ORIGINAL ARTICLE

DISTRACTION OSTEOGENESIS FOR CORRECTING MANDIBULAR HYPOPLASIA IN CHILDREN

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ABSTRACT

The aim of this study was to determine the efficiency of extraoral bone anchored appliances to distract human mandible using the principles of distraction osteogenesis without orthognathic surgery, and to induce mandibular lengthening with minimal injury to soft tissues and neuro-vascular bundle.

Distraction osteogenesis is an alternative treatment method for the correction of mandibular hypoplasia. In this study, distraction with a unidirectional extra oral device was performed to gradually lengthen the corpus and ramus of patients who had hypo-plastic mandible.

Ten patients, six females and four males underwent unilateral and bilateral extra oral ramus and corpus distraction osteogenesis. After five days of latency period distraction was performed 0.5mm twice a day. Subsequent consolidation period was twelve weeks. This study was conducted in Adiparasakthi Dental College and Hospital in Tamilnadu, India. from 2004 to 2010.

In all the patients desired mandibular length (in 4 patients 10mm and in 6 patients 14mm) was achieved. Ultrasound examination was performed during the first, third, fifth, seventh, ninth and eleventh week, which showed echolucent area followed by hyperechoic spicules in a echolucent window and increasing echogenic material in distraction gap respectively. Posterior airway space (PAS) also increased due to advancement of mandible. Parasthesia was noticed in all the patients during activation but sensory function eventually regained during consolidation.

Satisfactory results from both aesthetic and functional standpoints were obtained by distraction osteogenesis of the ramus and corpus.

Key words: *Distraction osteogenesis, Mandibular hypoplasia in children*

INTRODUCTION

Deformities of the maxillofacial region are a source of great worry to patients as well as their relatives. Much more than any functional compromise that may be associated with the same, it is the social stigma that becomes a burden.

Surgeons all over the world have pioneered techniques to reconstruct these deformities. Quite a few of these have been abandoned for various reasons like morbidity, poor long term results etc. The main stay of surgical techniques for correction of these deformities has been osteotomies of the jaws but even these procedures have their own limitations and drawbacks.

Lengethening of limbs by distraction osteogenesis has captured the imagination of orthopaedic surgeons, the world over. The same technique has been applied

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to the maxillofacial region for the correction of deformities by some surgeons in the last decade.

It was decided to conduct a study of this technique in correcting dentofacial deformities to evaluate the various claims associated with it.

METHODOLOGY

This study was conducted on a group of patients with unilateral and bilateral mandibular hypoplasia.

Ten patients were included in this study. Six were females and four were males. Four of them had mandibular hypoplasia on the left side and 6 of them were bilateral following ankylosis. The age varied from six to nineteen years with an average of 10.5 years. Each patient was documented by photographs, radiographs (orthopantomogram, lateral and posteroanterior cephalograms), Ultra sound examination pre and post operatively. All patients were operated under general anaesthesia.

Inclusion criteria: Patients with mandibular hypoplasia and with hemifacial microsomia as well as patients with facial asymmetry with deviation of chin to the affected side.

Exclusion criteria: Patients with full component of permanent teeth with Angles Class I occlusion and patients with condylar hyperplasia.

SURGICAL PROCEDURE

The buccal surface of the hypoplastic angle was approached via an extra oral incision (Modified Risdom).

All the Cases were done by extra oral approach. An incision (3 cms) was placed by the skin lines of the submandibular fold. Marginal mandibular nerve was identified and preserved after dissection of the platysma. The masseter muscle sharply dissected off the buccal aspect of the mandible in a subperiosteal plane.

In two cases the osteotomy was placed mesial to the first molar in order to achieve mandibular body lengthening anterior to it.

In the next eight cases the osteotomy was placed at the angle in order to achieve lengthening of both ramus and body of mandible.

After placing the osteotomy two bicortical pins each (5cms) were inserted through a transbuccal incision on either side of the cut. Finally, a distraction device was fixed to the pins not too closely to the outer skin in order to allow good post operative cleaning.

The device was activated from the sixth post operative day. Daily distraction of one mm at the rate of 0.5mm two times a day was achieved by turning the both at the end of the device.

RESULTS

In all cases the extra oral appliance was activated from the sixth day. Medialization of chin was noted clinically during the activation phase. During the third week an ultrasound examination of the distraction site showed hyperechoic spicules in an echolucent window which suggested new bone formation. It was followed by fifth, seventh, ninth and eleventh week of ultrasound examination which revealed increasing echogenic material in the distraction gap (Table 1). After achieving a desired lengthening activation was stopped. The

TABLE 1: ULTRASONGOGRAPHIC MEASUREMENTS OF THE DISTRACTION GAP DURING THE CONSOLIDATION PHASE

Weeks post distraction	Ultrasonographic score (average = SD)	Gap width (average = SD mm)	Gap depth (average = SD mm)
T = 0	1.0	5.2 ± 0.4	8.9 ± 8.6
T = 3	1.0	5.2 ± 0.2	6.2 ± 2.2
T = 5	1.0	5.0 ± 0.7	5.9 ± 1.9
T = 7	2.6 ± 0.7	3.7 ± 1.2	5.0 ± 2.8
T = 9	2.7 ± 0.4	3.5 ± 1.0	3.3 ± 1.4
T = 11	3.1 ± 0.4	2.8 ± 0.9	2.5 ± 0.5

Ultrasonographic Score:

1. Sharp edges of distraction gap, no echogenic material inside distraction gap,
2. Edges rounded, <50% echogenic material in distraction gap,
3. Edges rounded, <50% echogenic material in distraction gap,
4. Cortical bridging of distraction gap,
5. Unable to measure

Gap width means distance between the most ventraly located of distraction gap and gap depth means per pendicular distance from the outer edges to the first echogenecities.

appliance was maintained in neutral position for the next eight weeks to allow consolidation. Then it was removed.

The external distraction proved to be successful in achieving mandibular lengthening and the process has been extremely benign for the patients. Morbidity is limited to the presence of mild scars located at the entrance of the screws and slightly enlarged by distraction. Parasthesia was noticed in all the patients on the distraction side and on the lip during the period of distraction but the sensory function was eventually regained during the consolidation period.

DISCUSSION

Reconstruction of the mandible in the adult, especially one in whom there is an associated soft tissue deficiency, is one of the most challenging problems in oral and maxillofacial surgery. These difficulties are compounded when the surgeon is faced with the complex deformities of craniofacial microsomia in a child. There are associated obstacles, including deformities of the maxilla, skull and overlying soft tissues, coupled with compensatory growth from the opposite side of the jaws. In addition there is the problem of unpredictable growth potential in the reconstructed mandible, which must maintain harmony with the rest of the facial skeleton. The aims, as with other congential anomalies, are to correct the functional and aesthetic deformities with similar tissues that have the growth potential to match the deficient part and which produce minimal scarring and donor site morbidity. This still remains an elusive goal.

There is much debate about the timing of surgery in the growing child. Some favour intervention at an early age to avoid secondary growth compensation in other areas and to minimize the psychological problems associated with a distorted body image. Others avoid early surgery in the hope that a single major procedure can be performed to correct the entire deformity once growth has ceased.

Reconstruction of the mandible with autogenous bone is currently the best method of repair. The choice has been between free nonvascularized bone grafts and vascularized bone grafts, whether pedicled or transferred from a distant site by microvascular techniques. Non vascularized bone grafts have the inherent problem of unpredictable survival of the transferred bone cells and their subsequent performance within the functional matrix of the soft tissues. Vascularized bone grafts overcome the problem of osteocyte survival and have the added advantage of transferring associated soft tissues. Even so, there are still difficulties with vascularized bone, and predictable results fall short of the mark.

Joseph McCarthy and his co-workers[1] have focused attention on an alternative method of providing lengthening of the mandibular bones by the use of distraction osteogenesis. After testing in experimental animals, they produced unilateral lengthening of the mandible of 18 to 20 mm in three young patients utilizing a relatively short period of distraction. This paved the way for a series of clinical studies on distraction osteogenesis in human mandibles.

Cornelius Klein and Hans Peter Howaldt[2] used a standard external fixation device commonly used in hand surgery with 2 double pin holders and a bolt at one end which permits gradual distraction of pins.

The external bone lengthening device which we have used in this study is similar to the one which was used in Cornelius Klein's study. The lengthening rod was activated by a screw mechanism. This appliance was used in three cases. It can be used only to correct unilateral mandibular deformity.

According to F Molina[3] the location of osteotomy varies according to the severity of the malformation. In patients with hypoplasia limited to the angle the osteotomy extends obliquely from the alveolar ridge to the angle. The vector of distraction crosses the osteotomy at 90 degrees.

In patients with hypoplasia affecting the angle and the ascending ramus, the osteotomy extends to the posterior edge of the ramus becoming more horizontal than oblique. The vector of distraction forces crossing the osteotomy becomes more vertical than oblique.

In this study, the osteotomy was placed obliquely from the alveolar ridge to the angle in patients with unilateral hypoplasia affecting the angle. We achieved the desired mandibular lengthening in all the cases.

In the present study both the pins on either side of the osteotomy were placed near the inferior border of

the mandible. The reason for this was to avoid inferior alveolar nerve injury while drilling the bone to allow pin placement. Also the pins were not placed above the inferior alveolar nerve canal in order to avoid injury to the underlying tooth buds. It was observed that the inferior border was getting distracted more than the alveolar ridges which is similar to Molina's study.

According to Ilizarov[4] success of distraction depends on the response of the initial callus to tensile stress. Therefore, in the endochondral bone, a latency period of 5-7 days after surgery is necessary to allow time for initial callus formation and healing of soft tissues.

Distraction protocols currently used in the cranio maxillofacial regional are derived from clinical and experimental studies in the long bones and from studies in the canine mandible. Most protocols include 4 to 6 latency period, a distraction rate of 1 mm per day and stabilization period twice the during of the distraction.

In the present study the distraction was done at a rate of 1mm/day with the rhythm being 0.5mm twice daily. The appliance was activated by the patient with minimal discomfort. This distraction rate follows the natural phenomenon of the regenerating biologic systems which allows the bone to regenerate after a lag phase of 6 days.[5]

After the active period of distraction, the distraction appliances are left in place for adequate consolidation and maturation of the bony callus. Most reports revealed that the 6-8 week consolidation period was the most appropriate for all mandibular lengthening and expansion.

In this study it was decided to maintain the appliance in the same position for the next 6-8 weeks in all the cases to allow consolidation.

Potential methods of noninvasive quantitative imaging of bone healing and re-modeling include quantitative computerized axial tomography (QCT), Ultrasound and magnetic resonance imaging (MRI), single-photon (SPA) and dual photon absorptiometry (DEXA), and acoustic ultrasound attenuation. Each of this methods has advantages and limitations. Each may prove helpful in examining a different aspect of the process of distraction osteogenesis. When such methods are applied, the biologic pathway proceeding to union can be monitored in order to regulate treatment. Ultrasound attenuation measurements parallel computed tomography as a measure of bone formation within the distraction gap.

Plain radiographs have limitations in detecting the smallest amounts of new bone formation that occur at the distraction site in the early stage of distraction. In clinical conditions, ultrasound has proved to detect the early new bone at the distraction site.

Mandibular osteodistraction has shown excellent regeneration potential, with almost full restoration of the structural, mechanical and functional integrity of the bone. However little is known about the effect of distraction on interior alveolar nerve function and the oral soft tissues in general.

Cephalometric analysis of distracted mandible revealed decreased ANB angle, decreased overjet and increased mandibular body and ramus length.[6] In this study on an average for all the cases it was observed ANB angle, overjet decreased mandibular body and ramus length was increased as per cephalometric analysis.

Dec W, Paltomaki T et al[7] conducted a study to determine how the vector of unilateral mandibular distraction affects treatment outcomes. Similar planning was done in this study and it was observed horizontal vector of distraction resulted in minimal increase in ramal length but marked shift in mandibular midline. In contrast vertical vector of distraction resulted in marked mandibular ramus lengthening but minimal mandibular midline shift.

Meazzini MC, Mazzoleni F et al[8] conducted a study to compare the mandibular vertical growth in patients with hemifacial microsomia who were treated with distractin. In this study the same comparison was done and it was observed the facial proportion of hemifacal microsomia patients are maintained, when not treated throughout the growth. The same proportions return to their original asymmetry after distraction are well accepted, Early surgery should be done after careful patient selection and clarification of the long term recurrence by genetically guided growth pattern.

Gursoy S, Hukki J, Hurmerinta K[9] conducted a study on Cephalometric analysis pre and post distraction and after one year had showed significant

correction of mandibular retrognathia and malocluion Excellent short term structural results of mandibular DO are not stable during treatment because of restricted mandibular growth. Cephalometric analysis performed in this study showed considerable posterior rotation and significant mandibular corpus and ramus growth.

Reina – Romo E, Sampietro-Fuentes A et al[10] analysed bio mechanical behavior of patients mandible before and after distraction with that of symmetric healthy mandible. It was observed in the present study the present model is a useful tool to understand the normal function of the mandible and to predict changes due to alternations in the mandible geometry, such as those occurring in hemifacial microsomia.

Hamada T. Ono T et al[11] performed orthodontic treatment in their patients to improve obstructive sleep apnoea. In the present study all the patients were subjected to orthodontic treatment six months after distraction to correct occlusal irregularities. Although the patients were satisfied with the treatment, condylar resorption was observed.

In the present study older pediatrico had no treatment failures, and had fewer postoperative complications compared to younger patients.[12]

CONCLUSION

Though results appear encouraging regarding the role of distraction osteogenesis in correcting mandibular deformities, it is obvious that a multi centric study with larger sample size and a long term follow up is required to come to a definite conclusion.

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