Case Report

Correction of Severe Skeletal Class II Discrepancy with Orthodontic Treatment Combined with Bimaxillary Orthognathic Surgery: A Case Report

Thanapat Sangwattanarat* Supunsa Pongtiwattanakul** Chonticha Kitiwiriyakul***

Abstract

Background: A 53-year-old Thai female patient came to the orthodontic clinic with upper anterior teeth protrusion and insecurity while smiling as the chief complaints. Her expectation was to correct these problems. The examination showed severe skeletal Class II discrepancy with hyperdivergent facial pattern, orthognathic maxilla but retrognathic mandible, and anterior gummy smile. An orthodontic treatment combined with bimaxillary orthognathic surgery was planned. The treatment objectives were to correct the upper anterior teeth protrusion and gummy smile and improve the patient's skeletal, dental, and soft tissue morphology. The treatment duration was 34 months to achieve normal skeletal, dental, and soft tissue structure in the anteroposterior, vertical, and transverse dimensions. At 30 months after completing treatment, the patient was recalled. We found acceptable function, improved esthetic results, and stability. The patient was pleased with the treatment outcome.

Keywords: Gummy smile, Orthognathic surgery, Retrognathic mandible, Skeletal Class II

Received: 22-Feb-2023 **Revised:** 8-Jul-2023 **Accepted:** 25-Aug-2023

Corresponding author: Thanapat Sangwattanarat
E-mail: thanapat.sang@cmu.ac.th

* Dentist, Faculty of Dentistry, Chiang Mai University, Mueang, Chiang Mai, Thailand
** Dentist, Professional Level, Ranong Hospital, Mueang, Ranong, Thailand
*** Dentist, Professional Level, Sukhothai Hospital, Mueang, Sukhothai, Thailand

Introduction

Class II malocclusion is one of the most prevalent developmental defects that affects 15 to 30 percent of most populations. This malocclusion is likely to have esthetic, psychological, and social consequences.[1,2] This dentofacial abnormality can be classified into maxillary excess, mandibular deficiency, or both. Because the ensuing abnormality can exhibit varying degrees of severity of Class II malocclusion in different ages, the chosen method of clinical therapy must be adapted accordingly.[3,4] In addition, a gummy smile is a significant esthetic problem for patients. This problem leads many patients to seek treatment to correct this issue. The etiology of a gummy smile is multifactorial that includes short upper lip length, hyperactivity of the upper lip, short clinical crown, altered passive eruption, gingival hyperplasia, dentoalveolar extrusion, and vertical maxillary excess. Correcting this problem can be achieved through various treatments that include dental, skeletal, or soft tissue alterations, or a combination of these approaches.[5,6]

In patients with a skeletal Class II relationship, the treatment options vary depending on the severity of the malocclusion, facial appearance, patient expectations, and the level of cooperation.[2,7] When dealing with growing patients, it is proper to use growth modification treatments that involve either removable or fixed functional appliances. Patient cooperation should be a primary focus in these treatments. When there are mild to moderate anteroposterior skeletal discrepancies in adult patients with acceptable vertical facial proportions and no transverse skeletal abnormalities, camouflage orthodontic treatment can be an option.[4] The primary component of camouflage treatment is upper incisor retraction. This is accomplished by either extracting the upper first premolars or performing whole maxillary arch distalization with temporary anchorage devices, and protraction of the lower incisors to obtain normal overjet.[3] In some cases, extractions of the mandibular second premolars are also performed to obtain a Class I molar relationship through lower molar mesialization. However, this treatment is restricted in its ability to compensate for underlying skeletal discrepancies because it relies on tooth movements. In severe cases, camouflage treatment means fitting teeth on improper skeletal bases, which can lead to possible periodontal problems such as gingival recession in the lower anterior area, root resorptions, worsening facial esthetics, and occlusal instability.[8,9] Therefore, orthodontic treatment combined with orthognathic surgery is the best treatment alternative to achieve the ideal results in terms of function, esthetics, and stability in patients who have severe anteroposterior skeletal discrepancies, transverse maxillary skeletal constriction, airway problems, and improper facial esthetics.[10] Orthodontic treatment combined with orthognathic surgery in a 53-year-old woman with skeletal Class II malocclusion related to retrognathic mandible and follow-up at 30 months were described in this case report.

Case report

A 53-year-old woman sought orthodontic treatment at the orthodontic clinic, dental hospital, Faculty of Dentistry, Prince of Songkla University with a chief complaint of upper incisor protrusion and a gummy smile. The patient reported no known underlying disease or allergy and was not taking any medication. The extraoral examination presented normal facial development. The frontal view showed a symmetrical dolichofacial type. In the rest position, the patient had incompetent lips. A high smile line was presented while smiling. The patient exhibited a convex facial profile and an acute nasolabial angle (Figure 1). The patient had no signs or symptoms of temporomandibular disorders.[11]

The intraoral examination found a large overjet (4 mm) and deep overbite (5 mm). According to Angle's classification of malocclusion, the molars were Class I relationship and the canines were Class II relationship (5 mm on the right side and 2 mm on the

left side). The upper dental midline coincided with the facial midline, and the lower dental midline deviated from the facial midline to the right by 1 mm. Space analysis demonstrated mild crowding of the upper arch (Figures 2 and 3). Neither dental interference nor functional shift was detected. The soft tissue presented normal oral soft tissue, mucosa, and adequate attached gingiva. The tongue size and position were normal. The periodontium was diagnosed with gingivitis on a reduced periodontium.

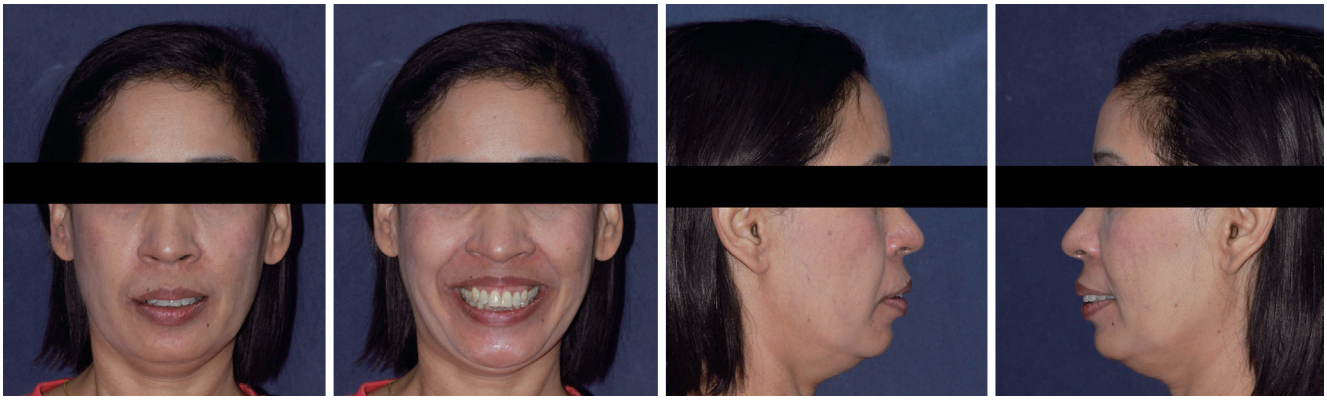

Figure 1 Pretreatment extraoral examination

Figure 2 Pretreatment intraoral examination

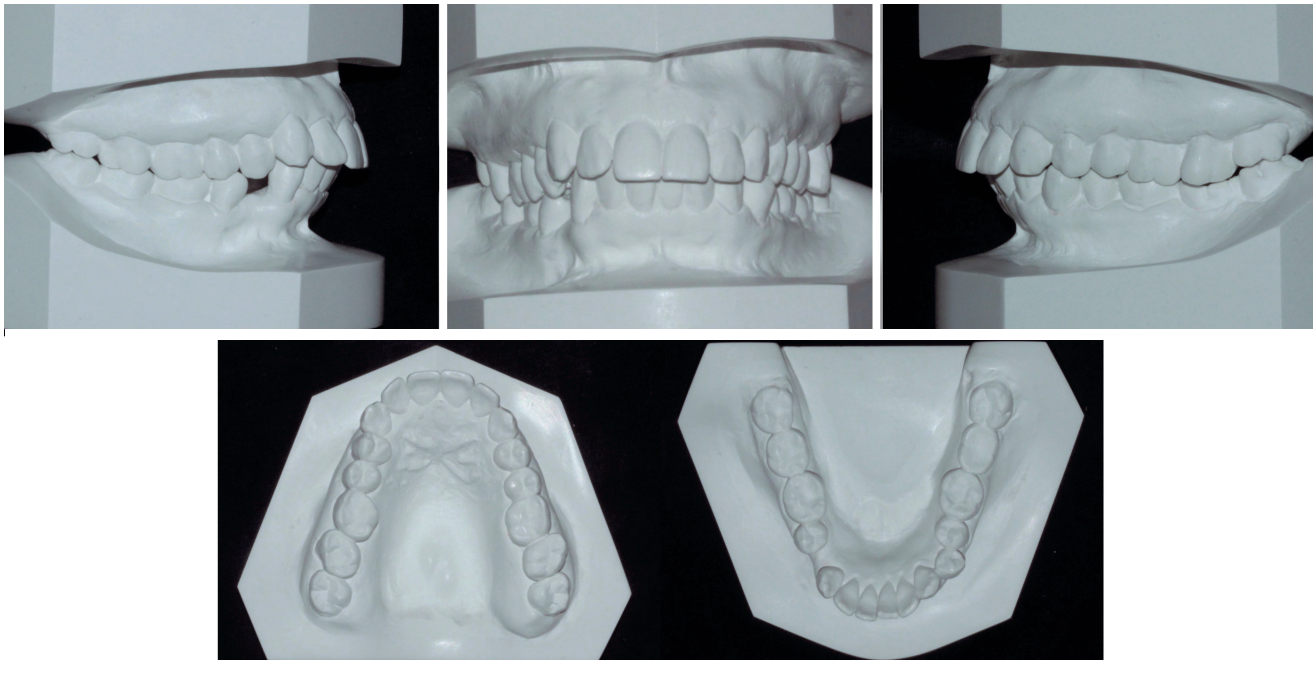

Figure 3 Pretreatment dental models

Table 1 Pretreatment Korkhaus's analysis

	Maxillary arch		Mandibular arch	
Type	Thai norm[12]	Pretreatment	Thai norm[12]	Pretreatment
Arch height (mm)	19.10 ± 2.40	19.00	17.3 ± 2.30	16.50
Anterior arch width (mm)	36.40 ± 1.90	31.50	36.2 ± 2.10	33.00
Posterior arch width (mm)	46.80 ± 2.20	41.00	45.7 ± 2.20	43.00

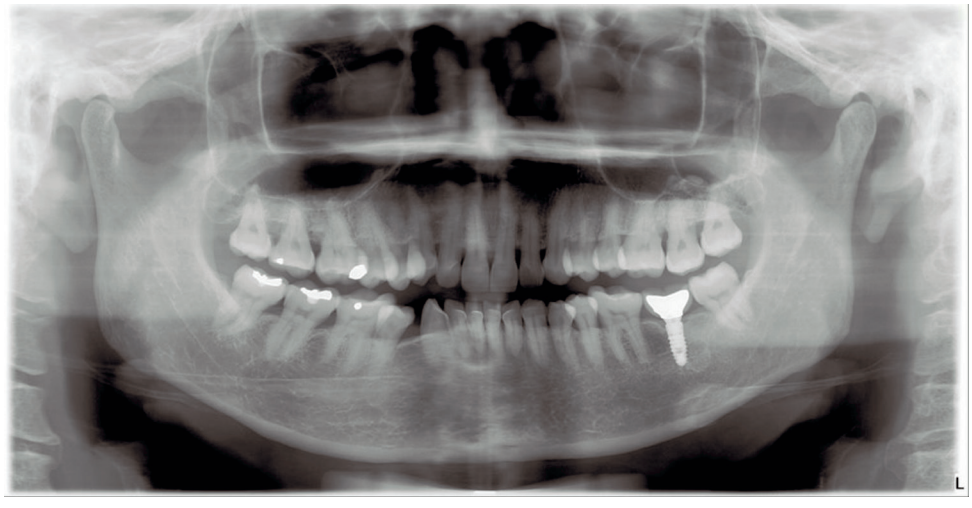

Figure 4 Pretreatment panoramic radiograph

Korkhaus's analysis showed that the lower anterior arch width (AAW) and posterior arch width (PAW) were wider than the upper AAW and PAW. Upper and lower AAW and PAW were narrower than standard value. The upper arch height (AH) was larger than the lower AH. Both upper and lower AH were larger than standard values (Table 1). Space analysis measurements revealed that the upper arch had a space deficiency of 1.50 mm.

Panoramic radiograph showed dental development at the permanent dentition stage with loss of the mandibular right first premolar due to dental caries (Figure 4). The maxillary nasal septum, bone density, and trabeculation were within normal limits with no other visible pathology; however, maxillary sinus pneumatization was at the 16 to 18 and 26 to 28 areas. Asymmetrical mandibular condyles were noted in that the right condyle was smaller than the left condyle. There were radiopaque masses size 2 x 3 mm at the base of the maxillary sinus apically to the right maxillary canine and left maxillary second molar.[13] Lateral cephalometric analysis[14] indicated a skeletal Class II hyperdivergent pattern with orthognathic maxilla and retrognathic mandible. Also observed were normally inclined but protruded upper incisors, proclined and protruded lower incisors, acute interincisal angle, protruded upper lip, normally positioned lower lip, and a normal nasolabial angle (Figure 5 and Table 2). The postero-anterior (PA) cephalometric analysis indicated that the right and left condyles were asymmetrical, and the left and right ramal heights were equal. The right body of the mandible was longer than the left side by 4 mm, maxillary plane canting by the left side was lower than the right side by 1 mm, and no occlusal plane canting was noted (Figure 6).

Figure 5 Pretreatment lateral cephalogram

Figure 6 Pretreatment postero-anterior cephalogram

Table 2 Pretreatment cephalometric analysis

Area		Measurement	Norm (Mean ± SD)	Pre treatment	Interpretation
Skeletal	Maxilla to cranial base	SNA (degree)[15]	84 ± 4	82	Orthognathic maxilla
		SN-PP (degree)[16]	9 ± 3	8	Normal inclination of maxilla
	Mandible to cranial base	SNB (degree)[15]	81 ± 4	75	Retrognathic mandible
		SN-MP (degree)[15]	29 ± 6	38	Hyperdivergent pattern
		SN-Pg (degree)[15]	82 ± 3	76	Retrognathic mandible
		NS-Gn (degree)[15]	68 ± 3	73	Hyperdivergent pattern
	Maxillo-mandibular	ANB (degree)[15]	3 ± 2	7	Skeletal Class II
		Wits (mm)[14]	-3 ± 2	3	Skeletal Class II
		MP-PP (degree)[15]	21 ± 5	30	Hyperdivergent pattern
		FMA (degree)[16]	23 ± 5	29	Hyperdivergent pattern
Dental	Maxillary dentition	$\overline{1}$ to NA (degree)[15]	22 ± 6	28	Normally inclined upper incisors
		$\overline{1}$ to NA (mm)[15]	5 ± 2	9	Protruded upper incisors
		$\overline{1}$ to SN (degree)[15]	108 ± 6	108	Normally inclined upper incisors
	Mandibular dentition	$\overline{1}$ to NB (degree)[15]	30 ± 6	42.50	Proclined lower incisors
		$\overline{1}$ to NB (mm)[15]	7 ± 2	14.50	Protruded lower incisors
		$\overline{1}$ to MP (degree)[14]	99 ± 5	109	Proclined lower incisors
	Maxillo-mandibular	$\underline{1}$ to $\overline{1}$ (degree)[15]	125 ± 8	103	Acute interincisal angle
Soft tissue	Soft tissue	E line U lip (mm)[16]	-1 ± 2	4	Protruded upper lip
		E line L lip (mm)[16]	2 ± 2	3	Normally positioned lower lip
		Nasolabial angle (degree)[14]	91 ± 8	84	Normal nasolabial angle
		H-angle (degree)[15]	14 ± 4	25	Protruded upper lip

The problem list in this patient included 1) skeletal problems (skeletal Class II relationship with retrognathic mandible and hyperdivergent pattern), 2) dental problems (dental Class II malocclusion, protruded upper incisors, mild crowding of the upper and lower anterior teeth, proclined and protruded lower incisors, and lower dental midline shift to the right by 1 mm), and 3) soft tissue problems (convex facial profile, protruded upper lip, and anterior gummy smile). Therefore, the treatment objectives were: 1) to improve the skeletal relationship to obtain normally inclined and positioned upper and lower incisors, 2) to obtain normal alignment and Class I canine and molar relationship, 3) to center the lower dental midline, 4) to improve the facial profile, and 5) to reduce the anterior gummy smile. The etiology of the malocclusion[4] was from hereditary factors. The chin retrognathism, gummy smile, and the tooth and arch size discrepancies were similar to her mother's. According to the collected information, the patient was diagnosed as Class II skeletal relationship with retrognathic mandible, dental Class II malocclusion with large overjet and deep overbite, convex facial profile, and protruded upper lip. An orthodontic treatment combined with orthognathic surgery (two-jaw surgical plan) was proposed. In the pre-orthodontic phase, the patient was referred for treatment of the gingivitis on reduced periodontium by full mouth scaling and polishing. During the presurgical orthodontic phase, dental decompensation was performed by repositioning the teeth into a correct position relative to the skeletal bases. This is the opposite of camouflage treatment. The patient was treated with a pre-adjusted edgewise appliance with a bidimensional bracket system (0.018-inch bracket slot at the anterior teeth and 0.022-inch bracket slot at the canine and posterior teeth) for leveling and aligning, and tooth decompensation. In this case, tooth decompensation was proposed for tooth aligning in normal alveolar bone before surgery. All teeth were leveled and aligned starting with 0.012-inch nickel-titanium (NiTi) followed by 0.014-inch and 0.016-inch NiTi wires, 0.016 x 0.016-inch and 0.016 x 0.022-inch stainless steel (SS) wires, respectively. The upper arch was expanded to coordinate the PAW with the lower arch. A dual occlusal plane of the lower arch was maintained using stainless steel wire with a curve of Spee.

In the surgical phase, rectangular 0.016 x 0.022-inch SS wires were used in both maxillary and mandibular arches. Tooth numbers 14, 24, and 34 were extracted in an operating room. The maxilla was corrected by anterior segmental osteotomy to retrocline and impact the anterior segment to correct the protruded upper incisors and gummy smile. The mandible had an improved facial profile and the lower incisor inclination was corrected by two surgical procedures: 1) bilateral sagittal split ramus osteotomy (BSSRO) advancement (4 mm) and 2) subapical osteotomy tilt back and retroclined lower incisors. After the surgical phase, the post-surgical finishing orthodontic phase was performed by correcting the dental inclination and angulation into a proper function, improved esthetics, and stability. Artistic wire bending was used in the upper and lower anterior teeth.

The total treatment time was 34 months and divided into the presurgical orthodontic phase (16 months), surgical phase (2 months), and post-surgical orthodontic phase (16 months). At the end of the treatment, the extra-oral and intra-oral examinations showed that the patient had an improved facial profile and a less convex facial profile. Furthermore, the examinations showed competent lips, decreased incisal show at rest, normal smile line, normal overjet and overbite, molar Class I relationship, improved canine relationship, and the upper and lower dental midline coincided with the facial midline (Figures 7-9). However, the nasolabial angle had increased. A panoramic radiograph showed mild apical root resorption but no other pathological finding (Figure 10). The lateral and PA cephalometric analysis showed successful outcomes and met the established treatment objectives, i.e., skeletal Class I normodivergent pattern

Figure 7 Posttreatment extraoral examination

Figure 8 Posttreatment intraoral examination

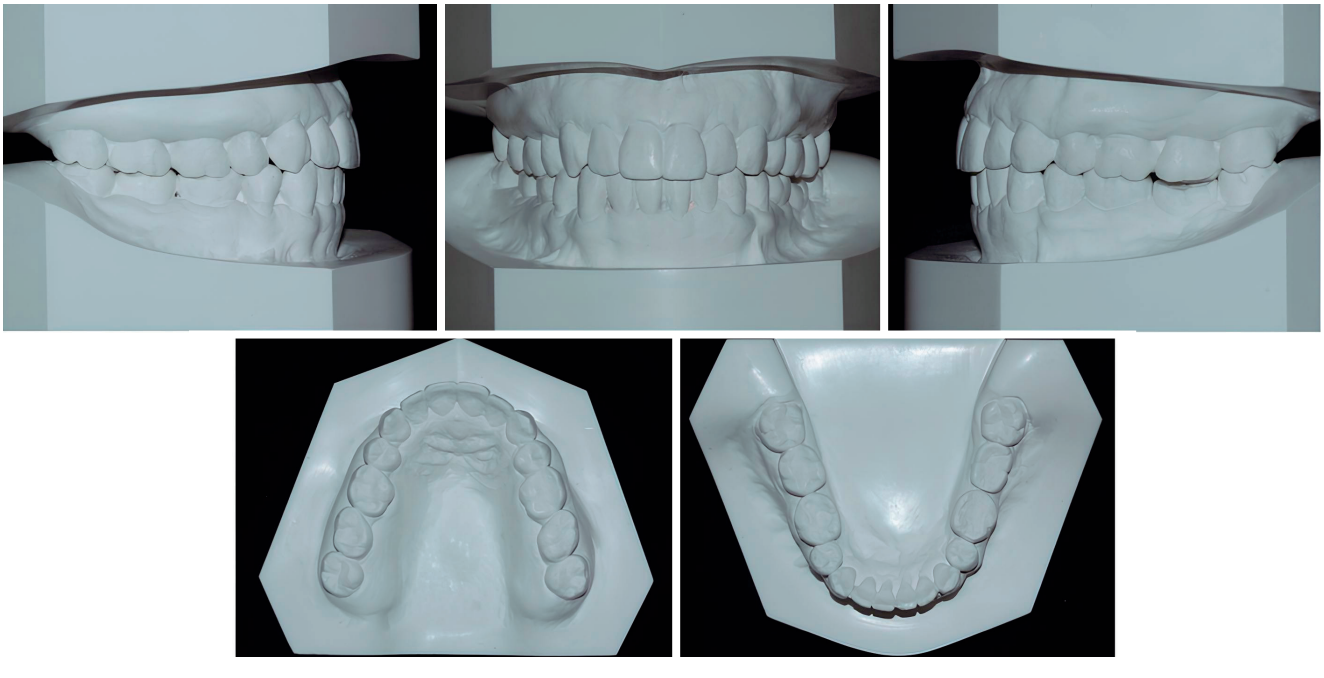

Figure 9 Posttreatment dental models

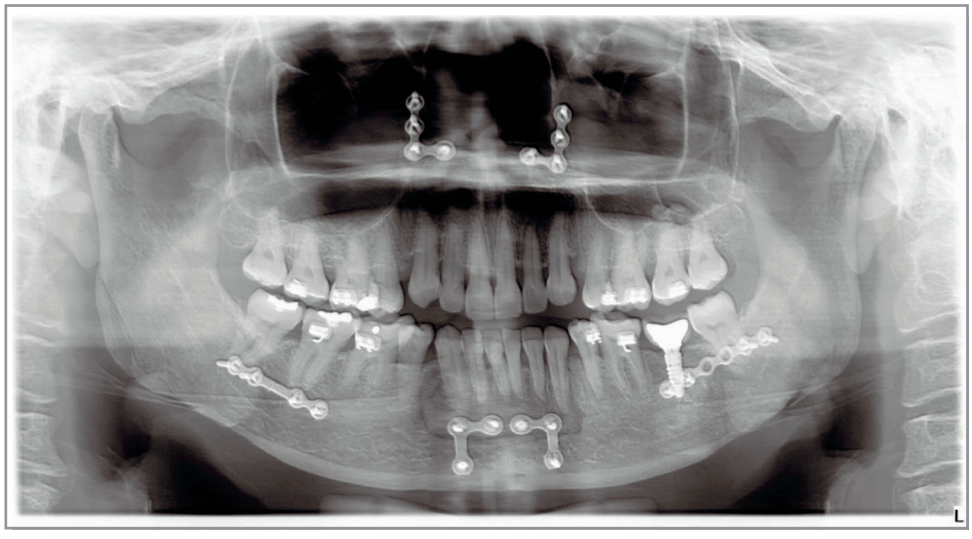

Figure 10 Posttreatment panoramic radiograph

Figure 11 Posttreatment lateral cephalogram

Figure 12 Posttreatment postero-anterior cephalogram

with orthognathic maxilla and mandible while maintaining maxillary plane canting without occlusal plane canting, and no chin deviation (Figures 11 and 12). Table 3 shows the results of the treatment: decreased SNA and increased SNB, improved divergent configuration, dental Class I normally inclined and positioned upper and lower incisors, normal interincisal angle, slightly convex facial profile, normally positioned upper lip but retruded lower lip, and normal nasolabial angle.

The pretreatment and posttreatment cephalometric superimposition tracings are shown in Figure 13. The changes observed were: position of the N point was maintained, the anterior maxilla moved inferiorly backward while the mandible moved forward, the upper and lower incisors had retroclined and retruded, and mesialization of the upper molars but the lower molars had distalized. Compared with pretreatment, the facial profile improved, the upper

Table 3 Comparison of pre and posttreatment cephalometric analyses

Area		Measurement	Norm (Mean ± SD)	Pre treatment	Post treatment	Differences
Skeletal	Maxilla to cranial base	SNA (degree)[15]	84 ± 4	82	80	-2
		SN-PP (degree)[16]	9 ± 3	8	9	+1
	Mandible to cranial base	SNB (degree)[15]	81 ± 4	75	77	+2
		SN-MP (degree)[15]	29 ± 6	38	34	-4
		SN-Pg (degree)[15]	82 ± 3	76	79	+3
		NS-Gn (degree)[15]	68 ± 3	73	70	-3
	Maxillo-mandibular	ANB (degree)[15]	3 ± 2	7	3	-4
		Wits (mm)[14]	-3 ± 2	3	-1	-4
		MP-PP (degree)[15]	21 ± 5	30	25	-5
		FMA (degree)[16]	23 ± 5	29	23	-6
Dental	Maxillary dentition	$\overline{1}$ to NA (degree)[15]	22 ± 6	28	21	-7
		$\overline{1}$ to NA (mm)[15]	5 ± 2	9	4	-5
		$\overline{1}$ to SN (degree)[15]	108 ± 6	108	102.50	-5.50
	Mandibular dentition	$\overline{1}$ to NB (degree)[15]	30 ± 6	42.50	26	-16.50
		$\overline{1}$ to NB (mm)[15]	7 ± 2	14.50	8	-6.50
		$\overline{1}$ to MP (degree)[14]	99 ± 5	109	93	-16
	Maxillo-mandibular	$\underline{1}$ to $\overline{1}$ (degree)[15]	125 ± 8	103	129	+26
Soft tissue	Soft tissue	E line U lip (mm)[16]	-1 ± 2	4	-3	-7
		E line L lip (mm)[16]	2 ± 2	3	-1	-4
		Nasolabial angle (degree)[14]	91 ± 8	84	89	+5
		H-angle (degree)[15]	14 ± 4	25	12.50	-12.50

Figure 13 Cephalometric superimposition of pretreatment (black) and posttreatment (red) tracings.

Figure 14 Extraoral examination at 30 months after debonding

Figure 15 Intraoral examination at 30 months after debonding

lip had retruded, the lower lip had protruded, and the nasolabial angle had increased.

Wraparound retainers were used in both the maxillary and mandibular arches in the retention period. The maxillary arch included a passive anterior bite plane in the wraparound retainer to maintain the vertical dimension.[4,17] The vertical dimension in this case had to be maintained using a retainer with a passive anterior bite plane because initially before treatment the patient had a deep overbite. The patient was instructed to wear both the upper and lower retainers full time except during meals and tooth brushing. The follow-up times were at 1 week, 1 month, and 3 months after debonding, and every 6 months thereafter to evaluate the function, esthetics, and stability.

The patient was recalled at 30 months after completing the treatment. The results found an acceptable profile, occluded occlusion, and no interferences on lateral and protrusive excursion. The protocol of wearing the retainer full-time was followed as requested. She put a lot of emphasis on wearing the retainer to maintain good position of the teeth (Figures 14 and 15).[18]

Discussion

The patient's primary complaint when she arrived at the orthodontic clinic was protruding upper incisors and a gummy smile. On clinical examination, the frontal view showed a symmetrical dolichofacial type, and the lateral view showed a convex profile. The patient had incompetent lips at the rest position. A gummy smile was presented when the patient presented a full smile. In this case, the patient had a Class I molar relationship on both sides. On the other hand, the canine relationship on the right and left sides were Class II canine relationships. The maxillary and mandibular arches presented mild crowding, deep overbite (4 mm), and large overjet (5 mm). The diagnosis was skeletal Class II hyperdivergent pattern with orthognathic maxilla and retrognathic mandible and dental Class II malocclusion with mild crowding of the upper and lower anterior teeth.

This patient had Class II skeletal characteristics with a hyperdivergent pattern and a convex facial profile with a retruded chin and protruded upper lip. The patient had a familial line with protruded upper incisors and a gummy smile. She reported no accidental trauma to the head or face area. Functional shift was not found in the clinical examination. The PA cephalometric analysis showed no chin deviation. The thin symphysis could limit orthodontic tooth movement in the lower incisors. Therefore, the treatment plan was to correct the upper incisor protrusions and gummy smile and improve the facial appearance and her smile. The plan included orthodontic treatment combined with orthognathic surgery. This treatment plan could correct her chief complaint and improve her skeletal structure. Moreover, this procedure had more stability than camouflage treatment by conventional orthodontic treatment.[19]

The gummy smile had a gingival show of 4-5 mm but no posterior gummy smile and no dual occlusal plane combined with an incisal show at rest of 3 mm. These observations indicated that a vertical problem did not cause the gummy smile. Therefore, the gummy smile would be corrected from the relationship between the alveolar bone and the anteroposterior protrusion of the upper incisors. The plan to correct the gummy smile and upper lip protrusion was performed by anterior maxillary osteotomy in the upper jaw combined with alar cinching to correct the wide nasal base. In the maxilla, a retroclined anterior segment was planned. In the mandible, the proclined and protruded lower incisors were corrected by subapical osteotomy setback and tilt back combined with the BSSRO mandibular advancement to achieve a normal position of the upper and lower lips.

Before starting the treatment, the treatment plan was discussed between the orthodontist and the maxillofacial surgeon. The patient was informed of all data, treatment objectives, treatment plan, expected outcome, and complications for a decision by the patient. The advantages of orthodontic treatment combined with orthognathic surgery[20] were 1) improved skeletal and dental conditions, 2) improved facial esthetics, 3) correcting the malocclusion, and 4) more stability than conventional orthodontic treatment. However, the disadvantages of this treatment plan were 1) risk of anesthesia, 2) surgical complications such as numbness, bleeding, or infection, 3) high cost, and 4) possible surgical relapse.[21]

In the presurgical orthodontic phase, the maxillary arch was well aligned in the normal alveolar bone; therefore 0.016 x 0.022-inch SS wire was used. The mild crowding of the mandibular arch was corrected, and the teeth were aligned and finally a 0.016 x 0.022-inch SS wire was used. From the maxillary and mandibular cephalometric superimposition of pre and posttreatment tracings, proclination of the upper and lower incisors was about 1 mm, but the upper and lower posterior teeth were in the same position. Extraction of the upper and lower first premolars, except for the lower right first premolar, was then planned.

A comparison of the clinical and lateral radiographic outcomes before and after treatment

was performed. Skeletal position showed the anterior segment of the maxilla (2 mm retraction) and mandible (3 mm retraction) were retracted. The mandible was advanced 4 mm to reduce the Class II skeletal relationship. Dental position showed Class I molar relationship on both sides was achieved with good intercuspation. The canine relationship was Class II 1-2 mm but there was a good cusp to fossa relationship with no occlusal interference. Canine guidance was achieved during eccentric movement with normal overjet and overbite. The patient accepted all treatment outcomes. Soft tissue position showed the upper lip was retracted into a normal position. The nasolabial angle had increased. Retraction of the lower lip improved the esthetics and chin position. The gummy smile was corrected to a normal smile line. The lateral profile improved while the vertical proportion was maintained.[20,22]

The following factors contributed to the favorable prognosis.[23,24] Normal overjet and overbite was achieved after treatment with maximum intercuspation, and the patient had no abnormal oral habits. During treatment, the intercanine and intermolar width were maintained. Coordinating the upper and lower arch was performed to maintain the dental position to reduce transversal relapse.[24] The patient's compliance was high, and she had a positive attitude regarding her orthodontic therapy. The selected surgical procedure was stable, and no relapse after surgery occurred.

During the retention period, the upper and lower wraparound retainers were introduced to the patient because these appliances would not cause occlusal interference. The patient was instructed to reduce the duration and frequency of wearing the retainer as dental stability increased.[25] After treatment, follow-up should be conducted at 1 week, 1 and 3 months, and every 6 months thereafter until there is no relapse and every year thereafter.

Conclusion

In this case, good treatment outcomes were achieved by orthodontic treatment combined with two-jaw orthognathic surgery to correct the upper lip protrusion and gummy smile. The patient had a normal smile line and a better lateral profile. She was satisfied with the results of the treatment and smiled with more confidence. The treatment resulted in maintaining good occlusion, no dental interference when performing eccentric movement, normal overjet and overbite, and normal interincisal angle.

Author contributions

TS: Original draft preparation, Manuscript review and editing; SP: Original draft preparation, Manuscript review and editing; and CK: Resources.

Ethical statement

The patiant's consent was obtained before publication.

Disclosure statement

Authors have no the conflict of interest.

References

1. Kiekens RM, Maltha JC, Hof MA, Kuijpers-Jagtman AM. Objective measures as indicators for facial esthetics in white adolescents. Angle Orthod 2006;76(4):551-6.
2. De Ridder L, Aleksieva A, Willems G, Declerck D, Cadenas De Llano-Pérula M. Prevalence of orthodontic malocclusions in healthy children and adolescents: a systematic review. Int J Environ Res Public Health 2022;19(12):7446.
3. Tehranchi A, Behnia H, Younessian F, Hadadpour S. Advances in management of Class II malocclusions. In: Motamedi MHK, editor. A textbook of advanced oral and maxillofacial surgery. Rijeka: Intech; 2016.p.20.
4. Bishara SE. Class II malocclusions: diagnostic and clinical considerations with and without treatment. Semin Orthod 2006;12(1):11-24.
5. Dym H, Pierre R. Diagnosis and treatment approaches to a "gummy smile". Dent Clin North Am 2020;64(2):341-9.

6. Pongsupot S, Suntornlohanakul S. Comparison of Class II malocclusion characteristics. Thai J Orthod 2020;8(2):25-32.
7. Arnett GW, Gunson MJ. Facial planning for orthodontists and oral surgeons. Am J Orthod Dentofacial Orthop 2004;126(3):290-5.
8. Basciftci FA, Usumez S. Effects of extraction and nonextraction treatment on Class I and Class II subjects. Angle Orthod 2003;73(1):36-42.
9. Demir A, Uysal T, Sari Z, Basciftci FA. Effects of camouflage treatment on dentofacial structures in Class II division 1 mandibular retrognathic patients. Eur J Orthod 2005;27(5):524-31.
10. Khechoyan DY. Orthognathic surgery: general considerations. Semin Plast Surg 2013;27(3):133-6.
11. Al-Moraissi EA, Wolford LM, Perez D, Laskin DM, Ellis E. Does orthognathic surgery cause or cure temporomandibular disorders? a systematic review and meta-analysis. J Oral Maxillofac Surg 2017;75(9):1835-47.
12. Chintawongvanich J, Thongudomporn U. Arch dimension and tooth size in Class I malocclusion patients with anterior crossbite. J Dent Assoc Thai 2013;63(1):31-8.
13. Sisman Y, Ertas ET, Ertas H, Sekerci AE. The frequency and distribution of idiopathic osteosclerosis of the jaw. Eur J Dent 2011;5(4):409-14.
14. Sorathesn K. Craniofacial norm for Thai in combined orthodontic surgical procedure. J Dent Assoc Thai 1988;38(5):190-201.
15. Suchato W, Chaiwat J. Cephalometric evaluation of the dentofacial complex of Thai adults. J Dent Assoc Thai 1984;34(5):233-43.
16. Dachkunakron S. Thai adult norms in various lateral cephalometric analyses. J Dent Assoc Thai 1994;44(5):202-14.
17. Rinchuse DJ, Miles PG, Sheridan JJ. Orthodontic retention and stability: a clinical perspective. J Clin Orthod 2007;41(3):125-32.
18. Schott TC, Schlipf C, Glasl B, Schwarzer CL, Weber J, Ludwig B. Quantification of patient compliance with hawley retainers and removable functional appliances during the retention phase. Am J Orthod Dentofacial Orthop 2013;144(4):533-40.
19. Proffit WR, Fields HW, Larson B, Sarver DM. Contemporary orthodontics. 6th ed. Philadelphia: Elsevier; 2018.p.664-7.
20. Bousaba S, Siciliano S, Delatte M, Faes J, Reychler H. Indications for orthognathic surgery, the limitations of orthodontics and of surgery. Rev Belge Med Dent (1984) 2002;57(1):9-23.
21. Kim YK. Complications associated with orthognathic surgery. J Korean Assoc Oral Maxillofac Surg 2017;43(1):3-15.
22. Broers DLM, van der Heijden G, Rozema FR, de Jongh A. Do patients benefit from orthognathic surgery? a systematic review on the effects of elective orthognathic surgery on psychosocial functioning and patient satisfaction. Eur J Oral Sci 2017;125(6):411-8.
23. Al-Moghrabi D, Barber S, Fleming PS. Removable retention: enhancing adherence and the remit of shared decision-making. Br Dent J 2021;230(11):765-9.
24. Kartal Y, Kaya B. Fixed orthodontic retainers: a review. Turk J Orthod 2019;32(2):110-4.
25. Mollov ND, Lindauer SJ, Best AM, Shroff B, Tufekci E. Patient attitudes toward retention and perceptions of treatment success. Angle Orthod 2010;80(4):468-73.