รายงานผู้ป่วย
Case Report

Corticotomy-Assisted Rapid Maxillary Expansion in Thai Adult Patient with Maxillary Transverse Discrepancy due to the Skeletal Malunion: A Case Report

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Abstract

This case report describes a 24-year old Thai male patient with misaligned teeth as a chief complaint. The major findings were maxillary transverse discrepancy with bilateral posterior crossbite, multiple tooth losses and collapsed maxillary arches due to a history of compounded fractures after a motorcycle accident and maxillary/mandibular malunion after surgical treatment with internal fixations. A multidisciplinary treatment plan was designed, agreed upon by the patient and implemented. An approach of corticotomy-assisted rapid maxillary expansion, using conventional corticotomy with a bone graft and Hyrax appliance as a maxillary expander, was performed. The Hyrax was actively expanded for 5 rounds (1 mm) per week for 8 weeks after the corticotomy. After which, a fixed orthodontic appliance (bidimensional edgewise appliance) was inserted for 6 weeks. Total duration of the treatment plan was 26 months to achieve: (1) a satisfactory intra-arch alignment, (2) sufficient interproximal spaces for final restorations, and (3) an acceptable inter-arch relationship in every spatial dimension. The outcomes of this case report can reassure dental clinicians that these complex maxillary and mandibular malunion scenarios in skeletal transverse discrepancies can be reversed with this comprehensive treatment protocol combining corticotomy with orthodontic treatment.

Keywords: Fixed orthodontic appliances, Hyraxes, Palatal expansion technique

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Introduction

Common clinical features of maxillary transverse discrepancies manifest as either a unilateral or bilateral posterior crossbite.[1,2] There are several orthodontic techniques to tackle these discrepancies including slow and rapid maxillary expansion.[3,4] Moreover, some surgical procedures have been performed to break the surrounding sutures, then expand the palate surgically (segmental Le Fort I osteotomy) or orthodontically (surgically assisted rapid palatal expansion; SARPE).[5,6] The indication for each technique depends on several factors i.e., amount of expansion, skeletal maturity, vertical pattern and posterior tooth inclination.[7] In adult patients with maxillary transverse discrepancy, Le Fort I expansion and SARPE are indicated. Though the segmental Le Fort I osteotomy is predictable and commonly used to correct maxillary transverse discrepancies up to 7-8 mm in adults,[6] it is usually associated with postsurgical instability and relapse.[8] Therefore, an overexpansion strategy is recommended.[6,8] The other surgical procedure, SARPE, has become more common for treating adult patients as it provides a better stability.[9] However, some drawbacks were found in this technique including long duration of treatment, invasiveness, and buccal periodontal attachment loss.[10-12]

In 1959, corticotomy was introduced as an alternative surgical procedure to assist orthodontic treatment.[13] In 1975, it was first used to assist maxillary expansion.[14] The objective of corticotomy was to reduce the resistance of cortical bone, facilitate the inflammatory response and increase bone turnover rate to accelerate orthodontic tooth movement, also named accelerated osteogenic orthodontics (AOO) or periodontally accelerated osteogenic orthodontics (PAOO).[15,16] Moreover, particulate bone graft can be added in the surgical side to prevent a reduction of periodontium.[16] A recent study uses piezo-bone perforation as a corticotomy technique in a skeletally mature Moroccan patient with a 9-mm maxillomandibular transverse differential index.[17] A fixed palatal expander was inserted immediately after the corticotomy. It was activated 1 mm weekly for 8 weeks and maintained for another 2 months. At the end of treatment, the maxillary transverse width could be expanded for up to 10 mm Treatment outcomes were stable for 3 years. The aim of this case report was to perform a corticotomy-assisted rapid maxillary expansion on Thai patient with a complex maxillary transverse discrepancy.

Case report

The patient was a 24-year-old Thai male with chief complaints of misaligned teeth. His medical history records reported a previous motorcycle accident (5 years ago) with loss of several teeth and multiple craniofacial bone fractures, including the zygoma, maxilla and mandible. Surgical fixation of all fracture sites and extraction of all unrestorable teeth was performed under general anesthesia by the medical surgeon in Prince of Songkla University Hospital. Afterwards, all remained affected teeth were treated following a comprehensive plan, which included dental fillings, root canal treatment and intermediate restorations.

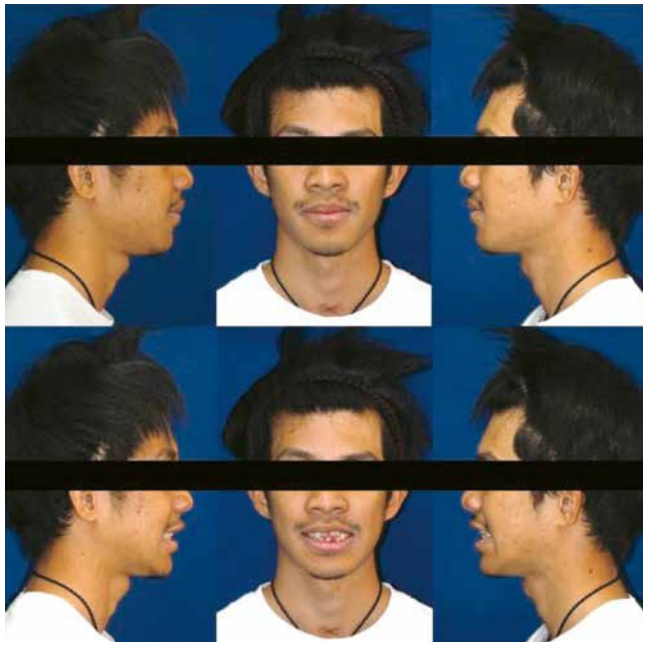

Figure 1 Pretreatment extraoral examination

Figure 2 Pretreatment intraoral examination

Extraoral examination showed unbalanced and asymmetrical dolichofacial type with a 3 mm chin deviation to the left, occlusal plane canting down at the right, nasal ridge deviation and a low smile line (Figure 1). His facial profile was a slightly convex profile with a normal nasolabial angle. No signs or symptoms of temporomandibular joint disorders were noted.

The intraoral examination indicated a fair oral hygiene (Figure 2). Mucosal scars were presented at mid palatal area. Asymmetrical arch shape was found due to a malunion of left and right maxilla. Tooth number 21, 31, 41, 37, 38, 48 18 and 28 were missing. Tooth number 11, 32, 42 and 43 were mesially tipped into the edentulous area. Tooth number 11 was restored with tooth color-liked material around half of the actual inciso-cervical size. Teeth number 32 and 43 were partially dentin fractured. The incomplete crown structures made the actual assessments for overjet, overbite and midline deviation challenging. The major malocclusal discrepancy was the bilateral posterior crossbite at tooth numbers 23-27/32-36 and 16-17/47. Molar relationships were Class III 7.5 mm on the right and Class II 6 mm on the left.

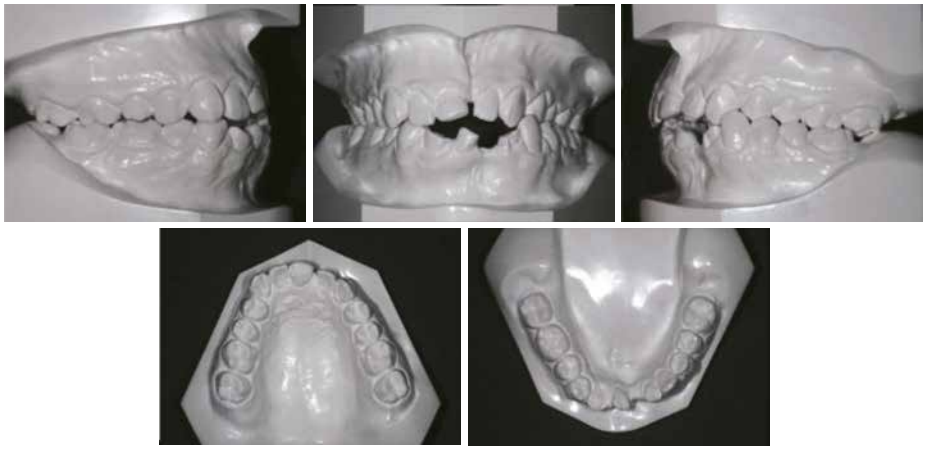

Figure 3 Pretreatment dental cast

Table 1 Pretreatment Korkhaus' analysis

Type	Upper		Lower	
	Thai norm[18]	Pretreatment	Thai norm[18]	Pretreatment
Arch height (mm)	19.1 ± 2.4	23	17.3 ± 2.3	20
Anterior arch width (mm)	36.4 ± 1.9	43	36.2 ± 2.1	40
Posterior arch width (mm)	46.8 ± 2.2	48	45.7 ± 2.2	56

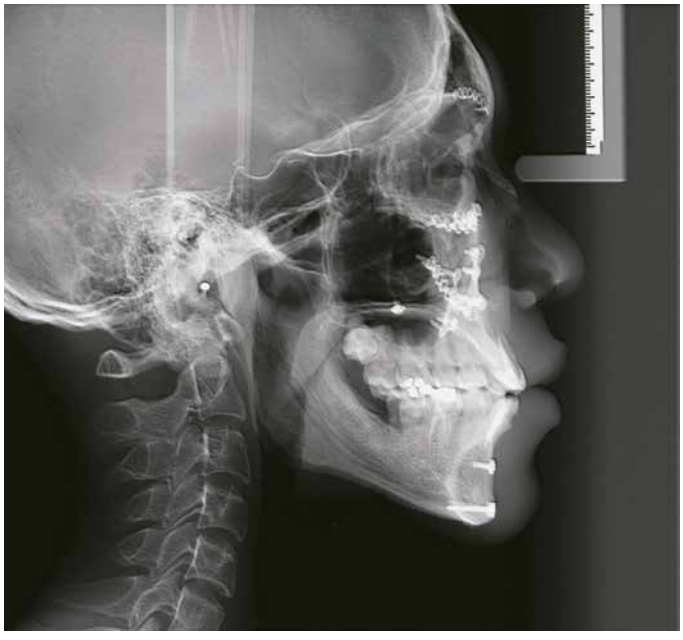

Figure 4 Pretreatment lateral cephalogram

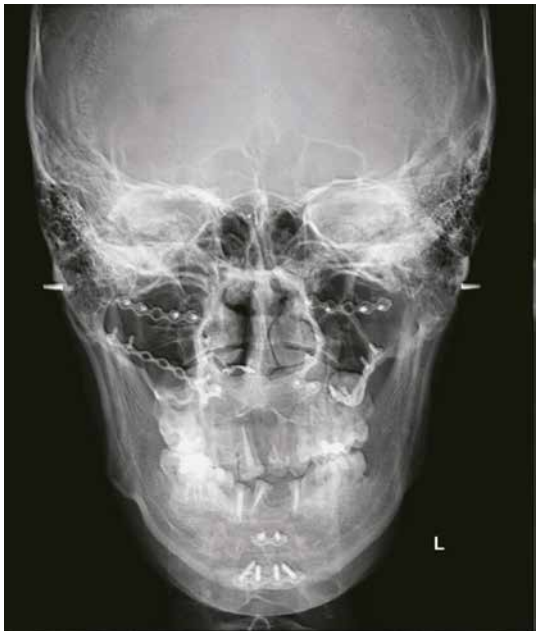

Figure 5 Pretreatment postero-anterior cephalogram

Table 2 Pretreatment cephalometric analysis

Area		Measurement	Norm Mean±SD	Pretreatment	Interpretation
Skeletal	SN Plane	FH-SN (degree)	6±3	10	Steep SN plane
	Maxilla to Cranial base	SNA (degree) SN-PP (degree)	84±4 9±3	83 7	Orthognathic maxilla Normal inclination of maxilla
	Mandible to Cranial base	SNB (degree) SN-MP (degree) SN-Pg (degree) NS-Gn (degree)	81±4 29±6 82±3 68±3	80 33 80.5 68	Orthognathic mandible Normodivergent pattern Orthognathic mandible Normodivergent pattern
	Maxillo-Mandibular	ANB (degree) Wits (mm) MP-PP (degree) FMA (degree)	3±2 -3±2 21±5 23±5	3 4 26 23	Skeletal Class I Skeletal Class II Normodivergent pattern Normodivergent pattern
Dental	Maxillary dentition	1 to NA (degree) 1 to NA (mm) 1 to SN (degree)	22±6 5±2 108±6	16 6 99	Normally inclined upper incisor Normally positioned upper incisor Retroclined upper incisor
	Mandibular dentition	ī to NB (degree) ī to NB (mm) ī to MP (degree)	30±6 7±2 99±5	30 8.5 98	Normally inclined lower incisor Normally positioned lower incisor Normally inclined lower incisor
	Maxillo-Mandibular	1 to ī(degree)	125±8	131	Normal interincisal angle
Soft tissue	Soft tissue	E line U. lip (mm) E line L. lip (mm) Nasolabial angle (degree) H-angle (degree)	-1±2 2±2 91±8 14±4	0 2 86 15	Normally positioned upper lip Normally positioned lower lip Normal nasolabial angle Normally positioned upper lip

Figure 6 Pretreatment panoramic radiograph

Analysis of the dental casts (Figure 3) confirmed the intraoral examination. In addition, the anterior and posterior arch widths presented a narrower maxilla for 3 and 8 mm respectively (Table 1). In comparison with Thai norm[19-21], the cephalometric analysis was as follow (Figure 4, Table 2); Skeletal Class I normodivergent pattern with orthognathic maxilla and mandible, normally inclined and positioned upper and lower (tooth number 42) incisors, normal interincisal angle, normally positioned upper and lower lips and normal nasolabial angle. The Grummon's analysis of postero-anterior cephalogram (Figure 5) showed maxillary canting (right side is 6 mm lower than left), occlusal plane canting (right side is 1.5 mm lower than the left), right ramus of mandible was longer, left body of mandible was slightly longer and chin had a 3 mm deviation to the left. Panoramic radiograph (Figure 6) showed maxillary sinus pneumatization adjacent to the posterior tooth roots, normal bone density and trabeculation, symmetrical mandibular condyles, upper left and right third molars bony impaction with completed root formation, missing teeth (31, 37, 38, 41 and 48), root canal treatments (on 11, 32, 42, 43 and 46), metal plates and screws at both sides of zygoma, maxillary and mandibular symphysis and no visible pathology.

The ideal treatment plan in this case was found to be orthodontic treatment combined with orthognathic surgery (both maxillary and mandibular) to correct skeletal problems which were expand and relocate the left and right part of maxilla which were previously malunion, and mandibular osteotomy to correct left jaw deviation. However, this patient didn't concern about the total facial appearance. Moreover, he rejected any major surgical procedure along with this orthodontic treatment. So, the treatment objectives in this case were to align all teeth, fulfill edentulous area with prosthesis, restore the fractured teeth and correct transverse discrepancy with alternative treatment protocol, the corticotomy-assisted rapid maxillary expansion, other than major surgical procedure to obtain normal intra-arch and inter-arch relationship.

To be specific, the space at upper left central incisor would be gained from rapid palatal expansion in the upper arch. When consider the initial occlusion, intercuspation on both left and right side is almost acceptable; nearly Class III full cusp relationship on the right and nearly Class II full cusp on the left. So, the substitution of dental position; tooth number 44 as lower right canine, number 33 as lower left first premolar, was contemplated. In addition, the required

Figure 7 Corticotomy procedure

Figure 8 Hyrax appliance

space of lower anterior teeth could be fulfilled by only one incisor-sized prosthesis, so, only 5 teeth (remained tooth number 32, 42, 43, 44 and 1 prosthesis) would represent lower anterior teeth at the end of treatment. This reduced number of teeth inevitably resulted in reduction of Bolton's discrepancy; the size of lower anterior teeth was proportionally smaller than the upper anterior teeth. To compensate this discrepancy and obtain normal overjet, the size of prosthesis at lower incisor area and the final restoration of 32, 42 and 43 should be bigger than normal.

The corticotomy-assisted rapid maxillary expansion was proposed to resolve the severe maxillary constriction while minimizing the drawbacks on the periodontium. Our protocol adapted from previous techniques[17] with some modifications to suit the treatment objective in this case. In pre-orthodontic phase, the patient was referred for scaling, upper third molars removal and intermediate restoration on teeth number 42 and 43 with temporary resin composite crowns to create labial bonding surface. The orthodontic bands were tried in upper first premolars and first molars for Hyrax fabrication. After that, corticotomy was performed by a team of oral and maxilla-facial surgeons. The full thickness flap was done under local anesthesia. The maxillary surrounding plates and screws were removed. Then, circular cortications of 0.5 to 1 mm depth with carbide round bur were performed at both buccal and palatal sides (Figure 7). After that, the particle demineralized freeze-dried allograft bones were used to augment all corticated area.

After suture removal, the Hyrax was inserted and expansion was initiated immediately (Figure 8). Activation of such expansion started with 5 rounds (1 mm) per week for a total of 8 weeks. If posterior crossbite was found to be overcorrected, the expansion screw was locked by applying light-cured compomer (Figure 9). After 6 weeks with Hyrax appliance stabilization, bi-dimensional preadjusted edgewise appliances (slot 0.018" at incisors and slot 0.022" at all remains) were bonded and leveling phase was started with 0.012" followed by 0.016" nickel-titanium wires on both arches. After 6 months, the Hyrax was removed and tooth number 14, 16, 24 and 26 were re-bonded with a bi-dimensional bracket system (slot 0.022"). In the movement phase, stainless steel arch wires were used (0.016", 0.016"x0.016" and 0.016"x0.022"). When the

Figure 9 Maintaining the Hyrax appliance

interproximal spaces at the upper and lower left central incisors were satisfactory, dental prostheses were bonded to the brackets to address esthetical concerns. Eventually, 0.016”x0.022” stainless steel arch wires with torque and artistic bend were used at the finishing phase to align all teeth within a harmonized arch shape and establish a satisfactory and well-balanced intercuspation. After 26 months of active treatment, all treatment plan objectives were met and attained. The appliances were removed, and upper and lower wrap-around retainers were placed on both arches.

Figure 10 Posttreatment extraoral examination

Figure 11 Posttreatment intraoral examination

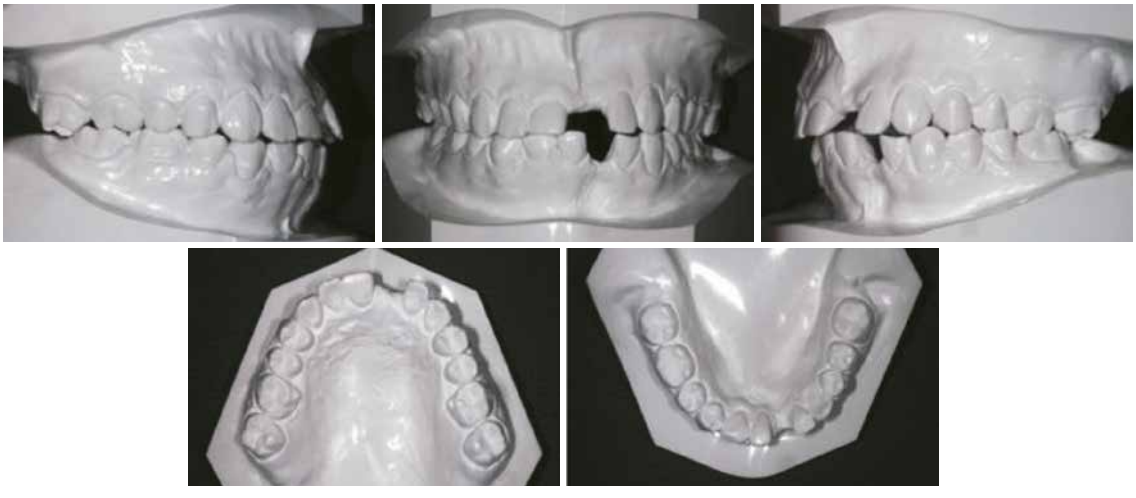

Figure 12 Posttreatment dental cast

Figure 13 Posttreatment panoramic radiograph

Figure 14 Posttreatment lateral cephalogram

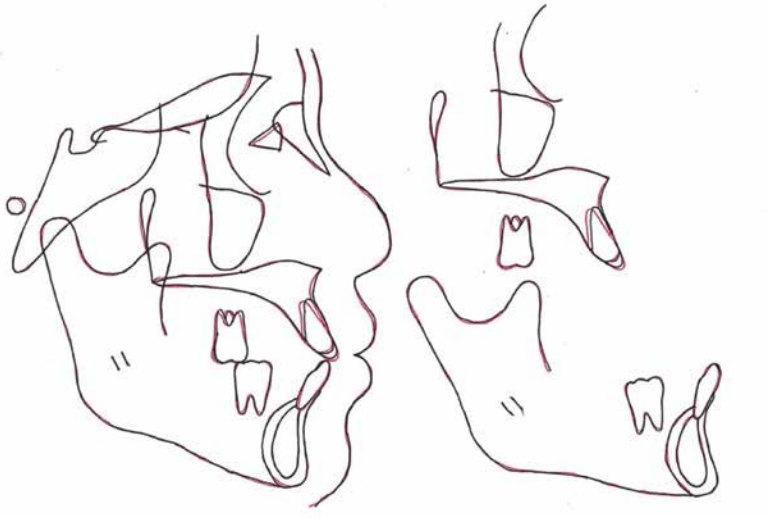

Figure 15 Lateral cephalometric superimposition

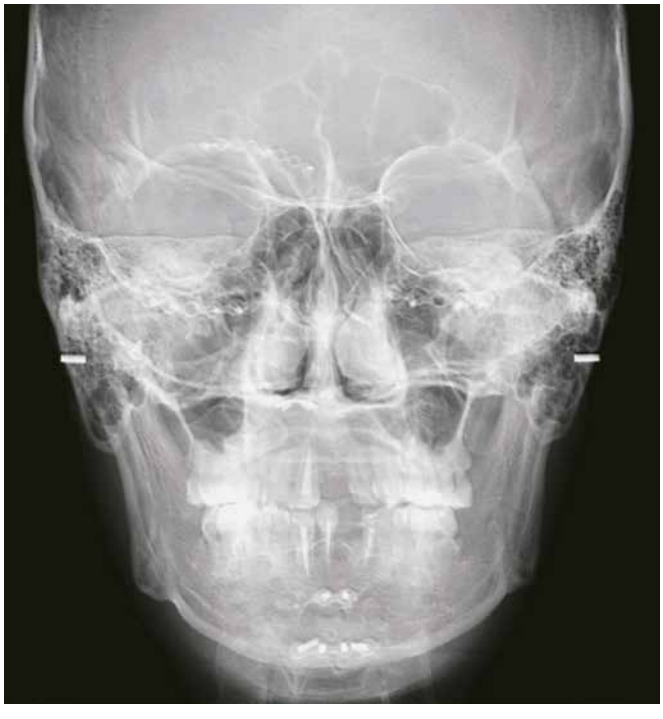

Figure 16 Posttreatment postero-anterior cephalogram

Table 3 Comparison of pre- and posttreatment cephalometric analysis

Area		Measurement	Norm Mean±SD	Pre treatment	Post treatment	Differences
Skeletal	SN Plane	FH-SN (degree)	6±3	10	10	0
	Maxilla to Cranial base	SNA (degree) SN-PP (degree)	84±4 9±3	83 7	82.5 7	-0.5 0
	Mandible to Cranial base	SNB (degree) SN-MP (degree) SN-Pg (degree) NS-Gn (degree)	81±4 29±6 82±3 68±3	80 33 80.5 68	80 33 80.5 68	0 0 0 0
	Maxillo-Mandibular	ANB (degree) Wits (mm) MP-PP (degree) FMA (degree)	3±2 -3±2 21±5 23±5	3 4 26 23	2.5 4 26 23	-0.5 0 0 0
Dental	Maxillary dentition	1 to NA (degree) 1 to NA (mm) 1 to SN (degree)	22±6 5±2 108±6	16 6 99	20 6.5 102	+4 +0.5 +3
	Mandibular dentition	ī to NB (degree) ī to NB (mm) ī to MP (degree)	30±6 7±2 99±5	30 8.5 98	30 8.5 98	0 0 0
	Maxillo-Mandibular	1 to ī(degree)	125±8	131	128	-3
Soft tissue	Soft tissue	E line U. lip (mm) E line L. lip (mm) Nasolabial angle (degree) H-angle (degree)	-1±2 2±2 91±8 14±4	0 2 86 15	0 2 86 15	0 0 0 0

Table 4 Comparison of pre- and posttreatment dental cast analysis

		Pretreatment	Posttreatment
Overjet		2 mm	3 mm
Overbite		-2 mm	0.5 mm
Canine relationship	Right	Class II 2.5 mm	Class II 2 mm
	Left	Class I	Class I
Molar relationship	Right	Class III 7.5 mm	Class III 7 mm
	Left	Class II 6 mm	Class II 7 mm
Upper	Midline	Shifted to the left 1.5 mm	Center
	Arch form	V-shaped	Paraboloid-shaped
	Intercanine width	30 mm	37 mm
	Intermolar width	48 mm	53 mm
Lower	Midline	Shifted to the left 3 mm	Shifted to the left 4 mm
	Arch form	V-shaped	Paraboloid-shaped
	Intercanine width	25 mm	25 mm
	Intermolar width	56 mm	56 mm

At the completion of all treatment steps, the extraoral examination indicated that the facial appearance had changed (Figure 10). The patient was happy and was confident to smile. The intraoral examination and the dental casts showed well-aligned upper and lower teeth. The transverse discrepancy was corrected. The upper dental midline coincided with the facial midline. Class I canine relationship on the left and slightly Class II canine relationship on the right were obtained. Proper overjet and overbite were acceptable before referring patient to perform final restorations (on 11, 22, 32, 42, 43) and placement of dental prostheses to replace upper and lower left central incisors (Figure 11 and 12). Lateral excursions demonstrated group function with no working or balancing interferences. The panoramic radiograph showed root parallelism with no significant root resorption or obvious alveolar bone loss (Figure 13). The cephalometric analysis and superimposition (Figure 14, 15; Table 3) showed no change in maxilla, mandible, lower anterior facial height, mandibular plane angle, molar position, lower incisor position and inclination. The Grummon's analysis of postero-anterior cephalogram (Figure 16) showed maintained maxillary canting (right side is 6 mm lower than left), occlusal plane canting (right side is 1.5 mm lower than the left) and chin deviation to the left 3 mm Root of the upper right central incisor was torqued palatally following by a slightly retrusive of point A (subnasale). Maxillary dentition dramatically changed in terms of transverse width (Table 4).

Discussion

The treatment of maxillary transverse discrepancies in adult patients is challenging and complex to treat.[22] When the discrepancy is greater than 5 mm, the surgical assisted procedure may be required.[7] Other than SARPE, a previous report suggested corticotomy-assisted maxillary expansion as an alternative treatment option for up to 10 mm of maxillary transverse discrepancy.[17] The challenges in this case, other than a large amount of transverse discrepancy, were related to the postsurgical bone and tissue healing after the motorcycle accident. The tissue healing challenges included malunions in the maxilla and mandible, multiple tooth losses and abnormal tissue scarring especially at midpalatal area. Moreover, the patient rejected any major surgical procedure with general anesthesia along this orthodontic treatment. In order to overcome the above, a comprehensive stepwise treatment plan was considered. The goals of corticotomy in this case were to accelerate tooth movement during rapid palatal expansion and to gain adequate buccal bone support from bone augmentation. In addition, the activation of Hyrax was performed as soon as it could be inserted to maximize the effects of PAOO.[15,16] A bone augmentation during the corticotomy was recommended[23] to conserve the buccal periodontium. Though a previous study found an increased risk for gingival recession at canines, premolars and molars after orthodontic treatment,[24] there was no obvious buccal gingival recession found around teeth in this particular case.

The consideration of substitution at canine area are gingival zenith and color of the tooth.[25] In this case, these wouldn't be major issues because the area of substitution was at the lower arch that could hardly be seen. Another consideration was occlusal scheme, it is still inconclusive whether canine guidance, premolar guidance or group function is the best functional occlusion.[26] However, the group function was planned as a final occlusal scheme in this case in order to distribute the force on all posterior teeth not only on the substituted teeth at canine areas during lateral excursion.

During the debonding procedure, the intermediate restoration at upper right central incisor was dislodged. With many limitations during the COVID-19 pandemic period, the new intermediate restoration was slightly unfitted with the retainer. Moreover, due to the limited transportation at that time, the patient was unavailable to make an appointment

with the prosthodontist for a proper restoration with a dental crown. However, the newly made intermediate restoration was acceptable with both esthetic and function, so, the final restoration wasn't considered urgent and was therefore postponed.

At the completion of all treatment steps, all teeth were well-aligned, all edentulous areas were properly prepared for further prostheses and the normal occlusion was obtained. The abnormal size of the remaining lower anterior teeth will be corrected by restorative dentistry as planned. The patient's confidence was improved as indicated by the normal smile line post-treatment. According to lateral cephalometric superimposition, there was no change of antero-posterior and vertical relationship of maxilla and mandible except the subnasale point, which was retracted along the roots of the upper incisors (Figure 15). Though previous studies showed some degree of mandibular backward rotation after RPE,[27,28] the mandibular plane (FMA) in this patient was maintained. Also, a previous case report using a similar treatment approach still showed 1 degree of increased FMA after treatment but decreased into the initial FMA at the 3rd year follow-up visit.[17] This phenomenon can be explained by the intercuspation of the posterior teeth. Before treatment, both the bilateral posterior crossbite and the intercuspation was present. Similarly, the cusp to fossa relationship was also observed after treatment completion. The backward mandibular rotation might occur during the RPE in which the cusps of posterior teeth interfered intercuspal position represented by anterior openbite (Figure 16). However, no lateral cephalogram was taken during that time. In addition, the palatal cusps of upper posterior teeth were not extruded. The presence of such posterior extrusion can interfere with the occlusion if mandibular backward rotation is expected.

There were no major changes in the dentoalveolar areas according to the cephalometric superimposition except for the palatal root torque of upper right central incisor. The later was relevant towards obtaining an improved incisor inclination and interincisal angle. Though the right canine relationship was nearly a Class II post-treatment, the posterior teeth achieved an acceptable intercuspation and the patient was satisfied with the outcomes. However, there an increased overjet and lowed overbite measurements because final incisor restorations were not completed.

In retention phase (Figure 16), the upper and lower wrap-around retainers were used due to no occlusal part that could interrupt spontaneous eruption of posterior teeth to be more intercuspation.[29] Nevertheless, the occlusal rests at left and right upper second molars were placed in the upper retainer to prevent the extrusion of these nearly non-functional teeth[30] until the opposing denture would be made. The proper dental prostheses at upper and lower left central incisors were attached to the retainers for esthetic reasons and for maintaining space before final protheses were fabricated. A recommendation for new retainers was suggested to the patient after the final restorations and prostheses were done to ensure the best fit in the retention phase.

This case had a good prognosis because of the following reasons: 1) stable post-treatment intercuspation; 2) no abnormal oral habits; and 3) good patient compliance and attitude during orthodontic treatment. Though the amount of expansion in the maxilla was large (7 mm of inter-canine width and 5 mm of inter-molar width), Little et al. found only a few relationships between the amount of expansion and post-retention alignment.[31] Moreover, a previous study with similar treatment approach showed an acceptable stability after 3 years of follow-up.[17]

Including a bone perforation step with additional bone particulate grafting appeared to be an efficient strategy to treat individuals with history of complex fractures and malunions in the maxillary and mandibular regions. The presented clinical outcomes can reassure dental clinicians that these complex and multiple malunion scenarios skeletal transverse discrepancies can be reversed and patient satisfaction achieved

if a comprehensive treatment protocol combining corticotomy with an orthodontic-driven arch expansion is pursued.

Conclusion

Herein, we reported a successful corticotomy-assisted orthodontic treatment of a Thai adult patient with complex maxillary transverse discrepancy combined with maxillary and mandibular postsurgical malunions. Treatment outcome parameters indicated a satisfactory intra-arch alignment, sufficient space for final restorations and acceptable inter-arch relationships. The multidisciplinary management of such a complex case involved dental experts from orthodontics, maxillofacial surgery, prosthodontics and restorative dentistry and all contributed to its success.

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