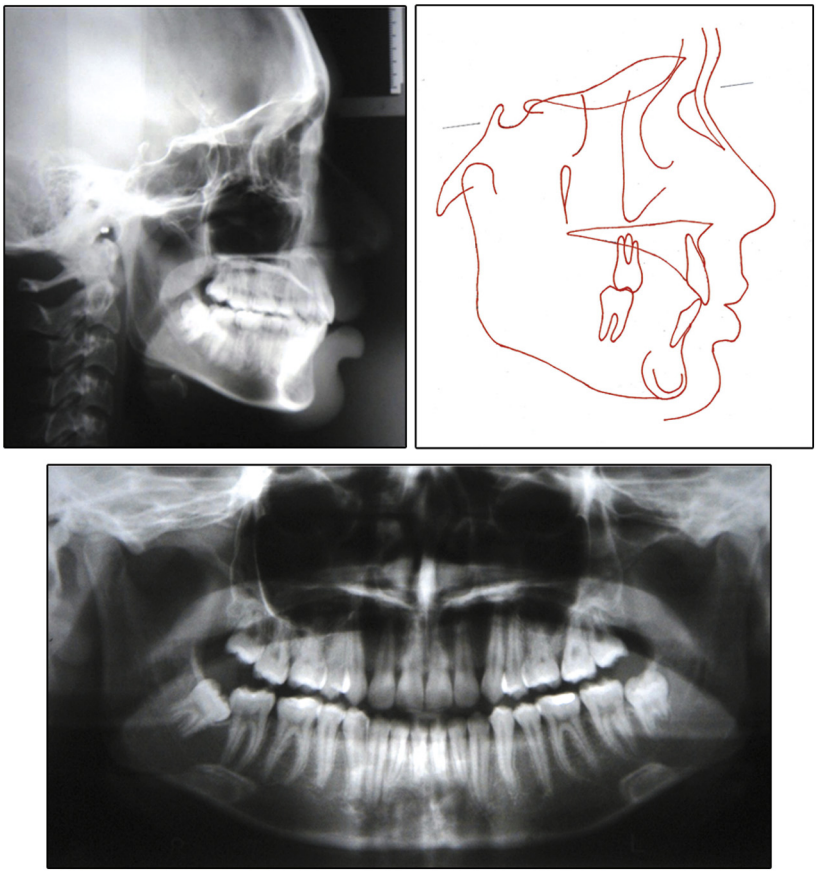

Fig 10. Posttreatment cephalometric radiograph, cephalometric tracing, and panoramic radiograph.

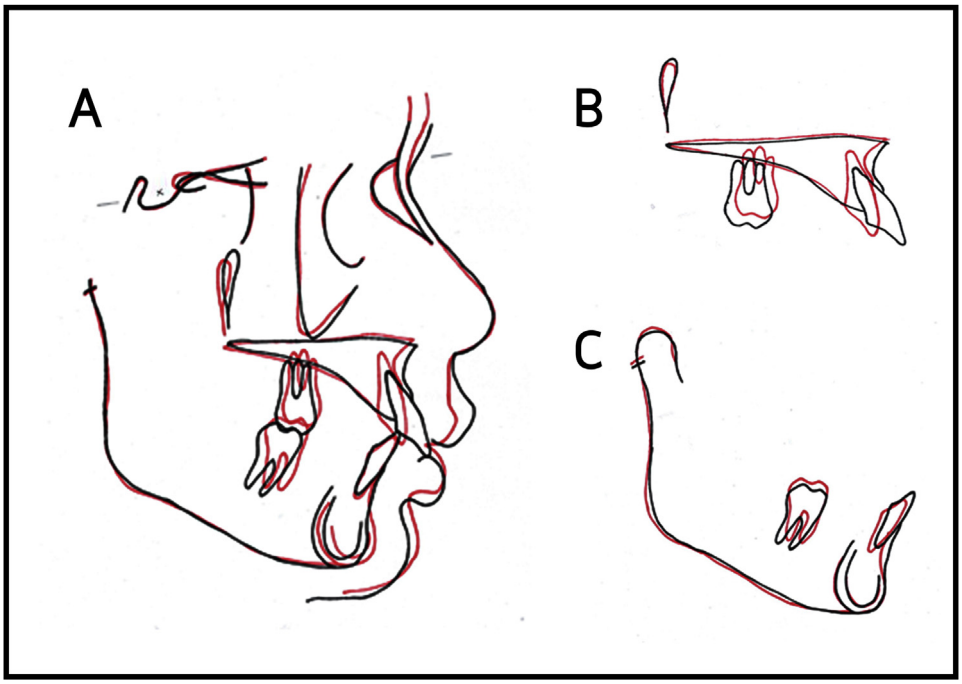

Fig 11. Superimposition of pre- and posttreatment cephalometric radiographs. **A,** Overall; **B,** maxilla; **C,** mandible.

Mandibular superimposition of pre- and posttreatment cephalometric radiographs (Fig 11, *C*) registered on the best fit of the anterior contour of the symphysis and endosteal inner contour of the symphysis, revealed a slight backward mandibular displacement. The B point moved backward 3 mm. The change in the mandibular occlusal plane was a forward rotation, centered anterior to the dentition and with vertical eruption of the molars than of the mandibular teeth. The lower first molars were extruded 2 mm. The lower incisors were intruded as the incisal edge moved downward 3 mm as a result of the treatment effect of using reverse curve of Spee.

DISCUSSION

Tadic and Woods noted in a literature review[29] that "if the main Class II problem was due to protrusive upper anterior teeth, the treatment should be focused on upper anterior teeth retraction, with or without extractions. If on the other hand, the problem was deemed to be largely one of mandibular retrusion, treatment was chosen with the aim of somehow increasing mandibular prominence." Those authors further observed that adopting a successful camouflage approach depended on maintaining adequate anchorage control. Soft tissue profile improvements for more challenging Class II Division 1 problems become achievable.

Tadic and Woods also reported their experiences of following soft tissue profile changes when applying maxillary extractions alone.[29] They observed that pretreatment morphologic variability among patients with Class II malocclusions had large influences on choices between extraction and nonextraction in addition to orthodontic appliance strategies. They concluded that there were special features of patients with Class II Division 1 malocclusions, such as thin upper lip, larger nasolabial angle, longer face type, and older age, that may make the treatment result with upper bicuspid extractions alone a less than acceptable outcome.

On the other hand, Janson et al reported that a satisfactory outcome could be expected with still-growing patients by adopting a camouflage approach with upper first bicuspid extractions and relying on miniscrew anchorage.[30] Those authors also claimed that treatment of Class II malocclusion with extractions of 2 bicuspids gives a better occlusal success rate than treatment with extractions of 4 bicuspids.[31]

Orthodontic miniscrews are smaller than osseointegrated dental implants.[13,14] In the present case, the miniscrews were placed at a high level (thick nonkeratinized mucosa) in the interdental bone between the maxillary first molar and second bicuspid. The position at this level proved to be appropriate as an intraoral bone anchorage for retraction and

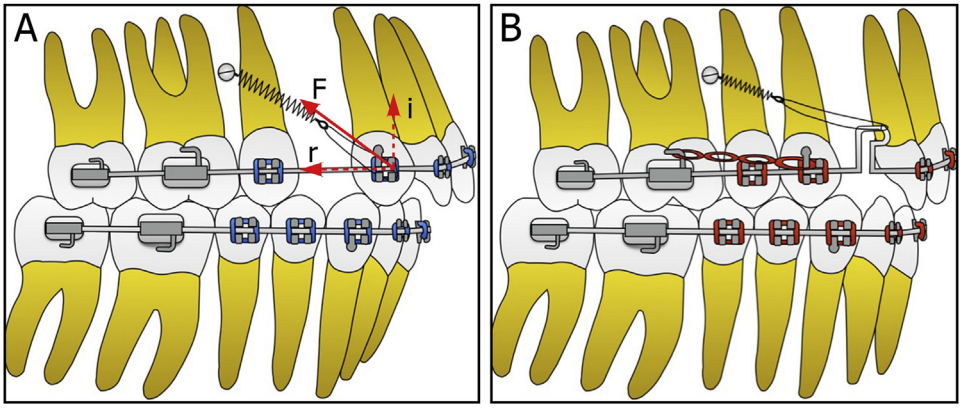

Fig 12. Force system involved: *F*, total force; *i*, intrusive force; *r*, retraction force. **A,** Movement phase; canine retraction with surgical miniscrew. **B,** Incisor retraction phase; closing loop archwire (inverse L-loop) and surgical miniscrew.

intrusion on the grounds of force magnitude and direction (Fig 12).

Miniscrews provide satisfactory anchorage for retraction of the upper anterior segment, but they do not remain stationary throughout orthodontic loading. It is important that there is sufficient clearance to prevent miniscrews from hitting any vital organs because of displacement to the mesial area of molars to avoid miniscrew–molar root contact.[32,33]

The characteristics of an ideal orthodontic anchor are (1) enough strength to resist the en masse orthodontic forces, (2) ease of insertion and removal, and (3) low cost.[34] The surgical miniscrew has these characteristics. However, surgical miniscrews have some disadvantages, such as their head features, and they are more difficult to handle with ligature ties than modern orthodontic miniscrews. Surgical miniscrews, which have no hole at the head, would inconvenience the insertion of a ligature tie for the retraction spring. From numerous studies of survival analysis in miniscrews,[28,35,36] the mean overall success rate is very high, so they can benefit the orthodontist to obtain an alternate orthodontic anchorage.

CONCLUSION

This case report describes a 15-year-old Thai female patient who presented with a convex lateral profile, Class II Division 1 incisor relationship, and skeletal type II with orthognathic maxilla and retrognathic mandible.

Treatment results achieved the patient's profile and esthetic goals regarding nasolabial angle, lip posture, and perioral protrusion as well as intraoral normal overjet and overbite with adequate interdigitation of canine and molar relationships.

Because there was apparently minimal use of intermaxillary anchorage, the labiolingual positions of the mandibular incisors were largely unaffected throughout treatment. Surgical miniscrews play a simple role as a major source of anchorage for maxillary anterior retraction and intrusion upper incisors. The treatment lasted for 2 years 6 months, and occlusion was effectively improved with good posttreatment stability. The treatment resulted in a well balanced and esthetically pleasing profile.

In dentistry today, it is becoming more difficult to satisfy patients' higher expectations for esthetics and comfort as well as their impatience with longer treatment periods. Clinicians will continue to research alternate approaches to providing patients with their desired treatment outcomes over the shortest time possible. Because miniscrews serve an alternative to conventional mechanics for anchorage control, clinicians are paying more attention to them. Desired treatment outcomes that are not possible with conventional mechanics may be achieved with miniscrew-supported orthodontic treatment. Miniscrews have recently become commonly accepted as a simple and effective tool in daily orthodontic practice.

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