

Corticotomy-assisted adult rapid maxillary arch expansion and ridge augmentation: An interdisciplinary case report with 7-year follow-up

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Adult orthodontic treatment involving maxillary transverse deficiency is a challenge for an interdisciplinary team. Surgically assisted rapid palatal expansion to segment the maxilla was once the treatment of choice, but the invasiveness, bone deficiency, and gingival recession hindered its acceptance. Corticotomy-assisted rapid maxillary arch expansion with ridge augmentation has the advantage of augmenting alveolar bony housing to accommodate and facilitate tooth movement. This approach was used to correct a severely constricted maxilla with bilateral posterior crossbite and anterior crowding in a 46-year-old man. Treatment time was 14 months. The accelerated arch expansion overcame the crossbite in 7 months, increasing intercanine distance by 5.2 mm and intermolar distance by 9.8 mm. Subsequent implant prosthesis was able to be restored in a functional normal occlusion. Satisfactory and stable clinical outcome was followed for 7 years. Corticotomy-assisted rapid maxillary arch expansion with alveolar bone augmentation is a novel and effective interdisciplinary approach for correcting adult maxillary transverse deficiency. Well controlled prospective clinical trials are warranted for further investigation. (*Am J Orthod Dentofacial Orthop* 2019;156:266-74)

Adult orthodontic treatment has become popular and an integral part of the interdisciplinary treatment. Maxillary transverse deficiency¹ represents a common clinical challenge for the team working to establish ideal alignment and occlusion not only for natural dentition but also for dental implant prostheses. Several approaches with fixed appliances and an expander for addressing maxillary transverse deficiency have been developed, including rapid maxillary expansion (RME),² slow maxillary expansion

(SME),³ and surgically assisted-rapid palatal expansion (SARPE).⁴ Although RME and SME are effective for growing teenagers, skeletally mature adult patients may be contraindicated for such approaches.^{2,3,5} Therefore, SARPE is the option of choice for mature palates. However, some disadvantages of SARPE are the resorption of buccal bone, dehiscence, and gingival recession.^{4,5} In addition, increased inter-nasal alae distance or widening of the nose may result as an undesirable side-effect.

Recently, corticotomy-assisted rapid tooth movement with ridge augmentation, or periodontally accelerated osteogenic orthodontics (PAOO), has gained popularity.^{6,7} Such an approach combines the application of the regional accelerating phenomenon (RAP)⁸ by means of alveolar bone decortication to increase regional bone remodeling to accelerate tooth movement and ridge augmentation procedures to overcome the deficiency of the alveolar ridge (usually buccal bone) and thus expand the “orthodontic wall.”⁹ Although several studies have demonstrated the temporal accelerating effect of corticotomy-assisted tooth movement, most of the studies that were included in a systemic review only demonstrate its utilization for canine retraction or exposure.^{10,11} The aim of the

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All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and none were reported.

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Submitted, January 2018; revised and accepted, February 2018.
0889-5406/\$36.00

<https://doi.org/10.1016/j.ajodo.2018.02.018>

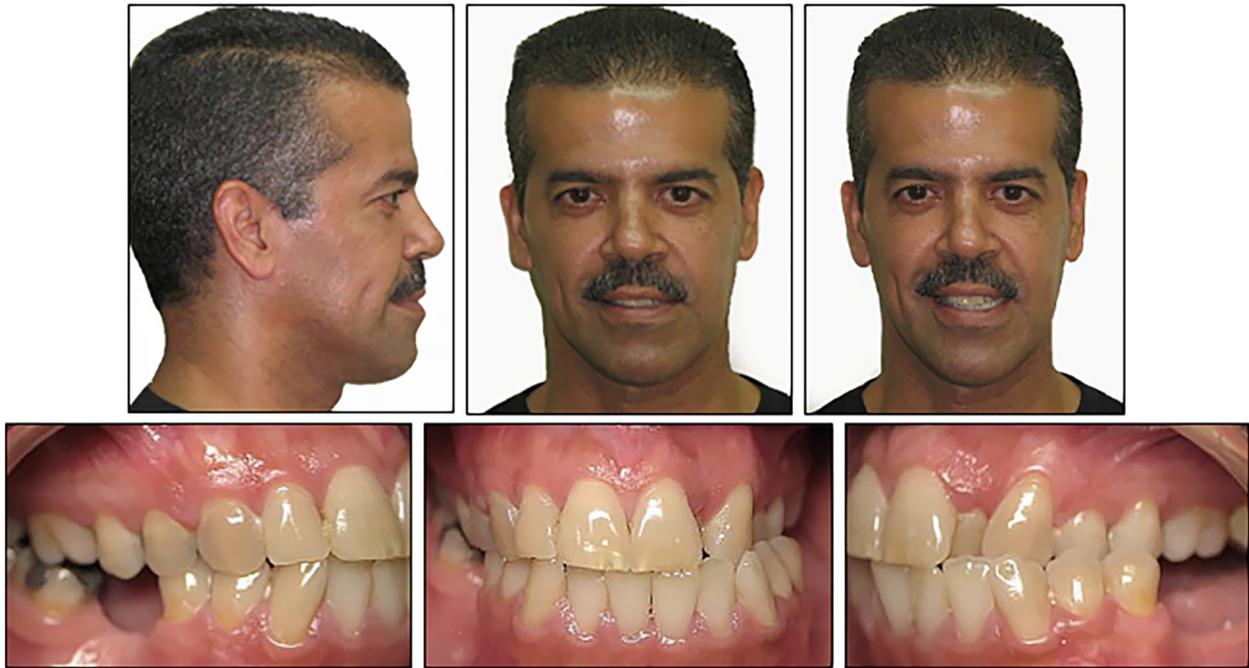


Fig 1. Pretreatment facial and intraoral photographs.

present case report is to demonstrate a novel approach of corticotomy–assisted rapid maxillary arch expansion and augmentation in an adult and the long-term stability of the treatment.

DIAGNOSIS AND ETIOLOGY

The patient, a 46-year-old Hispanic man, presented to our clinic with a chief complaint about the crowding of the anterior teeth and the desire to restore the missing mandibular molars with dental implants. His medical history was noncontributory.

Extraoral examination showed a slightly deviated facial midline and a more prominent chin on the left. The temporomandibular joint examination was normal with no functional shift of the mandible. His lateral profile was straight and the lips were competent at rest (Fig 1).

The intraoral examination revealed fair oral hygiene with healthy but thin biotype of the periodontium. Alveolar bone level height was within normal limits; however, prominent roots were palpable in the posterior maxilla. Maxillary arch constriction with bilateral posterior crossbite and palatal verted of maxillary left lateral incisor was also noted. Maxillary left second molar was not extruded but was also in crossbite relationship. The mandibular incisors exhibited mild crowding, and the patient was missing the mandibular right first

molar and all mandibular left molars. Canine relationships were Class III on the right and Class II on the left.

Analysis of the dental casts (Fig 2) confirmed the intraoral findings. In addition, the maxillary arch was constricted and narrow, resulting in an intercanine distance of 28.9 mm and intermolar distance of 41.3 mm (mesial-buccal cusp tip of first molars). The cephalometric analysis showed a moderate skeletal Class III relationship (ANB angle 2°, Wits appraisal –4.9 mm) with a high mandibular plane angle (SN-Go-Gn 41°), moderately protruded maxillary incisors (U1-NA 10 mm and 25°) and mandibular incisors (L1-NB 10 mm and 31°; Fig 7; Table).

The patient was diagnosed with facial asymmetry and deviation of mandibular midline, skeletal Class III relationship, partial edentulism of the mandible with mild to moderate mandibular and maxillary crowding, bilateral posterior crossbite, and a palatally verted maxillary left lateral incisor.

TREATMENT OBJECTIVES

The treatment objectives were to resolve the maxillary transverse discrepancy by expanding the maxilla and anterior decrowding. Mandibular ridge quadrant alveolar ridge augmentation was required for dental implant therapy, and subsequent implant-supported restorations would be fabricated. Meanwhile, treatment



Fig 2. Pretreatment dental casts.

Table. Cephalometric measurements

Measure	Norm	Pretreatment	Posttreatment
SNA (°)	82	83	83
SNB (°)	80	81	81
ANB (°)	2	2	2
Maxillary incisor–SN (°)	102	110	109
Maxillary incisor–NA (mm/°)	2.3/4	2.5/10	2.5/10
Mandibular incisor–NB (mm/°)	2.5/4	3.1/10	3.0/11
IMPA (°)	95	87	90
SN–GnGo (°)	33	41	41
LFH (mm)	57	62	62
Wits appraisal (mm)	0	–4	–4

objectives also included ideal overjet and overbite with canine guidance and maintaining vertical dimension as well as correction of midline discrepancy and the Angle sagittal relationship. Regular adult prophylaxis and optimizing oral hygiene for long-term periodontal health and stability was also planned.

TREATMENT ALTERNATIVES

After interdisciplinary treatment planning and discussion with the patient, 2 options were presented to the patient to address the constricted maxilla and crossbite: The first option involved SARPE with fixed

orthodontic appliances, and the second option was corticotomy-assisted rapid maxillary arch expansion with bone grafting and fixed orthodontic appliances. Both options would also correct the midline and include prostheses to replace missing teeth in the mandible.

The patient did not choose the first option owing to the potential complications, costs, invasiveness, and potential need for general anesthesia. Alternatively, the patient opted for the second option given its lesser invasiveness and the potential accelerating effects on the tooth movement after the procedure.

Removable partial denture as one of the options to replace missing teeth in the mandible was also offered to the patient but he wanted to have a fixed prosthesis and so dental implant therapy was planned. Mandibular right ridge augmentation with guided bone regeneration and mandibular left posterior ridge split technique with bone grafting followed by subsequent dental implant prosthesis were planned.

TREATMENT PROGRESS

Interdisciplinary treatment and sequence was coordinated and initiated after the patient's consent. After adult prophylaxis and reinforcement of oral hygiene, premolar and molar bands were inserted and impression taken in preparation for immediate delivery and activation of an expander after surgery. Preoperative clinical examination showed acceptable oral hygiene



Fig 3. Corticotomy-assisted rapid maxillary arch expansion and augmentation. **A**, Preoperative clinical assessment; **B**, alveolar bone corticotomy between roots with the use of a rotary instrument; **C**, particulate bone grafting for ridge and biotype augmentation.

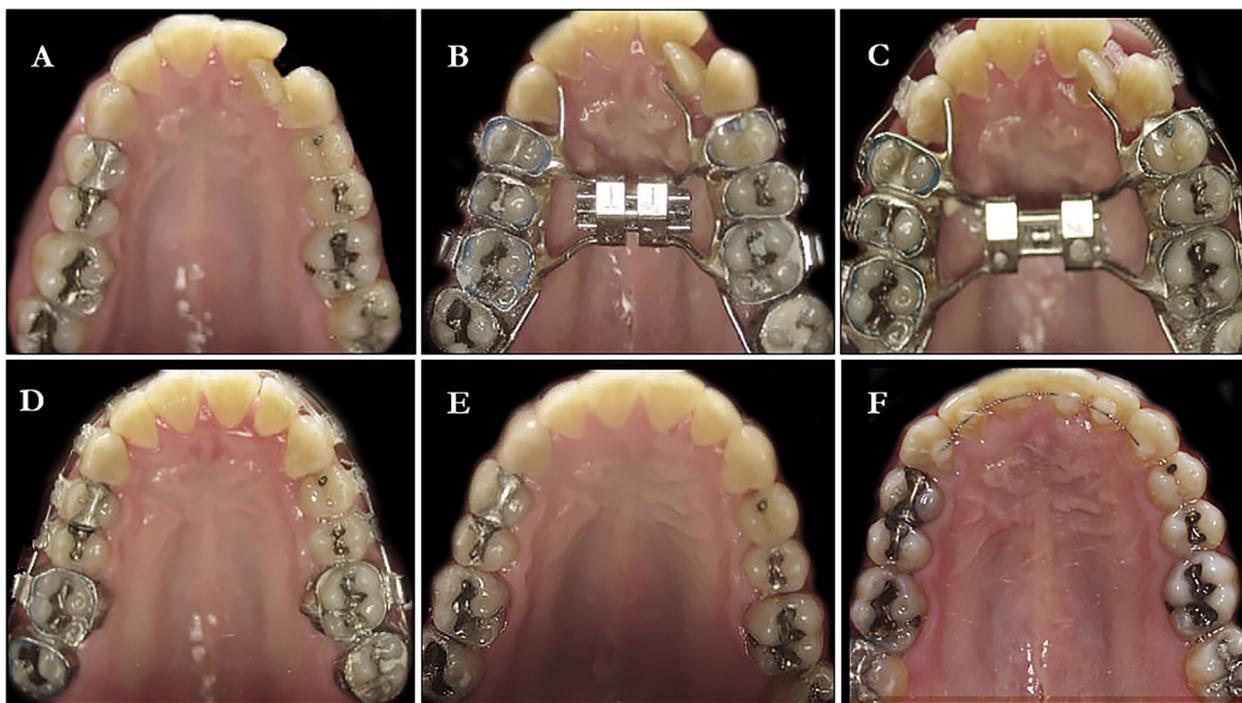


Fig 4. Rapid maxillary arch expansion. **A**, Preoperative occlusal view. Postoperative: **B**, 2 weeks, **C**, 4 weeks, **D**, 7 months, **E**, 14 months, and **F**, 7 years.



Fig 5. Postoperative progress, frontal view: **A**, 2 weeks, **B**, 4 weeks, **C**, 7 months, and **D**, 14 months.

and healthy gingiva (Fig 3, A). After profound infiltration of local anesthetics, intrasulcular incisions were made both buccally and palatally with vertical incisions followed by full-thickness flap. Thin buccal bone and fenestration defect as well as markedly protruding roots were noted after flap reflection (Fig 3, B). Decortication of the alveolar ridge between the roots was done only on the buccal areas (orthodontic pressure side). Decortication of the buccal side (pressure side) of the palatal root of molars and first premolars was done in a palatal approach. The depth of the decortication needs to penetrate cortical bone for activation of RAP, inducing blood supply and providing hematopoietic cells for alveolar ridge augmentation (Fig 3, C).^{6,7} The ridge augmentation procedure was performed with the use of particulate demineralized freeze-dried bone allograft (Cortical 350–500 μm , University of Miami Tissue Bank, Miami, Fla). Both buccal and palatal flap were repositioned and sutured with interrupted

polytetrafluorethylene sutures (Cytoplast USP 3-0; Osteogenic Biomedical, Lubbock, Tex). The patient was premedicated with 600 mg clindamycin and continued on 300 mg every 8 hours for 10 days. Acetaminophen with codeine was prescribed to avoid antiinflammatory effects. The patient was placed on chlorhexidine rinse. Moderate swelling was noted by the patient but resolved within a week. Sutures were removed after 10 days.

A 12-mm rigid banded palatal arch expander was inserted 10 days after the surgery and activated once a day for 0.25 mm/day (Fig 4, B), and mandibular brackets (0.018 \times 0.025 slot; ICE Inspire esthetic brackets; Ormco Co, Pomona, Calif) were bonded for dental alignment. Rapid arch expansion protocol was initiated after delivery of the device and followed at least every week for 5 weeks. Maxillary brackets (0.018 \times 0.025 slot) were bonded once expansion was completed and an open NiTi coil placed to get appropriate space for the

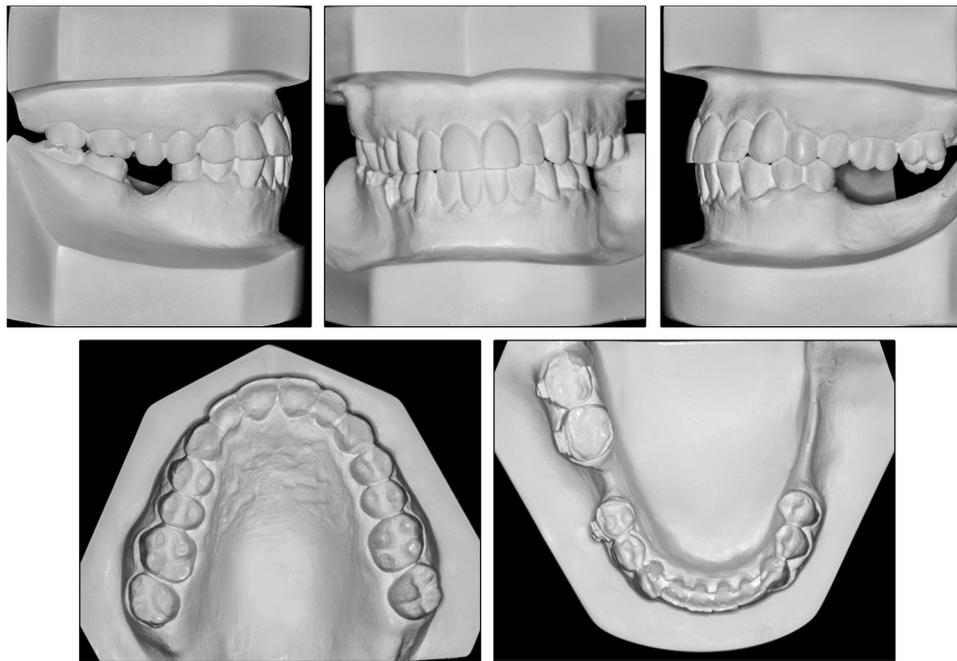


Fig 6. Post-orthodontic treatment dental casts.

maxillary left lateral incisor. The maxillary banded expander continued to be activated 1-2 turns every 1-2 weeks after correction of transverse discrepancy, to maintain adequate expansion. The appliance was then passive for 3 months. After its removal, a rigid modified Wilson with a transpalatal bar was fabricated and inserted. Orthodontic treatment was then aimed at achieving proper anteroposterior Class I buccal segment correction with the use of diagonal intraoral elastics (Class III elastics on the right side, Class I elastics on the left side). Orthodontic appliances were removed after 14 months of treatment.

TREATMENT RESULTS

After the corticotomy and ridge augmentation procedure, rapid maxillary arch expansion was evident, and the desired expanded arch shape was achieved and crossbite corrected after 7 months. The whole orthodontic treatment was completed in 14 months (Figs 4 and 5). Intercanine distance increased 5.2 mm at the canine tips (from 28.9 to 34.1 mm) and 2.8 mm at the buccal cervical margin (from 32.7 to 35.5 mm). The intermolar distance at the mesial-buccal cusp tip of the first molars increased 9.8 mm (from 41.3 to 51.1 mm). At the cervical margin of first molars there was an increase of 8.5 mm (from 47.7 to 56.2 mm; Fig 6). Buccal segment changes could be described as a combination of pure expansion, moving teeth out of the

buccal segment, and uprighting teeth embedded in the buccal alveolus.

Horizontal ridge augmentation was performed for the mandibular partial edentulous ridge during orthodontic treatment. Up to 5-6 mm clinical horizontal gain was achieved for alveolar ridge augmentation. Dental implants were placed and restored after completion of the orthodontic treatment with normal occlusion. Fixed retainers were bonded and the patient was followed for 7 years after the treatment (Figs 7, 8, and 9, B). Although minimal root resorption was noted after the orthodontic treatment, the expanded maxillary arch and the buccal tissue remain clinically stable without relapse. Periodontal examination was also within normal limits. The patient was very satisfied with the functional and esthetic outcome of treatment (Fig 7).

There were no significant anterior-posterior or vertical changes in the cephalometric radiograph (Fig 10), as expected because the results achieved were in the transverse dimension.

DISCUSSION

Maxillary transverse deficiency usually poses a challenge in adult orthodontics because the jaw bone and midpalatal suture of the maxilla has matured and stabilized.^{1,12} To correct such constricted maxillary arch with unilateral or bilateral crossbite combined with anterior crowding, significant maxillary arch

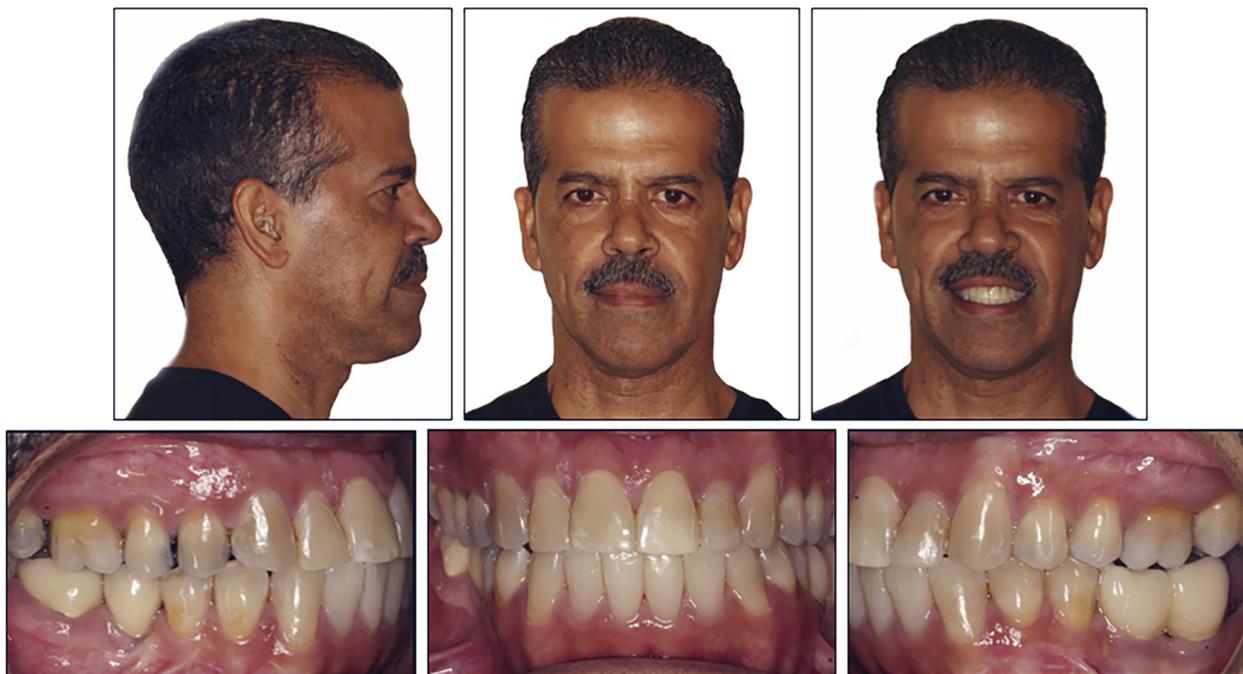


Fig 7. Seven-year posttreatment clinical photographs showed stable outcome.

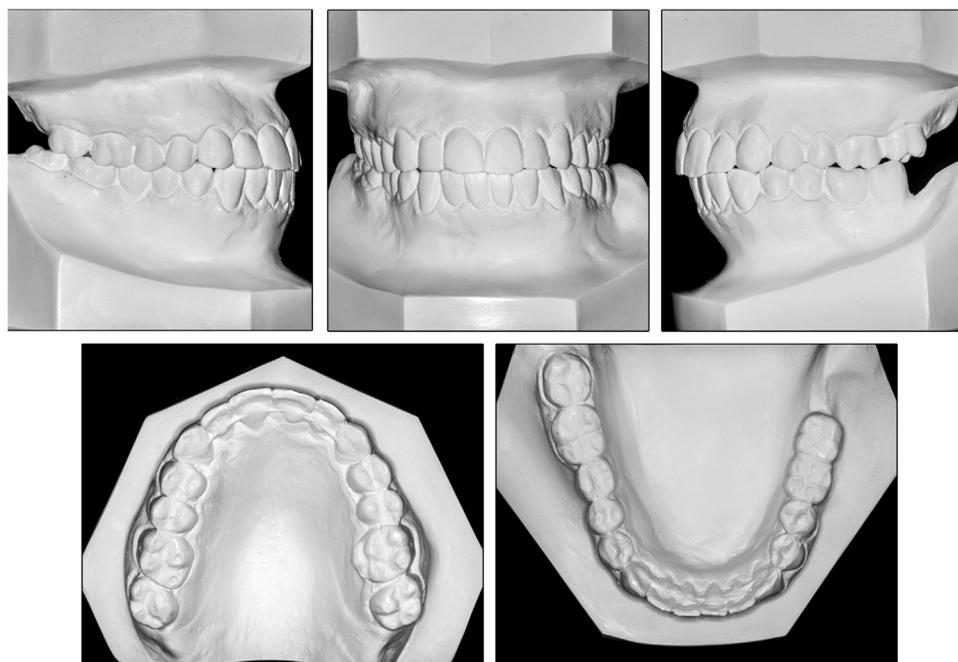


Fig 8. Seven-year posttreatment dental casts.

expansion is needed. In the presented case, significant arch expansion was successfully achieved in a reduced time, and the outcome not only corrected the crossbite but also gained space for the lateral incisor.

Lines¹³ was the first who proposed adult rapid maxillary expansion with the use of corticotomy. Compared with SARPE, selective alveolar bone corticotomy is more conservative as a periodontal surgery rather than

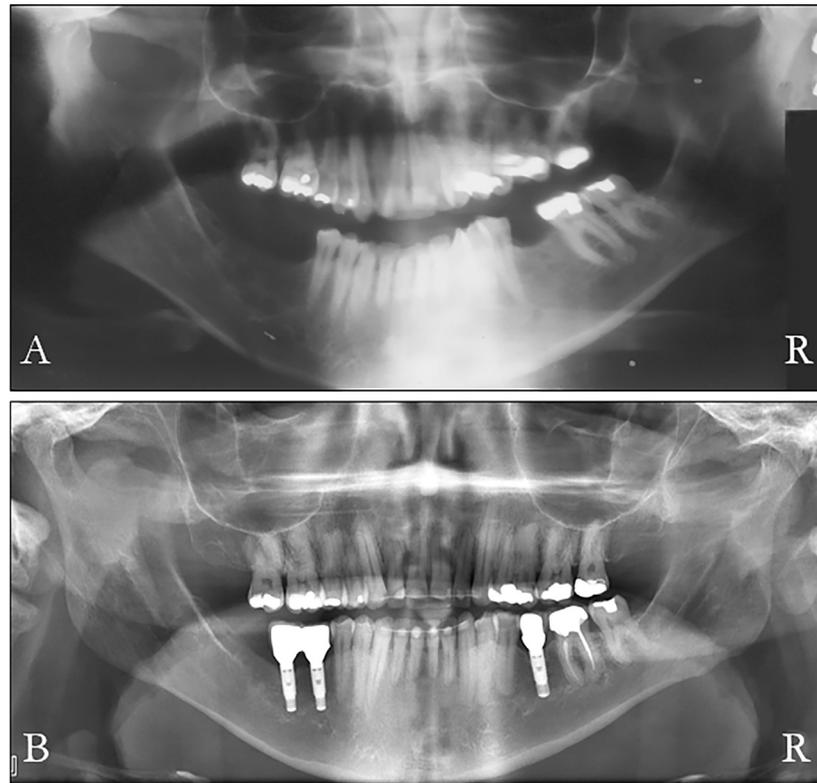


Fig 9. Panoramic radiographic exam: **A**, before treatment; **B**, 7 years after treatment.

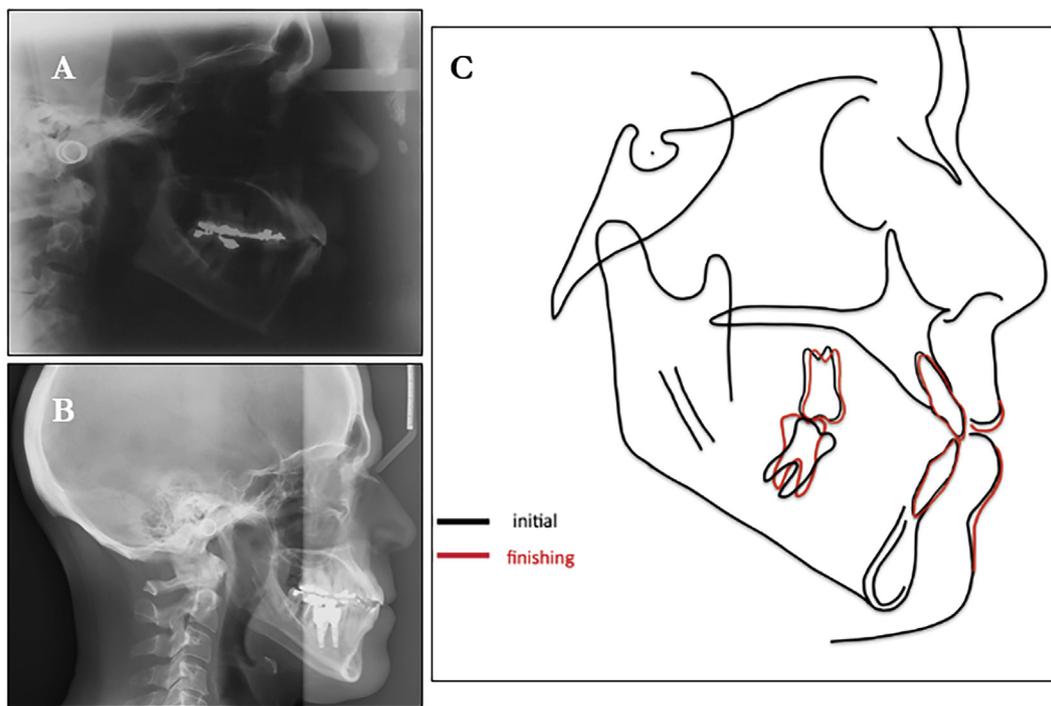


Fig 10. Cephalometric radiography: **A**, before treatment; **B**, after treatment during retention. **C**, Cephalometric analysis before (*black*) and after (*red*) orthodontic treatment.

a skeletal surgery which involves segmentation of the maxillary jaw bone. Although the temporal efficacy and short-term safety of corticotomy-assisted accelerated orthodontics, or surgically facilitated orthodontic treatment, has been concluded in systematic reviews,^{10,11} limited clinical studies have been published in the context of maxillary transverse deficiency. One case report published corticotomy-assisted rapid maxillary arch expansion without ridge augmentation in a 14-year-old girl.¹⁴ However, in adult patients, such an approach would need bone grafting to augment the alveolar ridge at the same time.¹⁵ The present case report has demonstrated the efficacy of this approach and documented a stable long-term result for 7 years.

Although a stable clinical outcome and patient satisfaction were reported in this case, mild external root resorption did occur. As many studies suggested, corticotomy-facilitated orthodontics may not cause adverse events on the periodontium,^{10,11} including similar root resorption rates.^{16,17} In addition, some preliminary results suggests that the RAP may decrease the resistance of the tooth movement and severity of the root resorption.¹⁸ PAOO also augments the alveolar bone and prevents tooth relapse following orthodontic treatment.¹⁹ In this case, long-term stability with minimal relapse was achieved.

CONCLUSIONS

Corticotomy-assisted rapid maxillary arch expansion with ridge augmentation is an novel and effective approach. Surgically-assisted orthodontic therapy provides an alternate treatment option in cases of adult maxillary transverse deficiency. This long-term case report demonstrated its efficacy and clinical stable results up to 7 years. Future larger well controlled clinical trials will be needed to validate the predictability and to optimize an evidence-based indication for this approach.

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