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Interim use of Hyrax Screw Assembly for Single-Step Closure of Small Alveolar Cleft Prior to Anterior Maxillary Distraction Osteogenesis

A technical note

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Abstract

Anterior maxillary distraction osteogenesis (AMDO) is often used for correction of maxillary retrognathia in select cleft lip and palate cases. Restoration of alveolar arch continuity is desirable prior to initiation of AMDO in these cleft maxillary deformities. However, AMDO is technically difficult in a patient with coexisting alveolar cleft where there is a discontinuity of the defect that presents a challenge in terms of adequate vector control of movement of anterior segment and potential risk of tipping of teeth which already have compromised anchorage/bone support on the cleft side. Treatment process becomes further challenging when ongoing management is compounded by failed previous alveolar cleft grafting procedures along with the patient's reluctance to undergo further grafting of alveolar clefts. Herein, we report a technical note demonstrating a novel application of the modification of the hyrax screw wherein an initially fully opened Hyrax screw was utilized as an interim assembly for accomplishing single-step closure of small alveolar cleft prior to commencement of anterior maxillary distraction osteogenesis. This technique may prove to be feasible for patients presenting with alveolar cleft defects of smaller widths of up to 5 mm and relatively well-aligned upper arches.

Keywords: Alveolar Cleft; AMDO; Hyrax Screw; Single-Step Closure.

Introduction

Maxillary hypoplasia and retrusion represent a significant component of Class III deformity in most patients with cleft lip and palate. Inspite of being widely adopted technique for one-stage correction of maxillary retrusion in cleft patients,[1] Le Fort I osteotomy technique is associated with higher relapse rates and may lead to emergence of velopharyngeal insufficiency and hypernasality of voice, especially with advancements greater than 10 mm.[2,3] On the other hand, by virtue of offering sufficient time for overcoming the tension on the palatal scar and for regeneration of the membranous bone along with coverage of adequate soft tissue, distraction osteogenesis (DO) results in better skeletal stability when compared to conventional Le Fort I orthognathic surgery.[4,5] However, when extraoral or intraoral distraction is performed at a Le Fort I level, the risk of velopharyngeal insufficiency and speech impairment has been shown to be similar to the risk observed in conventional Le Fort I advancement surgery.[6]

To overcome this potential disadvantage, tooth borne distraction of the anterior maxilla using anterior maxillary distraction osteogenesis (AMDO) has proven to be a feasible and stable modality,[6] while also offering alveolar bone space for correction of tooth malalignment and without hampering speech.[1] Rao Janardhan et al[7] reported successful utilization of tooth-borne distraction device for advancement of the anterior maxilla with no worsening of speech. Promising results with the use of hyrax distractor (for anteroposterior maxillary advancement) in terms of its efficacy, patient's satisfaction, and stability have also been demonstrated in literature.[8] However, AMDO is difficult in a patient with alveolar cleft where there is a discontinuity of the defect that presents difficulty in terms of vector control of movement of anterior segment and the probable risk of tipping of teeth which already have compromised anchorage/bone support on the cleft side. The present manuscript describes the novel application of the modification of the hyrax screw wherein a conventional Hyrax screw after being fully opened was utilized as an interim assembly for accomplishing single-step closure of small alveolar cleft of up to 5 mm prior to commencement of anterior maxillary distraction osteogenesis.

Methods

Case Description

An 18-year-old female patient with an operated left cleft lip and palate presented seeking treatment for correction of mid face retrusion. Case history was indicative of two previous

alveolar cleft grafting surgeries at ages of 11 years and 15 years, respectively, at another institution. The cleft was present between maxillary right central incisor (11) and left canine (23) and was 5 mm wide at the level of the cementoenamel junction/ cervical margin of the adjoining teeth. Reverse overjet of 11 mm was noticed (Fig. 1a, b, c & d). The upper dentition was relatively well-aligned. There was scarring at the sites of surgery in the palate, alveolus and lip.

The patient as well as her parents declined for any further grafting of the alveolar cleft. In order to correct the alveolar discontinuity prior to maxillary advancement, closure of this small alveolar cleft as well as osteotomy cuts for AMDO were planned in a single step. The treatment protocol was approved by the Institutional Ethical Committee and patient gave informed consent and acceptance about the treatment protocol.

Description of technique

Following preparation of the models in die-stone, proposed vertical osteotomy cuts were made on both sides between the premolar and molar on the cast. A 9 mm Hyrax expansion screw (Leonne, Italy) (pitch = 1 mm) was fully opened, and its arms were adapted at the labial aspect of the anterior teeth with its body positioned between 11 and 23. The appliance was acrylized in self-cure polymerizing resin at the labial, occlusal, and lingual aspects, and subsequently finished, polished and tried-in for passive fit (Fig 2a, b).

Intraoperatively, the osteotomy was performed as follows: Under general anesthesia with oral endotracheal intubation, a maxillary vestibular incision was made from first molar to first molar. A mucoperiosteal flap was reflected to expose the maxilla. A horizonal osteotomy cut parallel to the occlusal plane was made on both sides 5mm above the level of the root apices from the lateral nasal rim to the distraction site between the premolars and molars. Lateral nasal osteotomies were performed whilst protecting the nasal mucosa. The nasal septum was detached by using a guarded septal osteotome. Vertical osteotomy/interdental cuts were made in the buccal cortex between the second premolar and first molar (Fig. 3a). The palatal osteotomy was executed gently under tactile guidance with curved osteotome while taking care not to damage the palatal mucoperiosteum.

After confirming the completion of osteotomy, the acrylized Hyrax assembly was seated passively over the segment anterior to the osteotomy cuts, and the screw was closed with the

key till approximation was achieved by mesial movement and docking of two bony segments towards the cleft between teeth 11 and 23 (Fig.3b). As the bony segments from both sides closely approximated towards each other in an evenly controlled vector (without over-riding of segments), the closure of the cleft was visualized. Bone chips produced during osteotomy were placed in the region of the residual cleft site. A 1.5 mm titanium straight plate was adapted on both bony segments across the cleft and fixed with monocortical screws ensuring that the anterior maxilla remained as one single unit (Fig. 3c), in preparation for facilitating AMDO for correction of cleft maxillary retrognathia. The interim Hyrax assembly was removed following closure using a 3-0 Vicryl suture. Thereafter, a three-part tooth-borne bonded Hyrax distractor assembly (with 90° orientation for anteroposterior movement) oriented parallel to mid palatine plane was cemented. Gap created at the area of the two vertical osteotomies was utilized for anterior maxillary distraction at a rate of 1 mm per day as follows (Fig. 3d): After a latency period of 5 days, AMDO was initiated by turning the screw of the distractor assembly by half a turn (0.5 mm) every 12 hours, resulting to a total of one full turn every day i.e. 1mm/day. The screw was activated for 13 days, thereby amounting to a total correction of 13 mm. After completion of distraction, the central portion of the distractor assembly was sealed with composite resin and retained through a consolidation period of 4 months to allow for the mineralization and corticalization of the newly formed bone tissue prior to removal of distractor assembly. Postoperatively, the recovery period was uneventful with no detection of any relapse and complications.

Favourable results of the technique showing postoperative approximation of the bone in the cleft site and satisfactory improvement in esthetics along with good bone regeneration at the area of distraction are demonstrated through Figure 4a-4c. Alveolar space with good, regenerated bone quality and implants placed bilaterally in the distracted bone are evident by IOPA radiographs (Fig. 4d).

Ethical approval to report this case was obtained from the Institutional Research Ethics Committee. Written informed consent was obtained from the patient for her information and images to be published in this article.

Discussion

Premaxillary/ anterior maxillary and alveolar distraction osteogenesis (DO) have been widely used for management of severe midfacial retrusion including anterior crossbite in cleft lip and palate patients.[9-11]

Restoration of alveolar arch continuity is desirable prior to initiation of AMDO in cleft maxillary deformities. Restoration of large alveolar cleft defects by alveolar distraction osteogenesis utilizing intraoral tooth-borne distractor has been successfully reported in literature.[1,9] The tooth-borne trifocal distraction appliance involving the use of two Hyrax-screws has also been described for the controlled closure of a large alveolar cleft.[12] In cases of small alveolar clefts with enhanced chances of graft survival, bone grafting is an ideal option for the closure of cleft defects in order to achieve arch continuity, stabilise the maxillary segments, eliminate oronasal fistulae, optimise nasal morphology through nasal alar cartilage support, and finalize implant placement.[13] However, before commencement of AMDO, waiting time of at least 3-6 months is recommended for stabilization of graft. Challenge is usually encountered when some patients with history of previously failed alveolar bone grafting surgeries refuse to undergo another grafting procedure.

The conventional application of the Hyrax screw for closure of large alveolar clefts (activation of the appliance by opening the screw) has been widely documented in literature.[9,12] The majority of these applications involving Hyrax screw and fan-shaped screw entail opening of the screws to facilitate approximation of the alveolar segments towards each other.[8,12,14] On the other hand, the current technical note describes the novel application of the modification of the hyrax screw wherein a conventional Hyrax screw after being fully opened was utilized as an interim assembly for accomplishing single-step closure of small alveolar cleft of up to 5 mm prior to commencement of anterior maxillary distraction osteogenesis. The present interim tooth-borne Hyrax screw assembly facilitated controlled mobilization, docking and evenly close approximation of the bony segments (without over-riding of segments) towards the defect. This assembly enabled more precise bony movements while simultaneously maintaining bone to bone contact and stabilization of the osseous segments in the intended position during fixation, thereby aiding in accomplishing the anatomic objective in a single step.

Thus, based on the principle of patient-centred outcome and in accordance with patient's wishes, this technique involving the use of interim tooth-borne Hyrax screw assembly is suitable for clinical application in patients who are potential candidates for AMDO and also presenting with small alveolar interdental clefts (of up to 5 mm) that persist even after previous alveolar bone grafting surgeries. The advantages of this technique are the possibility of achieving arch continuity in the same operation by evenly controlled mesial movements of the bony segments towards each other, thus obviating the need for additional alveolar bone grafting surgery and preventing creation of any extraoral wound, making such therapy feasible especially for patients with small alveolar cleft defects of up to 5 mm. Simplicity of the design, ease of fabrication and exclusive tooth-borne usage minimizes the invasiveness of the procedure.

Limitations in generalizing the innovation: This technique cannot not be employed in large alveolar cleft defects wherein significant bone segment movements may be associated with significant relapse. Compromised periodontal support and advanced interdental bone loss are contraindications to the use of this approach.

Conclusion

In view of the promising results of this approach, this procedure may prove to be feasible for patients presenting with alveolar cleft defects of smaller widths and relatively well-aligned upper arches. Large sample size studies involving different populations with long-term follow-up are necessary to validate the current approach for routine use.

Conflict of Interest

The authors declare no conflicts of interest.

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Authors' Contribution

SM, HS and DS were responsible for the study conception and design and treatment of the patient. HS and SM contributed to the literature search and drafting the article. SM, HS, DS and PS contributed to the final editing and critical revision of the article. All authors have

made substantive contribution to this manuscript, and all have reviewed the final paper prior to its submission.

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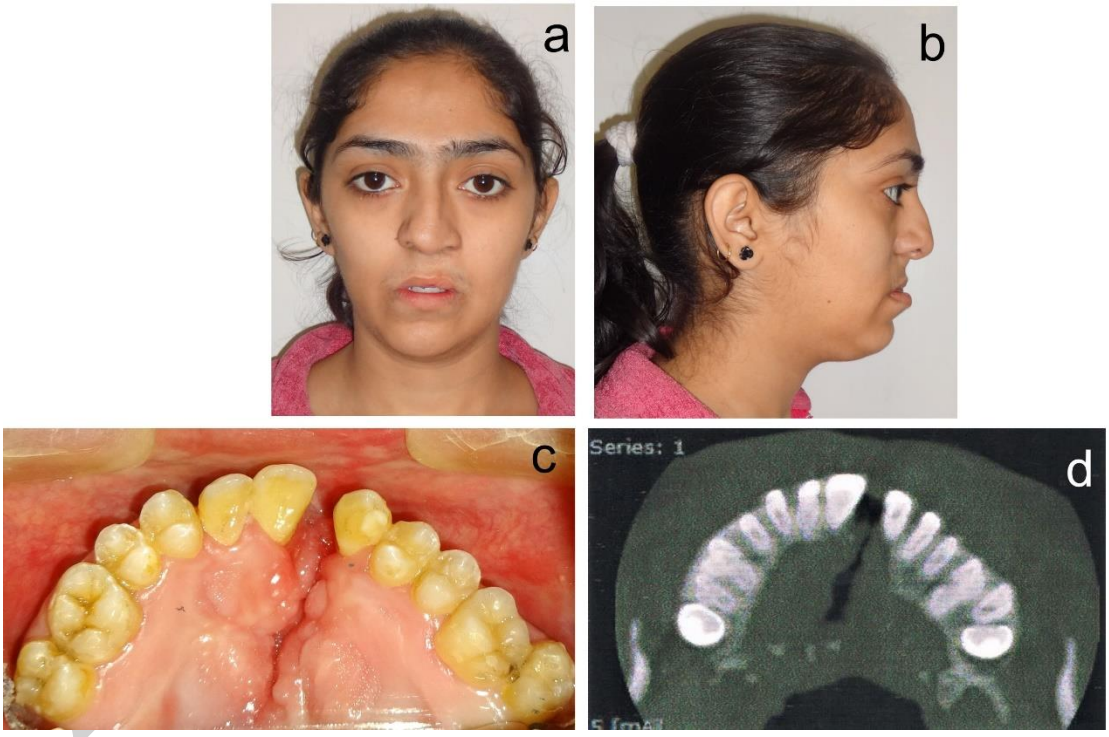

Figure 1: Pretreatment extraoral and intraoral photographs showing a cleft palate on the left side and alveolar cleft between 11 and 23: (a) Frontal photograph (b) Profile photograph (c) Intraoral occlusal view (d) Axial view.

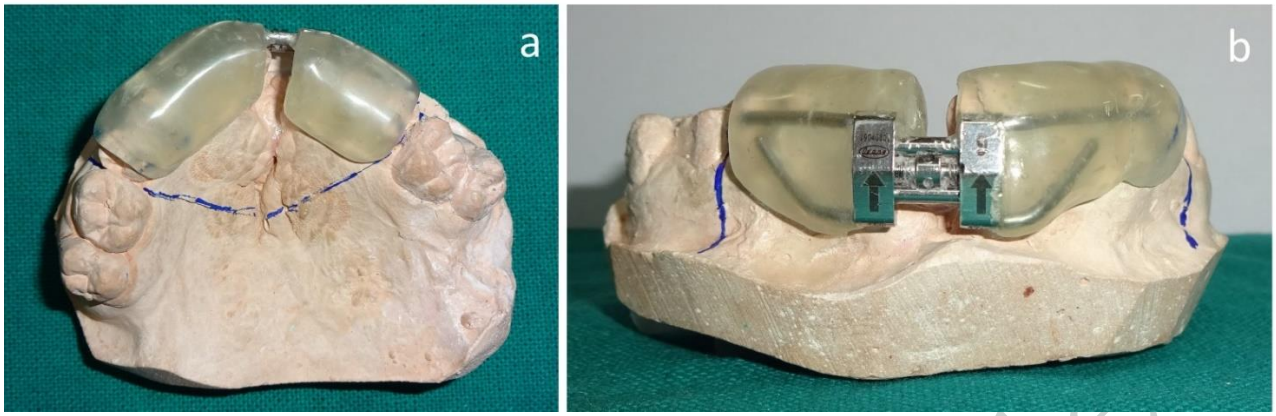

Figure 2: Marking of osteotomy cuts site and acrylized appliance with Hyrax screw in fully opened position: (a) Palatal view of the appliance (b) Front view of the appliance

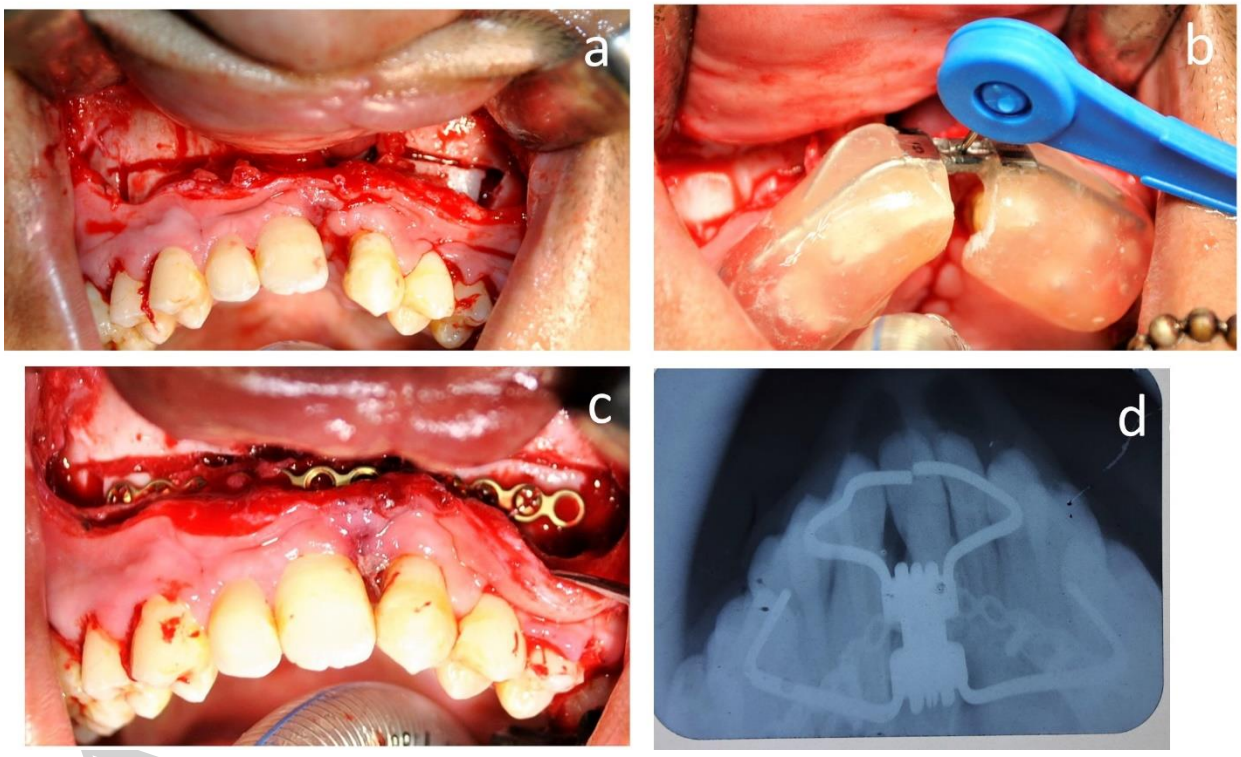

Figure 3: (a) Intraoperative photograph showing placement of osteotomy cuts, (b) Intraoperative photograph showing appliance in seated position and closure of screw assembly with key, (c) Approximation accomplished by mesial movement and docking of bony segments towards the interdental alveolar cleft between teeth 11 and 23, (d) Occlusal radiograph taken intraoperatively before commencement of AMDO

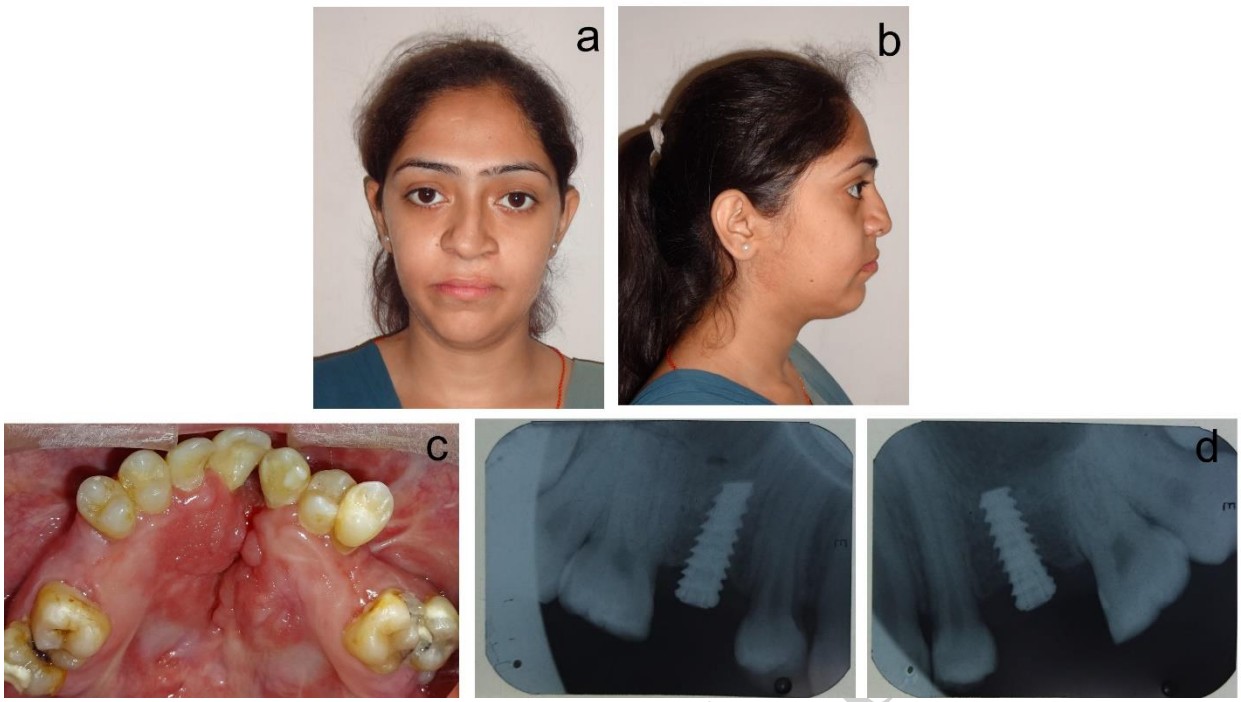

Figure 4: Treatment results: (a) favourable frontal esthetics after completion of AMDO, (b) improved profile esthetics after completion of AMDO, (c) Immediate post-distraction occlusal view after removal of distractor appliance, (d) IOPA x-rays showing good bone regeneration and implants placed bilaterally in the distracted bone between second premolar and first molar