Sultan Qaboos University Med J, November 2023, Vol. 23, Iss. 4, pp. 534–538, Epub. 30 Nov 23
Submitted 17 Nov 22
Revisions Req. 13 Feb & 4 Apr 23; Revisions Recd. 6 Mar & 8 Apr 23
Accepted 11 Apr 23
https://doi.org/10.18295/squmj.5.2023.025

TECHNICAL NOTE

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

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ABSTRACT: Anterior maxillary distraction osteogenesis (AMDO) is often used for the correction of maxillary retrognathia in select cleft lip and palate cases. The restoration of alveolar arch continuity is desirable before the 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 the movement of the anterior segment and the potential risk of tipping of teeth, which already have compromised anchorage/bone support on the cleft side. The treatment becomes more 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. This technical note demonstrates a novel application of the modification of the Hyrax screw where an initially fully opened Hyrax screw was utilised as an interim assembly for accomplishing the single-step closure of a small alveolar cleft before the 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: Distraction Osteogenesis; Cleft Palate; Cleft Alveolar; Maxillary Osteotomy; India.

Maxillary hypoplasia and retrusion represent a significant component of Class III deformity in most patients with cleft lip and palate. Despite being a widely adopted technique for one-stage correction of maxillary retrusion in cleft patients, Le Fort I osteotomy is associated with higher relapse rates and may lead to the emergence of velopharyngeal insufficiency and hypernasality of voice, especially with advancements greater than 10 mm.[1–3] On the other hand, by offering sufficient time for overcoming the tension on the palatal scar and the regeneration of the membranous bone, along with the 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 is similar to the risk observed in conventional Le Fort I advancement surgery.[6]

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

Case Description

An 18-year-old female patient, who presented to an academic teaching hospital in New Delhi, India, in 2020 with an operated left cleft lip and palate sought treatment for the correction of mid-face retrusion. The patient's case history was indicative of 2 previous alveolar cleft grafting surgeries at the ages of 11 years and 15 years at another institution. The cleft was present between the maxillary right central incisor (11) and left canine (23) and was 5 mm in width at the level of the cementoenamel junction/cervical margin of the adjoining teeth. In addition, a reverse overjet of 11 mm was noticed, and the upper dentition was relatively

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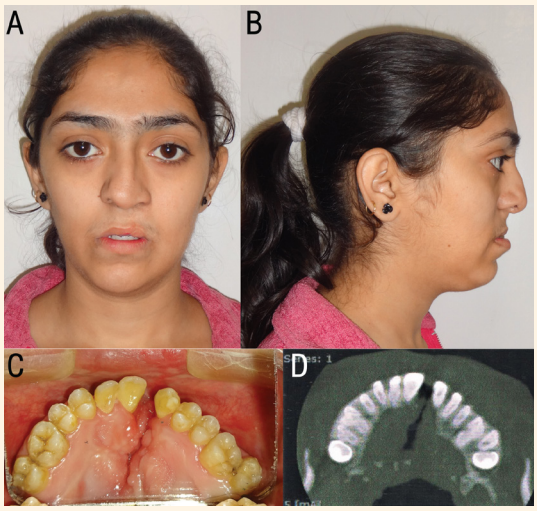

Figure 1: Pretreatment extraoral (**A**) front and (**B**) profile photographs as well as an (**C**) intraoral occlusal and (**D**) axial view of an 18-year-old female patient showing a cleft palate on the left side and an alveolar cleft between 11 and 23.

well aligned [Figure 1]. There was also scarring at the sites of surgery in the palate, alveolus and lip.

The patient and her parents declined any further grafting of the alveolar cleft. To correct the alveolar discontinuity before maxillary advancement, closure of this small alveolar cleft and osteotomy cuts for AMDO were planned in a single step.

Description of Technique

Following the preparation of the models in die stone, the proposed vertical osteotomy cuts were made on both sides between the premolar and the molar on the cast. Moreover, 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 acrylised in self-cure polymerising

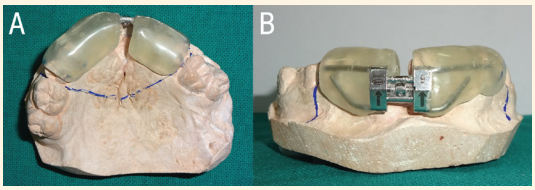

Figure 2: Photographs of the (**A**) palatal and (**B**) frontal view of the appliance showing markings of the osteotomy cut site and the acrylised appliance with Hyrax screw in fully opened position.

resin at the labial, occlusal and lingual aspects, being subsequently finished, polished and tried in for passive fit [Figure 2].

Intraoperatively, the osteotomy was performed as follows: under general anaesthesia with oral endotracheal intubation, a maxillary vestibular incision was made from the right permanent first molar to the left permanent first molar, and a mucoperiosteal flap was reflected to expose the maxilla. A horizontal osteotomy cut parallel to the occlusal plane was made on both sides 5 mm 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 while protecting the nasal mucosa. The nasal septum was detached by using a guarded septal osteotome. Furthermore, vertical osteotomy/interdental cuts were made in the buccal cortex between the second premolar and first molar [Figure 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 acrylised 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 [Figure 3B]. As the bony segments from both

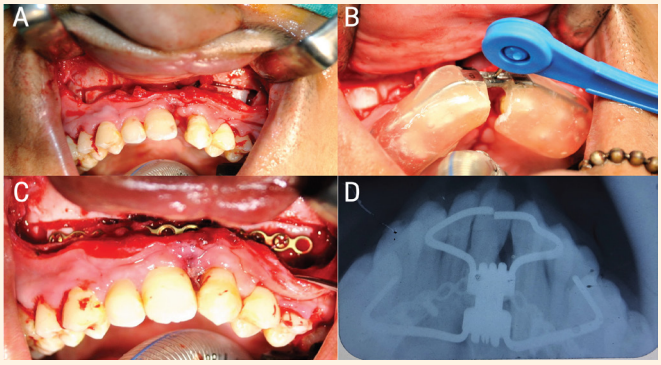

Figure 3: Intraoperative photographs showing (**A**) the placement of osteotomy cuts, (**B**) the appliance in a seated position and the closure of screw assembly with key, (**C**) approximation accomplished by mesial movement and docking of bony segments towards the interdental alveolar cleft between teeth 11 and 23 and (**D**) an occlusal radiograph taken intraoperatively before the commencement of anterior maxillary distraction osteogenesis.

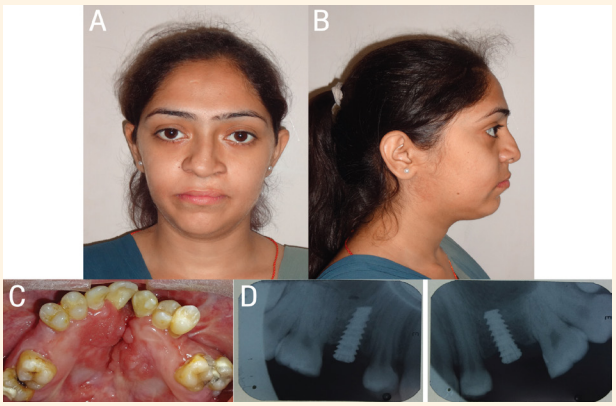

Figure 4: Photographs after the completion of anterior maxillary distraction osteogenesis showing (**A**) favourable frontal aesthetics, (**B**) improved profile aesthetics, (**C**) immediate post-distraction occlusal view after the removal of the distractor appliance. Intraoral periapical radiograph X-rays showing (**D**) good bone regeneration and implants placed bilaterally in the distracted bone between second premolar and first molar.

sides were closely approximated towards each other in an evenly controlled vector (without over-riding of segments), the closure of the cleft was visualised; the 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 1 single unit [Figure 3C] in preparation for facilitating AMDO for the correction of cleft maxillary retrognathia. The interim Hyrax assembly was removed following the closure using a 3-0 Vicryl suture. Thereafter, a 3-part tooth-borne bonded Hyrax distractor assembly (with 90° orientation for anteroposterior movement) oriented parallel to mid palatine plane was cemented.

The gap created at the area of the 2 vertical osteotomies was utilised for anterior maxillary distraction at a rate of 1 mm per day [Figure 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 in a total of 1 full turn every day (i.e. 1 mm/day). The screw was activated for 13 days, thus amounting to a total correction of 13 mm. After the completion of the 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 mineralisation and corticalisation of the newly formed bone tissue before the removal of the distractor assembly. Postoperatively, the recovery period was uneventful, with no detection of any relapse and complications.

Favourable results of the technique showing a postoperative approximation of the bone in the cleft site and satisfactory improvement in aesthetics, along with good bone regeneration at the area of distraction [Figure 4A–C]. Alveolar space with good, regenerated bone quality and implants placed bilaterally in the distracted bone are evident by intraoral periapical radiographs [Figure 4D].

The ethical approval for the treatment protocol and 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 DO have been widely used for the management of severe midfacial retrusion, including anterior crossbite in cleft lip and palate patients.[9–11]

The restoration of alveolar arch continuity is desirable before the initiation of AMDO in cleft maxillary deformities. Moreover, the restoration of large alveolar cleft defects by alveolar DO utilising intraoral tooth-borne distractor has been successfully reported in the literature.[1,9] The tooth-borne trifocal distraction appliance involving the use of 2 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 to achieve arch continuity, stabilise the maxillary segments, eliminate oronasal fistulae, optimise nasal morphology through nasal alar cartilage support and finalise implant placement.[13] However, before the commencement of AMDO, a waiting time of at least 3–6 months is recommended for the stabilisation of

the graft. A challenge is usually encountered when patients with a history of previously failed alveolar bone grafting surgeries refuse to undergo another grafting procedure.

The conventional application of the Hyrax screw for the closure of large alveolar clefts (i.e. the activation of the appliance by opening the screw) has been widely documented in the literature.[9,12] The majority of these applications involving a Hyrax screw and a fan-shaped screw entail the opening of the screws to facilitate the approximation of the alveolar segments towards each other.[8,12,14] On the other hand, the present technical note describes the novel application of the modification of the Hyrax screw, where a conventional Hyrax screw, after being fully opened, was utilised as an interim assembly for accomplishing single-step closure of a small alveolar cleft of up to 5 mm before the commencement of anterior maxillary DO. The present interim tooth-borne Hyrax screw assembly facilitated controlled mobilisation, docking and close approximation of the bony segments (without the over-riding of segments) towards the defect. This assembly enabled more precise bony movements while simultaneously maintaining bone-to-bone contact and the stabilisation 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 the patient's wishes, this technique, which involves the use of interim tooth-borne Hyrax screw assembly, is suitable for clinical application in patients who are potential candidates for AMDO and 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 the creation of any extraoral wound, making such therapy feasible, particularly for patients with small alveolar cleft defects of up to 5 mm. The simplicity of the design, ease of fabrication and exclusive tooth-borne usage minimises the invasiveness of the procedure.

However, this technique cannot be employed in large alveolar cleft defects where 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.

AUTHORS' CONTRIBUTION

SM, HS and DS were responsible for the study's conception and design, as well as the treatment of the patient. HS and SM contributed to the literature search and drafting of the article. SM, HS, DS and PS contributed to the final editing and critical revision of the article. All authors approved the final version of the manuscript.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

FUNDING

No funding was received for this research.

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