CASE REPORT

Reconstruction of a Post Traumatic Anterior Maxillary Defect by Transport Distraction Osteogenesis

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Abstract Rehabilitation of segmental defects of maxilla presents a reconstructive challenge to obtain an ideal osseous form and height with adequate soft tissue investment. Though variety of prosthetic and surgical reconstructive options like the use of vascularized and non vascularized bone grafts are available they produce less than optimal results. Bone transport distraction is a reliable procedure in various maxillofacial bony defect reconstruction techniques. We describe herein a technique of maxillary bone transport distraction using an indigenously designed, custom made trifocal transport distractor performed in a post traumatic avulsive defect of the anterior maxilla. Transport distraction was successful for anterior maxillary alveolar bony regeneration, with excellent soft tissue cover and vestibular depth, which also helped close an oroantral/oronasal fistula.

Keywords Anterior maxillary defect · Maxillary transport distraction · Trifocal distraction

Introduction

Maxillary bone with its relatively inelastic soft tissue investment and a highly complex anatomical configuration creates a specialized challenge in its optimal reconstruction. Most maxillary defects are often composite in nature

which often necessitates the restoration of bone and soft tissue.

The utility of the dentoalveolar bone transport in cleft alveolus and palate patients have been widely reported [1, 2], however the utility of transport distraction in segmental maxillary reconstruction has been limited and is in its infancy. We report herein a surgical technique for reconstruction in a case of post traumatic avulsive injury of the anterior maxilla using an indigenous transport distraction device.

Case Report

A 28-year-old male patient, a case of road traffic accident (RTA), was transferred to our hospital for management of his facial injuries. Clinical examination revealed a complete avulsion of the anterior maxilla extending from the first premolar region on the right side to the second premolar region on the opposite side involving the nasal floor with extensive oroantral communication on either side which was closed primarily.

Post operatively a well healed anterior maxillary defect of approximately 45 mm was present extending across the midline (Fig. 1). The curvilinear defect extended from anterior to the first premolar region on right side extending across the midline to the second premolar region on the left side (Fig. 2). The defect extended from the alveolar margin to just short of the nasal floor in a supero-inferior direction. The vertical height of the defect was approximately 20 mm and the curvilinear defect spanned approximately 20 mm in length on the right side to the midline and 25 mm on the left side to the midline. The remaining residual ridge had a proper arch form that facilitated placement of the distractor and vector control

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Fig. 1 Post traumatic avulsive defect of anterior maxilla after primary closure showing the extent of the defect clinically

Fig. 2 Preoperative 3D CT showing the curvilinear defect extending from first premolar region on right side across the midline to the second premolar region on the left side

during distraction. A medical grade SS custom made trifocal distraction device was fabricated for reconstruction of the defect. The device consisted of two arched stainless steel hollow guidance rod, conforming to the arch form on either side and united at the midline with a stainless steel retention screw to effect trifocal bone transport and easy application of the device.

Surgical Technique

The patient was taken for distractor placement under general anesthesia. An oral intubation was done due to associated nasal complex fracture with collapse of the

cartilaginous framework and severe septal deviation that made nasal intubation difficult. A vestibular incision was placed and the transport segment was marked on the right side extending from the distal edge of the residual host bone with the first and second premolars in it. A transport disc of approximately 20 mm in height $\times$ 15 mm in length $\times$ 10 mm in width was created encompassing both the premolars on the right side (Fig. 3). An interdental vertical osteotomy cut was made between the second premolar and the first molar, taking care not to injure the roots of the adjoining teeth. This vertical cut extended 5 mm short of the alveolar crest to 5 mm above the apices of the premolar teeth and was taken horizontally above the root apices to the distal edge of the residual host bone. Once the cut was taken through the labial cortex and marrow to its entire length and width, punch holes were made at a depth through the palatal surface, taking care not to injure the palatal mucoperiosteum. A second transport disc of approximately 15 mm in height $\times$ 15 mm in length $\times$ 10 mm in width (Fig. 4), without teeth was created on the left side, followed by transfixing the transport and retentive devices at the predetermined sites. The individual distractors were joined in the midline by a solid stainless steel screw. The segment was then gently mobilized to ensure the completeness of the cuts. The device was activated after a latency period of 5 days, with twice daily frequency until further activation was not possible. 5 ml of autologous PRP was injected into the maturing callus on

Fig. 3 Intra operative picture showing the transport disc prepared on the right side incorporating two premolar teeth

Fig. 4 Intra operative picture showing the transport disc prepared on the left side

Fig. 5 Post distraction OPG showing consolidating distraction regenerate with distractor in situ

either side to enhance the osteogenic potential following distraction. A 3 month consolidation phase was allowed for the distraction regenerate to mature (Fig. 5), after which the distraction device was disengaged. The distracted regenerate was able to restore the missing anterior maxillary arch form, to near normal anatomy with good labial sulci depth (Fig. 6).

During the time of disengagement of the device, a gap of 5–6 mm was observed at the docking site in the midline between the transport segments which was bridged with cancellous bone graft harvested from the anterior iliac crest. The cancellous graft was protected by a collagen membrane (Healiguide™) and the membrane was stabilized by sutures to the surrounding periosteum. The transport segments were stabilized by a midfacial plate spanning across the intervening graft material.

Fig. 6 Post consolidation photograph of the maxillary arch showing excellent restoration of the anterior maxillary arch form and vestibular depth

Fig. 7 Oblique 3D CBCT showing the consolidated regenerate on L side and the remaining defect

The post consolidation imaging using cone beam CT confirmed formation of normal bone. A distraction regenerate of approximately 2 cm was obtained on the right side and 2 cm on the left side (Fig. 7). Patient was maintained by functional loading with an interim removable partial denture till maturation of the distraction regenerate. Three TRI One Piece Ball Attachment Mini Implants (EZ Hitec Implants, Herzlia, Israel) were placed in the matured distraction regenerate after 1 year to provide implant support over denture for prosthetic rehabilitation.

Certain pitfalls observed were that distraction was short by 4–5 mm in the midline which necessitated grafting of the docking site. The transport segment on the right side expressed palatal-sagittal deviation which required a vector guiding splint to mold the regenerate. The central midline retentive screw used to stabilize the distraction devices was impinging on the upper lip vermillion resulting in traumatic laceration which required primary closure at the time of distractor removal. The premolars in the transport disk on

the right side expressed severe tilting and mobility due to the pull of the transeptal fibers, with bone loss on the leading edge of the transport disc, necessitating extraction of both the premolars before implant placement. Other problems encountered intra operatively were extrusion of the distractor hardware that was partially covered by the keratinized distraction regenerate. No hardware failure was however encountered during the process of distraction.

Discussion

Maxillary dentoalveolar bone defects resulting from trauma, tumor resection and craniofacial deformities create tremendous aesthetic and functional handicaps and have remained a critical challenge for surgical reconstruction. A traditional approach with autogenous non vascularized bone grafts, pedicled or microvascular composite grafts cause donor site morbidity and often result in a less than desirable arch form and height required for adequate dental rehabilitation. Moreover scarring and fibrosis surrounding the underlying graft can lead to a poor vascular supply resulting in higher chances of wound dehiscence and bone resorption [3].

Prosthetic treatment options like use of an obturator or use of implant supported obturator prosthesis can also serve as an alternate treatment option for rehabilitation of maxillary segmental defects. Implant supported prosthesis with implants placed on the residual alveolar ridge or implants placed in remote locations in case of extensive maxillary defects can be used to gain anchorage for implant supported obturators for rehabilitation of maxillary segmental defects [4].

Distraction osteogenesis though labor-intensive, has the advantages of reduced surgical time and trauma with better restoration of three dimensional form of the missing soft and hard tissues. Distraction osteogenesis has been applied to multiple sites in the midfacial skeleton in pediatric and adult populations based on specific needs [1]. Reconstruction of an anterior maxillary defect could best be performed with trifocal transport of bone segments towards each other to reduce the duration of distraction by half and overcome the varying change in vector direction while traversing across the midline with bifocal transport. It would also overcome the problem of consolidation that would occur while traversing across midline and against the resistance offered by inelastic surrounding soft tissue [5].

Cheung et al. [6] first reported the feasibility of posterior maxillary reconstruction with transport distraction osteogenesis in an animal model. Niu and Han [7] reported the successful use of a semi buried, curvilinear distraction device for reconstruction of maxillary defects in a canine model. Neelakandan et al. [8] reported the reconstruction

of posterior maxillary defect using an indigenous intra oral transport distraction device. However few reports exist in the literature on use of trifocal DO to reconstruct anterior maxillary defects [9, 10]. In the present study, we created two transport disks that were guided to slide along the smooth arc of two curvilinear transport distractors joined in the midline.

The simple design of the distraction device facilitated easy application and removal with better patient compliance and fewer complications. As internal curvilinear devices were used other than the activating arm which projected through the cheeks, there was no need for pin tracking through the skin, avoiding the presence of a cutaneous scar.

The reason for including two teeth in the transport segment on the right side was to use them as abutments for rehabilitation after distraction, to clinically assess the movement of the transport segment and to form a better ridge and buccal sulcus because of the intactness of the alveolar component in the transport segment. Most noteworthy end result of the distraction was the presence of native keratinized attached gingiva in the reconstructed defect that helped to maintain a high degree of oral hygiene for maintenance of the prosthetic appliance.

Vector control during distraction of the transport segment in curvilinear defects is a major challenging factor in determining the ultimate outcome. Factors affecting a deviation from the desired vector could be a result of a combination of bending of the transport disk because of the modulus of elasticity of the newly generated bone, the impedance from adjacent attached tissues and thickness of the tissues on the leading edge of the transport disk [11]. Maxillary reconstruction represents a distinct subset of patients and the principal source of resistance in maxilla is the palatal tissue, shape of the remaining palatal vault, and presence of the nasal septum. However there is much less concern regarding mounting pressure from tissues anterior to the transport disk unlike in mandibular distraction [11].

Variety of methods of vector control have been described in the literature like the use of multiple linear vectors, exaggerated linear distraction (“sausage effect”), braced guided distraction, and osteotomies [11]. These methods can greatly assist the operator in achieving the goal of symmetrical reconstruction. Robinoy et al. [12] have listed several means of obtaining alveolar segment vector control like orthodontic mechanisms, splints, molding the regenerate and performing an osteotomy. The transport segment in our case on the right side expressed palatal-sagittal deviation which required a vector guiding splint to mold the regenerate.

At the end of the distraction, 5–6 mm gap was noticed at the docking site between the two transport segments, possibly as a result of intervening soft tissue and fibrocartilaginous cap existing between the transport segments and

interfering with the normal osseous union of the transport segments. Some authors [10, 13] reported that the transported segments could not meet because of interposed connective tissue and screw bending after the completion of distraction. Therefore, stabilization of the transport segments was made with a titanium midfacial plate and bone grafting in the intervening area between the two transported segments. More and more studies [9, 12] consider that compression osteosynthesis may be an effective method to resolve the question. However since in our case the gap between the transport segments were 5–6 mm, iliac crest cancellous graft was harvested and grafted in the intervening site.

Conclusion

In conclusion, an indigenous internal trifocal distraction device was used to reconstruct a post traumatic anterior maxillary defect with resultant desired maxillary bone form and elimination of the oronasal and oroantral fistula. As shown here, the bone transport distraction technique is an excellent modality for dentoalveolar regeneration in patients with subtotal defects of maxilla.

Compliance with Ethical Standards

Conflict of interest None.

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