Nasolabial and Interincisal Angle Evaluation in Anterior Maxillary Distraction Osteogenesis: A Case Study

Tojan Chacko Thekkekara, Varghese Mani, Kuriakose Antony, Binnoy Kurian

ABSTRACT

Maxillary hypoplasia is a common developmental problem in cleft lip and palate deformities. These deformities have traditionally been corrected by means of orthognathic surgery. Management of skeletal deformities in the maxillofacial region has been a challenge for maxillofacial surgeons and orthodontists. Distraction osteogenesis (DO) is a surgical technique that uses body's own repairing mechanisms for optimal reconstruction of the hard and soft tissues. We present four cases of anterior maxillary distraction osteogenesis with tooth-borne distraction device—Hyrax, which were analyzed retrospectively using cephalometrics. Changes in nasolabial angle and interincisal angle after distraction of anterior maxillary segment were studied to conclude that there was no much change in the the nasolabial angle while the interincisal angle showed marked improvement.

Keywords: Anterior maxillary distraction, Hyrax, Cleft lip and palate.

INTRODUCTION

Distraction osteogenesis is a method of endogenous tissue generation in which new bone is mechanically induced within the space between opposing bone surfaces that are gradually separated by means of incremental traction. Bone elongation technique was pioneered by Codvilla, who in 1905 published a case report of femoral extension using axial forces of distraction.1

The development of distraction osteogenesis has received an outstanding contribution from the work of Ilizarov, a Russian scientist, who in 1953 explained the scientific basis for the bone formation between the vascularized margins of osteotomized long bones. Ilizarov showed that lengthening of the long bones is possible without using a graft material.2-5 Use of this concept of distraction osteogenesis in the craniofacial skeleton experimentally was first reported by Snyder in 1973.6 Distraction osteogenesis (DO) is rapidly becoming an alternative technique to treat craniofacial dysplasias It was initially used successfully to treat unilateral or bilateral mandibular dysplasias.7

In 2003, the first successful clinical application of anterior maxillary segmental distraction (AMSD) using an intraoral toothborne distraction device was reported by Dolanmaz8 in a noncleft patient. He reported an advancement of 8 mm using an intraoral toothborne distraction device.

Wang XX et al9 in a clinical study treating the patients by anterior maxillary segmental distraction using internal distraction device and external distraction device reported to have achieved around 10.5 mm of advancement of maxilla and no patient had any sign of velopharyngeal morphological changes or speech deterioration. According to the study, the possible reasons for that are muscles of the velopharynx are not affected by anterior maxillary advancement and velopharyngeal mechanism is unaltered.

Block et al10-12 used tooth-borne and implant supported devices and demonstrated anterior maxillary advancement in dogs. They concluded that when a tooth-borne device was used, dental movements exceeded bone movements and relapse tendency is more.

The concept of gradually advancing the maxilla after Le fort1 osteotomy was originally presented by Molina and Monasterio.13 In this technique, an orthodontic face mask with elastics was used to deliver the traction force to maxilla.

Figueroa AA et al14 in 1999 analyzed 14 patients treated by maxillary distraction osteogenesis after complete osteotomy with a rigid external maxillary distraction device and found that to be highly effective treatment modality to
manage cleft-related maxillary hypoplasia. The technique allows vector control of the osteotomized maxilla throughout the distraction process.

Altuna et al\textsuperscript{15,16} used a tooth-borne device and reported reliable maxillary advancement in primates. Distraction osteogenesis can achieve advancement exceeding the advancements of the conventional osteotomies by 2 to 3 folds. This is because distraction osteogenesis by gradual stretching can overcome the natural soft tissue resistance, and can accommodate generating new soft tissue (histogenesis) simultaneously with skeletal augmentation.

According to Keudstall MJ and Vanderwal et al\textsuperscript{17}, Rotterdam palatal distractor-bone borne distractor used for the expansion of the transverse hypoplastic patients, like cleft palate gives more of an orthopedic expansion of the maxilla rather than tooth tipping.

**MATERIALS AND METHODS**

All the four patients included were above the age of 18 years with unilateral cleft lip and palate. Every patient was bonded with 0.022” slot MBT bracket system. In two cases, alveolar bone grafting had not been done. Initial alignment was done with 0.012”, 0.014” and 0.016” nickel titanium wires. After initial alignment, 0.019” × 0.025” nickel titanium wires were placed to get mild transverse expansion. Space was created in the premolar region using open coil springs on both sides to perform osteotomy. After attaining the adequate space, upper 1st molars and 2nd premolars were banded and impressions were made with the bands in place. Casts were prepared and hyrax screw (13 mm expansion) was soldered to the bands. 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 acquainted with the appliance. 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 anteroposterior movement and no transverse movement (Fig. 1).

The preoperative, postoperative after distraction and 1 year postoperative lateral cephalogram were analyzed for changes in nasolabial angle and interincisal angle.

**Surgical Technique**

Maxillary vestibular incision was made from 1st molar to contralateral first molar under general anesthesia with nasoendotracheal intubation. The infraorbital foramen and pyriform apertures were exposed by raising the Mucoperiosteal flap. 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**

After a 3 days’ latency period, the activation was started. Distraction was done at the rate of 0.5 mm (2 turns) twice a day for a period till the predetermined advancement was
achieved by the same person (Fig. 2). Once the activation was completed, the appliance was left in situ for the consolidation period of 3 months. Lateral cephalogram (Figs 3A to C) were taken immediately after completion of distraction, and after 1 year interval for evaluation of the nasolabial angle and interincisal angle.

**Postsurgical Orthodontic Phase**

Postsurgically, the anterior open bite was corrected with anterior box elastics which also gave a mild retraction of upper incisors. After closing of anterior open bite arch wire was changed to 0.019" × 0.025" SS wire. Distraction space was maintained using open coil springs. Later, fixed prosthesis was placed in the distracted area.

**RESULTS**

The nasolabial (Table 1) showed a mean reduction of 12.5° immediately after distraction but returned to almost the same value after 1 year of surgery with only 0.5° mean value increase. The interincisal angle (Table 2) showed a mean value reduction of 29.75° immediately after distraction and returned to normal values with improvement of 19.5° after postsurgical orthodontics.

The speech of the patients was formally assessed with speech therapist but no worsening in the speech was reported during and post-treatment period. The postoperative, distraction and consolidation periods were uneventful in our cases (Figs 4A to D).

**DISCUSSION**

Craniofacial distraction osteogenesis has become an accepted method worldwide for the treatment of congenital and acquired craniofacial anomalies. Le Fort I osteotomy with direct advancement has many disadvantages when used for the correction of hypoplastic maxilla in cleft lip and palate patients, such as limited advancement, requirement of bone graft, negative effect on velopharyngeal mechanism, high risk bone necrosis and relapse. In cleft lip and palate patients, where more amount of maxillary advancement is needed, mandibular setback along with maxillary advancement is done to correct the skeletal relation. The disadvantage of this two jaw surgery is that setback of a normal mandible can compromise final lower facial form, esthetics and facial harmony (Table 3).

Anterior maxillary osteotomy is mainly indicated for the correction of maxillary dentoalveolar protrusion. Three techniques are currently used to achieve the anterior maxillary osteotomy, Wassmund osteotomy, Wunderer osteotomy and maxillary anterior down fracture osteotomy by Epker.

Osteotomy cuts are essentially the same but each technique varies only in the incision design, access to the

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**Table 2:** Interincisal angle

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Figs 3A to C: (A) Preoperative lateral cephalogram, (B) Postdistraction lateral cephalogram, (C) One year postdistraction
maxillary bone and direction of maxillary mobilization. Advancement of the anterior maxilla by osteotomy is technically difficult because of tight palatal mucoperiosteum.

Bengi et al. used an individual tooth-borne distraction device to advance the maxillary segment in seven patients. The results showed that the premaxilla moved anterosuperiorly. 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. Karakasis et al. in 2004 presented a case report of gradual distraction osteogenesis using two intraoral bone borne unidirectional devices of Zurich ramus distractor for anterior maxillary advancement. The patient achieved satisfactory final occlusion and considerable esthetic improvement.

Maxillary distraction following anterior maxillary osteotomy has many advantages including greater advancement of the anterior maxilla, more stable and reliable long-term results, no need for bone graft, reduced negative effect on the velopharyngeal mechanism. Because of these reasons, distraction osteogenesis is used for the maxillary advancement in the cleft lip and palate cases.

Clinical parameters that affect the treatment outcome of distraction osteogenesis include the following:

- Age of the patient
- Surgical technique
- Distraction device
- Rate of distraction
- Rhythm of distraction
- Latency period
- Consolidation period

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Usually for distraction, two types of distractors can be used, external or internal distractors. Selection of a distraction device is based upon the surgical goals intended for the individual patient. The basic goals of any maxillary advancement surgery are to create a stable functional occlusion and good facial esthetics.

Concerning the choice of distractors, there is a strong trend toward internal distractors. The advantage of the internal distractors includes the unaltered social life of the patient. The eventual need for a second surgery to remove the device is the disadvantage of the internal bone borne distractors.

External bone borne distractors can produce facial scars, increased potential for sensory damage, infections, altered social life of the patient and need for special care throughout the treatment. So, in the reported cases, tooth-borne internal distractor, Hyrax was employed.

Block et al\textsuperscript{12} used tooth-borne and implant-supported devices to demonstrate anterior maxillary advancement in dogs. According to them, when a tooth-borne device is used, dental movement exceeds skeletal movement and the relapse tendency is more in the long term.

The optimum callus distraction is 1 mm daily. Fast distraction leads to ischemia and delayed ossification or pseudoarthrosis. Slow distraction results in premature ossification and consolidation. Illizarov showed that osteogenic activity was more when DO was performed 0.25 mm for four times a day. In our patients, we performed 0.5 mm of distraction twice daily. The advantage of this is that frequency of daily visits to hospitals could be reduced.

According to Illizarov, success of DO depends on response of initial callus to tensile strength. In the endochondral bone, a latency period of 5 to 7 days after surgery is necessary to allow time for callus formation and healing of soft tissues. The membranous bones of craniofacial skeleton which were thin and with rich blood supply require much shorter latency period. We preferred a latency period of 3 days in our patients.

After distraction was completed, open bite resulted. Gateno et al\textsuperscript{22} have reported that if the distraction force is applied below the center of resistance of the maxilla, a counterclockwise rotation will be induced with a tendency toward an anterior open bite. The opposite is true for forces above center of resistance which can end up in clockwise rotation of the maxilla. So when an intraoral toothborne device is used, it ends up in anterior open bite. This is a disadvantage noticed while using the toothborne distractor. The above situation is because the distraction force is applied coronal to the center of resistance of the osteotomized maxilla.

In the reported cases, the nasolabial angle became more acute after distraction. This was due to the anticlockwise rotation of the maxilla resulting in anterior open bite. Later after using intraoral box elastics, the anterior open bite was corrected and the nasolabial angle returned to the initial values.

The interincisal angle was more initially because of anterior crossbite. Following distraction, the interincisal angle became acute due to the anterior open bite and proclination of upper anteriors. Later after using box elastics, the incisors retruded and the interincisal angle returned to the normal range.

REFERENCES

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