Management of Cleft Maxillary Hypoplasia with Anterior Maxillary Distraction: Our Experience

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Abstract Maxillary hypoplasia is a common developmental problem in cleft lip and palate deformities. Since 1970s these deformities have traditionally been corrected by means of orthognathic surgery. Management of skeletal deformities in the maxillofacial region has been an important challenge for maxillofacial surgeons and orthodontists. Distraction osteogenesis is a surgical technique that uses body's own repairing mechanisms for optimal reconstruction of the tissues. We present four cases of anterior maxillary distraction osteogenesis with tooth borne distraction device-Hyrax, which were analyzed retrospectively for the efficacy of the tooth borne device-Hyrax and skeletal stability of distracted anterior maxillary segment.

Keywords Anterior maxillary distraction · Hyrax · Cleft lip and palate

Introduction

Maxillary hypoplasia is often an unavoidable sequelae in cleft lip and palate patients who had undergone timely surgical and orthodontic intervention. Lefort I advancement is the traditional management modality for correction of the maxillary hypoplasia in cleft lip and palate patients but the alteration of the speech and relapse rate after lefort I advancement is significant [1]. Distraction also has

significant risk of velopharyngeal insufficiency [2]. Anterior maxillary distraction for maxillary hypoplasia secondary to cleft lip and palate has the advantage of fewer chances of velopharyngeal insufficiency, speech alteration and lesser relapse rates.

The retrospective study of four cases was aimed to evaluate the efficacy of tooth borne distraction in anterior maxilla and skeletal stability of advancement over a period of 1 year in patients with maxillary hypoplasia secondary to cleft lip and palate.

Materials and Methods

All the four patients included were above the age of 18 years with unilateral cleft lip and palate. In two cases alveolar bone grafting had not been done. The preoperative, immediate post operative and 1 year post operative lateral cephalogram were analyzed for skeletal stability, using anterior nasal spine (ANS) to posterior nasal spine (PNS) dimensions and the changes in the ANS-PNS were recorded.

In all the cases NiTi coil springs were used to create space between maxillary premolars and molars for anterior maxillary osteotomy. After attaining the adequate space, the Hyrax (13 mm expansion) appliance was fabricated on the maxillary dental model by the orthodontist. Appliance was preoperatively checked in patient's mouth and kept in place without activation for a period of 1 month so that the patient gets used to the appliance. In all cases the premolars and molars were banded on either side. The same appliance was used later for distraction for anterior maxillary osteotomy; the appliance was placed with an orientation of 90° keeping the appliance parallel to mid palatine plane, such that its activation results in antero-posterior movement and no transverse movement (Fig. 1).

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Fig. 1 Hyrax appliance preoperative

Surgical technique

Under general anesthesia with naso endotracheal intubation, maxillary vestibular incision was made from 1st molar to contra lateral first molar. Mucoperiosteal flap was raised exposing the infraorbital foramen and pyriform aperture. Horizontal cuts were made 6 mm above the apices of the canine and parallel to occlusal plane, till the predetermined site of distraction. Lateral osteotomy of the lateral wall of the pyriform rim was done at the same level of the buccal cut, with care not to damage the nasal mucosa. The vertical cuts in the buccal cortex were made between the premolars and molars. The palatal mucosa was undermined, osteotomy was done using bur and osteotome. The anterior segment was mobilized using gentle digital pressure. The activator is activated intraoperatively to check the mobility of maxillary segment. The vestibular incision is closed using 3–0 vicryl suture material in layers.

In two cases bilateral sagittal split osteotomy was done along with the distraction of the anterior maxilla, to correct the mandibular excess.

Activation

The activation was started with 3 days latency period. Distraction was done at the rate of 0.5 mm (2 turns) twice a day by the same person for a period till the predetermined advancement was achieved (Fig. 2). After the completion of the activation period the appliance was left in situ for the consolidation period of 3 months. After the completion of the consolidation period the space between premolar and molar were closed orthodontically. Radiographs of lateral cephalogram (Fig. 3a–c) and orthopantomogram (Fig. 4a–c) were taken immediately after completion of distraction, and in 3 months interval for evaluation of the relapse rate and bone formation.

Fig. 2 Hyrax appliance post distraction

Results

The amount of maxillary advancement achieved was recorded by analyzing the lateral cephalometric radiograph (Table 1). In one of the cases 2 mm of relapse was noticed. The speech of the patients was not formally assessed but no worsening in the speech was reported during and post treatment period. The post-operative, distraction and consolidation periods were uneventful in our cases (Fig. 5a–d).

Discussion

Severe maxillary deficiency can be caused by cleft lip and palate, other craniofacial deformities, hypodontia, atrophy in the edentulous maxilla and trauma. Patients having maxillary deficiency secondary to cleft lip and palate present a difficult treatment challenge. Distraction osteogenesis (DO) is one of the recent major developments in the field of oral and maxillofacial surgery. The application of anterior maxillary distraction techniques has eliminated many of the significant disadvantages of relapse and velopharyngeal insufficiency associated with traditional surgical approaches for the management of patients with maxillary hypoplasia. Maxillary distraction can be applied in multiple ways to individualize the surgical plan based on esthetic and functional requirements [3].

Codvilla in 1905 first described DO for elongation of the shortened limbs [4], followed by Abbott in 1927 for tibia elongation [5]. In 1950's Gabriel Ilizarov [6, 7] was the one who popularized the technique by publishing extensive series of clinical and experimental report on DO. In early 1990's McCarthy et al. [8] demonstrated elongations of mandible using DO. Costantino et al. [9] in 1990 repaired the segmental defect in canine model. In the recent years

Fig. 3 a Preoperative lateral cephalogram b immediate post-operative lateral cephalogram c 1 year post distraction

Fig. 4 **a** Preoperative OPG **b** immediate post-operative OPG **c** 1 year post distraction OPG

Table 1 Changes in ANS-PNS using lateral cephalogram

Sl. no	Pre operative (ANS-PNS) (mm)	Post distraction (ANS-PNS) (mm)	1 year post distraction (ANS-PNS) (mm)	Replase (mm)	Advancement achieved (mm)
1.	44	51	51	0	7
2.	44	53	53	0	9
3.	45	52	52	0	7
4.	44	54	52	2	10

there has been a rapid advancement in the field of DO for correction of defects, congenital or acquired, in the oral and maxillofacial region.

Block and Brister (1994) [10] and Altuna et al. (1995) [11] examined anterior segmental distraction osteogenesis experimentally in the maxilla. Altuna et al. [11, 12] used a modified occlusal splint as tooth borne device on primates. They determined that anterior segment movement with distraction osteogenesis is a reliable method and can be

applied clinically. Wassmund in 1926 distracted the maxilla using DO, followed by Rosenthal in 1927 who used DO in distracting anterior mandible [13]. William Bell [14] used a Wassmund osteotomy to correct anterior maxillary retrusion and class III malocclusion. The advancement of the anterior maxilla is difficult with osteotomy and can be complicated by oro nasal fistula formation.

Dolomaz et al. [15] first described anterior maxillary distraction using two parts acrylic appliance with Hyrax screw. The acrylic plate covers the tooth occlusal surface that can lift the occlusion. In our cases we have not used acrylic splints for lifting the occlusion.

Bengi et al. [16] used an individual tooth borne distraction device to advance the maxillary segment. The results showed that the premaxilla moved antero superiorly. The soft tissue profile showed improvement, the length of the palatal plane and maxillary arch increased and sufficient space was gained to align the crowded teeth.

In a case report, Karakasis and Hadjiperous [17] presented gradual distraction osteogenesis using two intraoral bone borne unidirectional devices of Zurich ramus distractor for anterior maxillary advancement, resulting in satisfactory final occlusion and considerable aesthetic improvement.

Wang et al. [18] in a clinical study showed an advancement of 10.5 mm of anterior maxilla with no significant velopharyngeal insufficiency using internal distraction device and external distraction device. In our cases we achieved 10 mm of advancement with no alteration in speech.

Keudstall et al. [19] used Rotterdam palatal distractor-bone borne distractor for the expansion of the transverse hypoplastic patients, like in cleft palate. It gives more of an orthopedic expansion of the maxilla rather than tooth tipping.

Literature shows that clinical research was carried out by various centers to determine the optimal protocols for anterior maxillary distraction [20–25].

In our patients we created the required space for segmentalization of maxilla orthodontically. The osteotomy site was selected between the premolar and molar. In cleft lip and palate cases hypodontia in the anterior maxilla is a common feature. While doing the segmentalization of maxilla it is preferred to maintain at least 3 teeth per segment, for maintenance of an adequate good blood supply [26]. So keeping the osteotomy site between the premolar and molar region gives enough number of teeth that can aid maintenance of blood supply of the anterior segment of the maxilla. The prosthodontics rehabilitation of the posterior segment is easier.

The Hyrax appliance which was preoperatively fixed was removed intraoperatively for the palatal osteotomy. After mobilizing the premaxilla, Hyrax appliance was re-fixed with the assistance of the treating orthodontist. The removal and insertion of the appliance intraoperatively

Fig. 5 **a** Preoperative lateral profile **b** 1 year post-operative lateral profile **c** preoperative occlusion **d** 1 year post-operative occlusion

increases the surgical time but not significantly. We used the 3 days latency period in all the cases. In recent literature 0–5 days latency period have been advocated [27–30]. The distractor was activated twice daily 0.5 mm (2 turns) in the morning and 0.5 mm (2 turns) in the evening so that 1 mm per day of expansion was done, till the intended antero posterior movement was achieved. A period of 3 months consolidation period was followed in our case. Consolidation period may vary from 4 to 12 weeks [31–34]. The patient was followed-up regularly, initially on weekly intervals during consolidation period and later on monthly intervals for a period of one year. Distracted space maintenance can be achieved by fixed partial denture, removable partial denture, implants or orthodontic realignment. In our cases we have closed the space between the premolar and molar orthodontically.

In bi jaw deformity secondary to cleft lip and palate patients, anterior maxillary distraction along with Bilateral Sagittal Split Osteotomy have fewer complications in respect of velopharyngeal insufficiency and relapse rate as compared to traditional method of Lefort I and Bilateral Sagittal Split Osteotomy. In two of our four cases we did Bilateral Sagittal Split Osteotomy to correct the mandibular excess.

In traditional methods relapse of 20–60 % [35] have been reported in literature. One of our cases showed relapse of 2 mm similar to that reported by Richardson et al. [25]. Relapse of distracted anterior maxilla can occur in cleft lip and palate patients. Velopharyngeal insufficiency after Lefort I advancement is due to a stretch on the palatal musculature, worsening the velopharyngeal incompetence and hence the speech. Advantages of anterior maxillary distraction are that, it is a simple procedure as compared to

Lefort I osteotomy, with fewer complications and less relapse, additionally speech is not affected.

Conclusion

Anterior maxillary distraction is a relatively simple procedure to correct the maxillary deficiency secondary to cleft lip and palate. The advantages of anterior maxillary distraction are lesser velopharyngeal insufficiency, speech alteration and relapse.

References

- Hirano A, Suzuki H (2001) Factors related to relapse after Le Fort I maxillary advancement osteotomy in patients with cleft lip and palate. *Cleft Palate Craniofac J* 38:1
- Guyette TW, Polley JW, Figueroa A et al (2001) Changes in speech following maxillary distraction osteogenesis. *Cleft Palate Craniofac J* 38:199
- Perott DH, Berger R, Vargier K et al (1993) Use of skeletal distraction device to widen the mandible: a case report. *J Oral Maxillofac Surg* 51:435
- Chin M, Toth BA (1996) Distraction osteogenesis in maxillofacial surgery using internal devices: review of five cases. *J Oral Maxillofac Surg* 54:45–53
- Abbott LC (1927) The operative lengthening of the tibia and fibula. *J Bone Joint Surg* 9:128–139
- Hollier LH, Kim JH, Grayson B, McCarthy JG (1999) Mandibular growth after distraction in patients under 48 months of age. *Plast Reconstr Surg* 103:1361–1370
- Ilizarov GA (1971) Basic principles of transosseous compression and distraction osteosynthesis. *Ortop Travmatol Protez* 32:7–9
- Karp NS, McCarthy JG, Schrieber JS et al (1992) Membranous bone lengthening: a serial histologic study. *Ann Plast Surg* 29:2–7
- Cohen SR (1999) Craniofacial distraction with a modular internal distraction system: evolution of design and surgical techniques. *Plast Reconstr Surg* 103:1596–1607
- Block MS, Brister GD (1994) Use of distraction osteogenesis for maxillary advancement: preliminary results. *J Oral Maxillofac Surg* 52:282–286
- Altuna G, Walker DA, Freeman E (1995) Surgically assisted rapid orthodontic lengthening of the maxilla in primates—a pilot study. *Am J Orthod Dentofac Orthop* 107:531–536
- Altuna G, Walker DA, Freeman E (1995) Surgically assisted rapid orthopedic lengthening of the maxilla in primates—relapse following distraction osteogenesis. *Int J Adult Orthodon Orthognath Surg* 10:269–275
- Stucki-McCormick SU (1997) Reconstruction of the mandibular condyle using transport distraction osteogenesis. *J Craniofac Surg* 8:48–53
- Bell WH (1968) Surgical correction of anterior maxillary retrusion: report of a case. *J Oral Surg* 26:57
- Dolanmaz D, Karaman AI, Ozyesil AG (2003) Maxillary anterior segmental advancement by using distraction osteogenesis: a case report. *Angle Orthod* 73:201–205
- Bengi O et al (2007) Cephalometric evaluation of patients treated by maxillary anterior segmental distraction. A preliminary report. *J Craniomaxillofac Surg* 35:302–310
- Karakasis D, Hadjiperous L (2004) Advancement of anterior maxilla by distraction. *J Craniomaxillofac Surg* 32:150–154
- Wang XX et al (2009) Anterior maxillary segmental distraction for correction of maxillary hypoplasia and dental crowding in cleft palate patients: a preliminary report. *Int J Oral Maxillofac Surg* 38:1237–1243
- Koudstaal MJ, VanDer Wal KGH, Wolvius EB, Schulten AJM (2006) The Rotterdam palatal distractor: introduction of the new bone borne device and report of the pilot study. *Int J Oral Maxillofac Surg* 35:31–35
- Alkan A, Bas B, Özer M, Bayram M, Yüzbasioğlu E (2008) Maxillary anterior segmental advancement of hypoplastic maxilla in cleft patients by distraction osteogenesis: report of 2 cases. *J Oral Maxillofac Surg* 66:126–132
- Bengi O, Karacay S, Akin E, Okcu KM, Olmez H, Mermut S (2007) Cephalometric evaluation of patients treated by maxillary anterior segmental distraction: a preliminary report. *J Craniomaxillofac Surg* 35:302–310
- Gualini C (2007) Advancement of maxillary anterior segment by distraction osteogenesis (DO): a case report. *Prog Orthod* 8:54–61
- Gunaseelan R, Cheung LK, Krishnaswamy R, Veerabahu M (2007) Anterior maxillary distraction by tooth-borne palatal distractor. *J Oral Maxillofac Surg* 65:1044–1049
- Harada K, Ishii Y, Ishii M, Imaizumi H, Mibu M, Omura K (2002) Effect of maxillary distraction osteogenesis on velopharyngeal function: a pilot study. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 93:538–543
- Richardson S, Agni NA, Selvaraj D (2011) Anterior maxillary distraction using a tooth-borne device for hypoplastic cleft maxillas—a pilot study. *J Oral maxillofac Surg* 69:542–548
- Varghese M (2010) Surgical correction of facial deformities Jaypee, India, pp 100
- Karaharju-Suvanto T, Peltonen J, Kahri A et al (1992) Distraction osteogenesis of the mandible: an experimental study on sheep. *J Oral Maxillofac Surg* 21:118
- Chin M, Toth BA (1996) Distraction osteogenesis in maxillofacial surgery using internal devices: review of five cases. *J Oral Maxillofac Surg* 54:45
- Rachmiel A, Jackson IT, Potparic Z et al (1995) Midface advancement in sheep by gradual distraction: a 1-year follow-up study. *J Oral Maxillofac Surg* 53:525
- Troulis MJ (2003) Effects of latency period in mandibular distraction osteogenesis (discussion). *Int J Oral Maxillofac Surg* 32:63
- Sawaki Y, Ohkubo H, Hibi H et al (1996) Mandibular lengthening by distraction osteogenesis of the mandible using osseo integrated implants and an intraoral device: a preliminary report. *J Oral Maxillofac Surg* 54:594
- Chiapasco M, Brusai R, Galioto S (2000) Distraction osteogenesis of a fibular revascularized flap for improvement of oral implant positioning in a tumor patient: a case report. *J Oral Maxillofac Surg* 58:1434
- Friedman CD, Constantino PD (1994) Use of distraction osteogenesis for maxillary advancement: preliminary results (discussion). *J Oral Maxillofac Surg* 52:287
- Rubio-Bueno P, Padrón A, Villa E et al (2000) Distraction osteogenesis of the ascending ramus for mandibular hypoplasia using extraoral or intraoral devices: a report of 8 cases. *J Oral Maxillofac Surg* 58:593
- Posnick JC, Dagys AP (1994) Skeletal stability and relapse patterns after Le Fort I maxillary osteotomy fixed with miniplates: the unilateral cleft lip and palate deformity. *Plast Reconstr Surg* 94:924–932