Miniscrew-assisted nonsurgical palatal expansion before orthognathic surgery for a patient with severe mandibular prognathism

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A transverse maxillary deficiency in an adult is a challenging problem, especially when it is combined with a severe anteroposterior jaw discrepancy. The demand for nonsurgical maxillary expansion might increase as patients and clinicians try to avoid a 2-stage surgical procedure—surgically assisted rapid palatal expansion followed by orthognathic surgery—and detrimental periodontal effects and relapse. In this regard, a miniscrew-assisted rapid palatal expansion was devised and used to treat a 20-year-old patient who had severe transverse discrepancy and mandibular prognathism. Sufficient maxillary orthopedic expansion with minimal tipping of the buccal segment was achieved preoperatively, and orthognathic surgery corrected the anteroposterior discrepancy. The periodontal soundness and short-term stability of the maxillary expansion were confirmed both clinically and radiologically. Effective incorporation of orthodontic miniscrews for transverse correction might help eliminate the need for some surgical procedures in patients with complex craniofacial discrepancies by securing the safety and stability of the treatment, assuming that the suture is still patent. (Am J Orthod Dentofacial Orthop 2010;137:830-9)

Transverse maxillary deficiency is a relatively common clinical problem. It has been reported that 9.4% of whole populations and nearly 30% of adult orthodontic patients have a maxillary transverse deficiency related to a posterior crossbite.1,2 Although rapid palatal expansion (RPE) has been a reliable treatment modality in prepubertal patients, there have been controversies regarding nonsurgical expansion in adults.3 Surgically assisted RPE (SARPE) has been the treatment of choice to resolve the high resistance from the bony palate and the zygomatic buttress,4 in contrast to reports of successful nonsurgical expansion in young adults.5,6 The difficulties in dealing with the transverse discrepancy are associated with the limited range of tooth movement in the transverse dimension, described by Proffit et al2 as the “transverse envelope of discrepancy.”

Maxillary constriction combined with severe anteroposterior discrepancy is challenging, because it usually requires 2 surgeries: SARPE followed by orthognathic surgery. Since many patients are reluctant to undergo multiple surgical procedures, the demand for nonsurgical treatment might increase. However, even though nonsurgical palatal expansion is feasible, ample orthopedic expansion of the basal bone rather than dentoalveolar tipping is essential to prevent detrimental periodontal effects such as bony dehiscence and to establish proper posterior occlusion.7 In this regard, the appliance should be designed appropriately to maximize the skeletal effects.

Since conventional rapid palatal expanders that are either tooth-borne (hyrax type) or tooth-and-tissue-borne (Haas type) cause questionable effects on the basal bone, a rigid element that delivers the expansion force directly to the basal bone could be a solution. For this purpose, a miniscrew-assisted rapid palatal expander (MARPE) was designed and used in an adult patient. This case report shows the treatment effects and stability of the MARPE in a patient with severe maxillary constriction and mandibular prognathism.

DIAGNOSIS

A 20-year-old man had severe mandibular prognathism. His past medical and dental histories were not...
remarkable. Initial intraoral and extraoral views showed a severe Class III malocclusion and a concave profile with a protrusive mandible and a retrusive maxilla (Fig 1). The severe bilateral buccal crossbite was associated with relative constriction of the maxilla (Fig 2). The crossbite remained when the casts were repositioned to a Class I molar relationship, indicating an absolute transverse deficiency. Maxillary and mandibular intermolar widths were 42.0 and 44.5 mm, respectively, indicating that about 8 mm of maxillary expansion was needed to establish proper buccal occlusion. Excessive buccal tipping of the maxillary second molars was also noted. Incisor overbite was +4.5 mm, and overjet was −7.0 mm (Fig 3).

The initial lateral cephalometric analysis showed a severe anteroposterior discrepancy with an ANB of −9.0°, SNA of 82.9°, and SNB of 91.9°, and dental compensation represented by U1 to SN of 117.0° and IMPA of 74.0°. The Wits appraisal was −20.5 mm. The SN-MP angle was relatively low (28.7°) (Fig 4, Table).

From the posteroanterior (PA) cephalometric analysis, the maxillary basal bone width measurement was 66.8 mm, and interantegonial notch width was 96.0 mm, with resultant a maxillomandibular differential of 29.2 mm (Table).

**TREATMENT OBJECTIVES**

The treatment objectives were to (1) correct the maxillary deficiency with sufficient maxillary expansion, (2) maintain sound periodontal support in the maxillary arch throughout treatment, (3) establish an esthetic profile with maxillomandibular orthognathic surgery, and (4) establish proper buccal occlusion.
TREATMENT ALTERNATIVES

Because of the severe anteroposterior jaw relationship, orthognathic surgery was inevitable. Accordingly, several treatment options were suggested to deal with the transverse discrepancies.

A SARPE before orthognathic surgery can be a reliable treatment option. Because of the severe maxillo-mandibular discrepancy and the midface deficiency, 2-jaw surgery with a LeFort I osteotomy was indicated. However, since SARPE and maxillary LeFort I osteotomy cannot be performed simultaneously, the patient would require 2 stages of surgery. The possible increases in surgical trauma and costs were concerns.

Maxillary segmental osteotomy for bilateral expansion of the maxillary posterior segments with the mandibular surgery was also considered to correct both the transverse and anteroposterior skeletal discrepancies in 1 surgery. However, lateral movements of the maxillary segment have been shown to be considerably unstable.

Extraction of the maxillary premolars can be a solution to reduce the relative discrepancy between the maxillary and mandibular buccal segments, since it results in a full-step Class II molar relationship. In this patient, however, the transverse discrepancy at the molar width was still there when the diagnostic casts were repositioned in a Class II relationship. Furthermore, incisor retraction would have prolonged the overall treatment. The increase in the negative overjet after maxillary
incisor retraction would then necessitate excessive surgical jaw movement that could be detrimental for the stability of the surgery.

Sufficient orthopedic expansion of the maxilla could eliminate the need for invasive surgery, if appropriately performed. However, in this patient, maximum skeletal expansion without severe dental tipping and undesired periodontal side effects would be necessary, and the results would need to be stable after treatment. Special considerations were needed in designing the appliance for nonsurgical expansion.

**TREATMENT PROGRESS**

A MARPE was fabricated with some modification of the conventional RPE. An impression was made with the bands on the first premolars and first molars, and a conventional hyrax expander was constructed on the cast. Four rigid connectors of stainless steel wire with helical hooks were soldered on the base of hyrax screw body. Two anterior hooks were positioned on the rugae region, and the other 2 posterior hooks were placed on the parasagittal area (Fig 5, A). The hooks were adjusted for passive contact with the underlying tissues. The MARPE was then placed and cemented on the patient’s first premolars and molars. Orthodontic miniscrews (Orlus, Ortholution, Seoul, Korea) with a 1.8-mm collar diameter and a 7-mm length were placed in the center of the helical hooks under local infiltration anesthesia. The wires were adjusted to maintain passive contact with the collar of the miniscrews. Nonsteroidal anti-inflammatory drugs were prescribed for pain control (Fig 5, B).

The hyrax screws were turned once a day starting the next day. Separation of the midpalatal suture was con-firmed with intraoral radiographs and a PA cephalogram (Figs 5-7). The miniscrews were maintained in place with no notable positional change throughout the expansion phase. Expansion was terminated at 6 weeks, resulting in an 8.3-mm increase in intermolar width. After active expansion, the MARPE was maintained for 3 months to allow bone formation in the separated palatal suture. The buccolingual molar inclination did not change after expansion and alignment (Fig 8). Transitional soft-tissue inflammation around the miniscrews in the posterior palate occurred during expansion but subsided after removal of the appliance. The maxillary second molar axis was corrected by applying elastic chains to the hooks attached to the molar bands.

The transverse increases were 2.4 mm in maxillary basal bone width and 2.5 mm in nasal width, respectively (Fig 7, Table).

Complete arch alignment and coordination were performed for the orthognathic surgery. At 10 months, a 2-jaw orthognathic surgery was performed involving a maxillary LeFort I osteotomy for posterior impaction and advancement and mandibular setback by 18.0 mm with bilateral vertical ramus osteotomies (Fig 9).

Occlusal settling was performed with vertical elastics. All brackets and bands were removed after 16 months of treatment (Figs 10-12). Fixed retainers were attached on the maxillary and mandibular anterior teeth. A maxillary circumferential retainer was also used to secure the stability of the expanded maxillary arch.

There was no remarkable change in the clinical crown heights at debonding compared with the initial status. There was no notable gingival recession or bony dehiscence in the posterior segments.

Stable posterior occlusion was maintained for 18 months after debonding. Gingival recession or attachment loss was not remarkable compared with the initial status at 18 months after debonding (Fig 13, A-E). An axial computed tomogram was taken 12 months after debonding to view the periodontal status of the maxillary buccal segment. An axial section at 3 mm from the proximal cementoenamel junction showed sound periodontal surroundings in both the anterior and posterior regions around the roots (Fig 13, F).

**TREATMENT RESULTS**

Adequate nonsurgical bodily expansion of the maxillary buccal segments was achieved. Desirable buccal segment occlusion was established. The patient had sound and stable periodontal support after expansion and completion of treatment. Balanced facial esthetics resulted from the orthognathic surgery.
DISCUSSION

It has been a general perception that the predictability of orthopedic expansion is greatly reduced after 15 years of age, when SARPE may have to be used. However, the validity of surgical or nonsurgical treatment should be reexamined in terms of feasibility, safety, and stability.

Early histologic studies showed that palatal suture obliteration or synostosis begins when people are in their thirties, and fusion of facial sutures is rare in older skulls, unlike the cranial sutures, which were confirmed by Knaup et al, who claimed that bony fusion in the midpalatal suture was rare in subjects under 25 years. These findings substantiate anecdotal case reports in which conventional RPE produced successful orthopedic effects.

Nevertheless, a recent study showed that nonsurgical expansion even in prepubertal patients leads to thinning of the buccal alveolar wall, which could develop a bony dehiscence. This effect was more evident in patients with tooth-borne expanders than tooth-and-tissue-borne expanders. This demonstrates the increased risks of transverse expansion in postpubertal patients, in
whom stronger bone-borne anchorage is needed than conventional expanders. Taken together, the maximum skeletal effect during and after expansion is a crucial factor whether the expansion is surgical or nonsurgical.

Although surgical osteotomies obviously allow maxillary skeletal expansion in adults, there have been controversial opinions about the stability of the arch width. Phillips et al9 reported considerable relapse after expansion with LeFort I and segmental osteotomy in 39 patients. SARPE, therefore, was expected to show superior stability compared with segmental osteotomy, since it allows tissue adaptation during the expansion and subsequent consolidation period. However, an empirical comparison between SARPE and nonsurgical expansion has been difficult, mainly because of the problems in designing a controlled experiment between age-matched groups.18,19 Berger et al20 stated that the 1-year stability of SARPE in postpubertal subjects was not significantly different from that of nonsurgical expansion in prepubertal patients. Therefore, it can be speculated that the treatment effects and the stability of nonsurgical expansion in adults are comparable with those of SARPE, when the orthopedic expansion is secured.

Diagnostic criteria for surgical intervention have been suggested in several ways. Handelman et al6 stated that surgically assisted expansion should be used when the required expansion of intermolar width exceeds 8
mm. Betts et al\textsuperscript{21} suggested the maxillomandibular width differential measured from the PA view, as a guide for surgical expansion. According to those criteria, our patient would need 2-stage surgery. However, Bailey et al\textsuperscript{18} favored simultaneous segmental osteotomy and mandibular surgery over 2-stage surgery in long-face patients with narrow maxillae, due to surgical trauma, morbidity, and cost. Thus, nonsurgical expansion may be justified when it leads to treatment effects similar to those of SARPE.

\textbf{MARPE} is a simple modification of the conventional RPE appliance; the main difference is the incorporation of several miniscrews to ensure expansion of the underlying basal bone and maintain the separated bones during the consolidation period. Posterior miniscrews were placed close to the midpalatal suture to use the bone thickness of the nasal crest.\textsuperscript{22,23} The treatment effects in this case can be defined as a combination of skeletal and dentoalveolar expansion, since the appliance is tooth-and-bone-borne. The literature shows

\textbf{Fig 9.} Treatment progress: \textbf{A-C,} after expansion at 6 weeks; \textbf{D-F,} before orthognathic surgery; \textbf{G-I,} after orthognathic surgery.

\textbf{Fig 10.} Posttreatment facial photographs.
Fig 11. Posttreatment casts.

Fig 12. Posttreatment x-rays and cephalometric superimposition.
that considerable dentoalveolar expansion also occurred with SARPE,24 and the amount of expansion at the maxillar basal bone was not as much as the dentoalveolar expansion.25 A triangular expansion represented by greater dentoalveolar expansion with less basal bone expansion seems unavoidable because of the anatomic structure and the appliance design, whether the expansion is surgical or nonsurgical.

Some bone-borne maxillary expanders have been proposed in reports to facilitate the skeletal expansion following lateral osteotomies.26-28 In contrast, our tooth-and-bone-borne appliance required a simple procedure for miniscrew placement and definitely did not need an osteotomy, implying that an effective replacement of SARPE with MARPE in young adults may be possible.

In spite of our promising clinical results, the MARPE appliance cannot be expected to force the separation of obliterated sutures in older adults. Therefore, the indications for MARPE should be confined to young adults from the late teens to the midtwenties, based on the earlier studies.11,29 SARPE can still be a treatment of choice for older patients.18 The primary objective of the appliance is to gain maximum skeletal effects in the patent sutures but not necessarily in the obliterated sutures. Possible mechanical resistance from the circummaxillary sutures could be another limiting factor even when the suture is patent.4 Because of the variations in suture development and the complexity of craniofacial structures, a prospective study needs to be conducted to evaluate the reliability of this appliance in adults compared with growing children.

CONCLUSIONS

This case report introduced an RPE reinforced by orthodontic miniscrews (MARPE) positioned on the palatal bone. It demonstrated the clinical effects in treating a young adult with severe maxillary constriction and mandibular prognathism. To avoid multiple surgeries, nonsurgical maxillary expansion was performed with the MARPE to achieve both skeletal and dentoalveolar expansion for transverse correction. Subsequent orthognathic surgery corrected the mandibular prognathism and vertical excess. The stability of the expansion and the periodontal status were favorable from the follow-up clinical and radiologic findings. This report proposes effective incorporation of orthodontic miniscrews for transverse correction; this can eliminate the need for multiple surgeries in patients with complex craniofacial discrepancies and secure the safety and stability of the transverse correction.

REFERENCES


