Distraction Osteogenesis in Management of Mandibular Deformities

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Abstract

Background : The concept of Distraction Osteogenesis is applied in Maxillofacial surgery extensively in the recent past, revolutionizing the concept of management of facial deformities specially the mandible.

Methods : This article describes intra oral mandibular distractors in managing mandibular deformities in 9 cases.

Conclusion: Surgical intervention is possible in very young patients. Distraction Osteogenesis does not reduce the need for orthodontic intervention. A multifarious approach to the problem, should form the basis of treatment of mandibular deformities.

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Key Words: Distraction osteogenesis; Mandibular hypoplasia; Congenital deformities

Introduction

Distraction Osteogenesis is the biologic process of new bone formation between adjoining bone segments that are gradually separated by incremental traction. Ever since the technique was propounded by Ilizarov [1] in orthopaedic surgery, it has gained wide spread popularity. The success of the procedure in human mandibles by McCarthy [2] and other workers [3] led to its extensive application in craniomaxillofacial surgery. The ability to reconstruct combined deficiencies in bone and soft tissues [4] makes this process unique and invaluable.

The basic concept is induction of new bone formation along the vector of pull obviating the need for a bone graft. The increase in mandibular bone stock will provide more reconstructive options for subsequent orthognathic surgical techniques.

The common indications for distraction in mandible are mandibular hypoplasia due to congenital deformities like Nager's syndrome, Treacher Collin's syndrome, Piere Robin syndrome, Cranofacial scoliosis and Hemifacial microsomia; sequelae of TMJ ankylosis (Fig 1) and mandibular asymmetry.

Material and Methods

Nine cases of diverse mandibular deformity were undertaken for surgical correction using intraoral mandibular distractors. The details of patients and factors involved are given in Table 1. All cases were subjected to Cephalometric analyses to determine the extent and plane of deficiency.

Objective analyses gave the exact amount and vector of distraction to be achieved. In six cases, vertical intra oral distractors were placed obliquely on the ramus to achieve distraction in both horizontal and vertical planes.

The first significant finding in all cases was the development of an anterior open bite during the distraction phase. This was corrected during the first month by using a modified activator appliance, which helped mould the soft callus. The cycle of distraction was done at a rate of 0.4 mm twice daily to achieve a distraction of 0.8mm in a day. The period for consolidation of new bone was 8 weeks before surgically recovering the distractors.

Three cases required an additional surgical procedure like advancement genioplasty to improve the facial profile. One case under went premaxillary osteotomy to improve the facial appearance.

Fig. 1 : Lateral cephalograph with severe mandibular deficiency

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Fig. 2 : The vertical intra oral distractor positioned

Fig. 3 : The change in profile after advancement genioplasty

Fig. 4 : Evidence of new bone formation in the ramus after distraction

Table 1

Consolidated patient data

Patients	Sex	Age	Site	Etiology	Amt of distraction	Additional surgery	Uni/Bilateral	Orthodontic treatment
1	M	21	Ramus	Ankylosis	14.8 mm	Genioplasty	Bilateral	Yes
2	F	14	Ramus	Condylar agenesis	14 mm	—	Unilateral	Yes
3	M	21	Body	Ankylosis	9.6 mm	Genioplasty	Unilateral	Yes
4	F	18	Ramus	Ankylosis	11 mm	—	Bilateral	Yes
5	F	11	Ramus	Ankylosis	10.8 mm	—	Bilateral	Yes
6	F	15	Ramus	Ankylosis	15 mm	Genioplasty	Bilateral	Yes
7.	M	14	Body	Facial cleft	9.6 mm	Premaxillary	Bilateral	Yes
8	F	14	Body	—	12 mm	—	Bilateral	No
9	F	19	Ramus	Ankylosis	10.8	—	Bilateral	No

Results

Six out of the nine cases manifested mandibular deformity secondary to TMJ ankylosis and were surgically treated earlier. Age ranged between 14 and 21 years with a mean age of 17.5 years. They had a combined vertical and horizontal deficiency entailing placement of vertical distractor (Fig 2) in an oblique direction.

All cases of ankylosis had deficiency in both planes except one that needed just horizontal correction. The total distraction ranged from 9.6 mm to 15 mm with a mean of 12.3 mm. In severe ankylosis an additional surgical procedure like advancement sliding genioplasty (Fig 3) helped achieve a good profile. Another significant aspect was post surgical orthodontic correction in virtually all cases. Only 2 cases did not require post surgical orthodontic treatment. Satisfactory facial features – frontal and profile, were achieved in all cases with functional harmonious occlusion.

Discussion

Ilizarov used Distraction osteogenesis for the treatment of skeletal deformities of long bones, both congenital and acquired. Inflammation leads to tissue repair through an intramembranous ossification process, which terminates with formation of new bone (Fig 4). By artificially creating a fracture, a repair process is initiated. The application of a continuous stretching force on the bone segments with a device triggers growth.

The undifferentiated cells evolve into osteoblasts and begin formation of interlaced bone tissue. Muscle and soft tissue mass increases via a process referred to as distraction histogenesis. Clinically, this offers a distinct advantage as several craniofacial anomalies have soft tissue hypoplasia in addition to deficient bony structure. Neurovascular elements are also stimulated to regenerate.

Osteocyte viability is essential to provide an adequate source of osteoblastic activity at the distraction site. Hence, careful surgical technique to minimize thermal or mechanical bone injury must be ensured. Similarly, an adequate blood supply to the distraction site and an intact periosteum and endosteum are critical for osteogenesis. In our surgical protocol, bone cuts were restricted to corticotomy preserving the endosteal tissues.

The latency, rate and rhythm of distraction influence the quality of the regeneration. Of these latency is most controversial. Most maxillofacial surgeons recommend 4-7 days waiting following corticotomy before initiating distraction. In younger children, the high rate of bone metabolism favour a shorter waiting period. Waiting too long increases the risk of premature bone union. In our cases, distraction was started on the 4th day. The rate and frequency (i.e. rhythm) of distraction are also

important. If widening occurs too rapidly, a fibrous non-union results, whereas if the rate is too slow, premature bony union prevents lengthening to desired extent. Most studies suggest a rate of 1.0 mm/day. The ideal rhythm is a continuous form of distraction. However, this is impractical. Therefore, distraction frequencies of 2-3 times per day are followed. All our cases were subjected to two cycles of distraction per day at a rate of 0.4 mm per cycle. The length of consolidation ranged from 4-6 weeks. We allowed a gap of 8 weeks after the last distraction cycle and removal of the distractors.

Appliance rigidity during distraction and consolidation is critical to ensure that bending or shearing forces do not result in micro fractures of the immature columns of new bone within the regenerate, which lead to focal hemorrhage and cartilage interposition.

Conclusion

Distraction Osteogenesis holds great potential for osseous defects encountered in the craniofacial skeleton. The initial osteotomy procedure is less invasive and does not carry limitations and complications

associated with conventional orthognathic surgery. Surgical intervention is possible in very young patients. Distraction osteogenesis does not reduce the need for orthodontic intervention and therefore a multifarious approach to the problem should be followed.

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