Distraction Osteogenesis-Review

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Abstract:
Distraction osteogenesis is a biological process of Formation of the bone between the two bone spaces by the Gradual incremental traction. The simultaneous expansion of the soft tissues, including nerves, blood vessels, muscles, ligaments, fat and skin produces excellent aesthetic and functional results and minimizes the skeletal relapse.1
key words *: distraction osteogenesis,orthognathic surgery,destractive device*.

Introduction: Distraction osteogenesis is used in combination with orthognathic procedures is to correct dentofacial deformities caused by congenital or developmental factors, trauma or diseases such as cancer and also used to correct badly healed fractures. Distraction osteogenesis is done in several stages. However, in the first stage, an osteotomy cut is made on the bone followed by surgical insertion of a special mechanical device called as distraction device or distractor into pre - determined positions in the patient's jaw. This device can either be placed extra-orally or intra-orally. After a short waiting period of 5 -7 days (latency period), the process of distraction is carried out by rotating the corresponding screws in a prescribed rate and rhythm. After the desired expansion/distract ion is achieved, the device is left in place for a period of 60 -90 days (consolidation period). The device is then removed. Subsequent surgeries may be necessary depending upon the device used.

Material and method: over 64 article where selected for review following a comprehensive search of the literature from pubmed central.

INDICATIONS OF DISTRACTION OSTEOGENESIS IN CRANIOFACIAL REGION

- Craniofacial microsomia – unilateral on bilateral
- Nager 's s yndrome
- Treacher Collins syndrome
- Pierre Robin Syndrome
- TMJ ankylosis
- Post traumatic growth disturbances

- Developmental micrognathia
- Midface hypoplasia (craniofacial synostosis syndromes)
- Hypoplastic maxilla
- Condylar regeneration
- Correction of Class II skeletal discrepancies with underdeveloped mandibles due to other causes
- Expansion of mandibular symphysis – Brodie's syndrome
- Mandibular symphyseal distraction to resolve ar ch length discrepancies
- Ridge augmentation procedures
- Maxillary under-development in cleft lip and palate

- Non Union of fractures, Ridge augmentation procedures
- Surgically assisted rapid palatal expansion
- Rapid canine retraction

ADVANTAGES

The process of distraction osteogenesis has a number of advantages over the conventional orthognathic surgery procedures in the treatment of maxillomandibular deformities or discrepancies.

- It can be applied to cor rect deformities in the very young child as early as 2 years of age.
- Compared to the significant relapse in traditional orthognathic surgery procedures, there is minimal relapse in distraction osteogenesis. This is because, during distraction osteogenesis there is gradual distraction and lengthening of the soft tissue (skin, subcutaneous tissues and muscle) and the functional matrix surrounding the bony skeleton along with the bony lengthening.
- Gradual lengthening also allows the soft tissue matrix to adapt and hence leads to extremely stable results. Contrarily, orthognathic surgery aims at acute repositioning of the bony segments without any adaptation of the soft tissue and muscle envelope. The failure of the soft tissue and muscles to adapt to the changes contributes to significant relapse after orthognathic surgeries.
- Orthognathic surgeries only permit acute changes changing the shape and form of bone to maximize the three dimensional structural, functional and esthetic needs of the patient. It contrast, the bony regenerate formed by distraction osteogenesis is continuously molded by the neuromuscular envelope. The orthodontist plays an important role in determining the final shape of the distracted bone by regulating the vector of distraction and by the use of elastics or extraoral devices like the chin cup during and after distraction.

- There is no need for autogenous bone grafting.

DISADVANTAGES AND LIMITATIONS

- Distraction osteogenesis cannot be useful in dysplasias due to excessive growth. It is treatment modality for deficiency problems only.
- Scarring can occur if extraoral approach is used.
- Risk of infection.

Discussion: Successful use of this technique on endochondral bones in 1950's led to its application on the bones of the craniofacial region in the 1970's. Rosenthal et al11 (1927) performed first mandibular osteodistraction procedure by using an intraoral tooth bone activated over a period of 1 month. The force was transferred from the cast to the bone via skin. Kazanjian et al12 (1937) performed mandibular osteodistraction by using gradual incremental traction instead of acute advancement. Haynes et al 14 (1939) applied external skeletal fixation for craniofacial fractures, using a number of pins connected to a rigid bar to treat a comminuted compound fracture of the mandible. Crawford et al13 (1948) applied gradual incremental traction to the fracture callus of the mandible. Before treatment the mandibular halves had collapsed medially, obliterating the incisor space and creating an apparent crossbite. By using jackscrew appliances, the fracture callus was stretched over a 3 days period to re - establish the original jaw position, which was fixed with a sectional occlusal splint. Gavril Ilizarov18 (1951) designed an apparatus with 2 rings joined by 3 or 4 threaded rods. Bone segments were secured to the rings by 2 thin tensioned wires inserted into the bone at a right angle to each other. He introduced the unique protocol of 5 -7 days latency period followed by distraction period at the rate of 1mm/day in four equal increments.

Snyder et al19 (1972) surgically shortened a canine mandible, thereby creating a crossbite. Ten weeks later the healed, shortened mandible was osteotomized and an extraoral distraction appliance was placed. Michieli, Miotti et al20 (1976) demonstrated the feasibility distraction pr otocol similar to Snyder's. Implementing a device cemented to the teeth, they lengthened the mandible of 2 dogs - one by 5mm and the other by 15mm after a bilateral reverse step osteotomy. Histologic examination revealed new bone formation originating from parallel ordered collagenous fibers, which subsequently remodeled to form lamellar bone. Panikarovski et al27 (1982) performed the first significant histologic examination of mandibular- distraction regenerates in 41 dogs. Newly created bone, in the form of longitudinally oriented trabeculae originated from the residual mandibular segments and progressed towards the fibrous interzone. The results of this study indicated that the mechanism of new bone formation during gradual mandibular distraction was similar to that of during limb lengthening. Adlam et al28 (1989) investigated relapse following midface osteotomies in cleft lip and palate patients in a retrospective study.

Schmelzeisen et al30 (1996) performed distraction osteogenesis for lengthening of the mandible and for reconstruction of bony defects with a motor -driven 2.7 mm. The power supply and the timer module were inserted subcutaneously in a neck pocket. A maximum distraction of 13 mm was observed. Cohen et al31 (1998) performed a subtotal cranial vault reshaping and monoblock facial advancement in a child having Pfeiffer's syndrome and corneal exposure. After 28mms of distraction the proptosis was largely corrected. Siciliano et al32 (1998) reported the first case of mandibular distraction osteogenesis applied to a fibula microvascularized flap used to reconstruct an almost entire mandible. The biological and physiological process of bone elongation is based on chondroid tissue. Albino Triaca et al33 (2000) treated a 20 year old patient for facial asymmetry with both maxillary and mandibular osteotomies and later with distraction osteogenesis using intraoral devices, they concluded that results produced perfect facial symmetry. Damon et al34 (2001) recommended TMJ arthroplasty before or at the time of initiation of distraction in cases of fibrous ankylosis after distraction osteogenesis of a costochondral neomandible to improve the functional outcome and reduce the chance of a fibrous nonunion at the distraction site. When it occurs, rigid internal fixation is a useful adjuvant. Tehranchi et al35 (2001) conducted a study on Facial Symmetry after distraction osteogenesis and Orthodontic Therapy. The study was to document changes in the facial symmetry of patients with severe hypoplastic mandibles treated with distraction osteogenesis and orthodontic therapy. The mean displacement of the chin poi nt to the midline was 1.5 mm and that of the mandibular central incisors to the midvertical line was 1.38 mm. The results indicated improvement in all patients. Stelnicki et al 36 (2002) reviewed a series of patients with mandibular costochondral grafts who underwent subsequent distraction osteogenesis of the graft. For the successful distraction of bone grafts in the mandible, the following criteria should be satisfied: (1) sufficient bone stock so that the amount of advancement (linear) to the width of the bone graft does not exceed the ratio of 1.5:1, (2) sufficient bone stock to ensure absolute stability of the distraction device, and (3) an interval of at least 6 months between the bone grafting procedure and initiation of distraction. Mofid et al37 (2003) developed an internalized springmediated device for mandibular distraction osteogenesis that can potentially abrogate the risks associated with patient compliance by allowing for automated distraction across an osteotomy. The maximum distraction achieved in an experimental specimen using the spring distractor was 3.7 mm. There were no histologic or radiographic differences found between study specimens and specimens subjected to traditional distraction methods. Hwang et al38 (2004) developed a new device based on lag screw principle which consisted of the distraction screw, hole implant fixture, supporting plate, and temporary short implant for vert ical alveolar bone distraction at the molar region. The direction of distraction could be adjustable, and the alveolar bone could be distracted vertically as well as horizontally. Loboa et al39 (2004) analyzed mechanobiological influences on successful di straction osteogenesis on 15 adult male Sprague–Dawley rats. And determined the tensile forces, displacements, stresses, and strains occurring throughout distraction and defined strain levels corresponding to high rates of bone regeneration. Interpretation of these data was that daily distractions cause daily tissue damage which triggers new mesenchymal tissue formation. Menon et al40 (2005) described intra oral mandibular distractors in managing mandibular deformities in 9 cases. Additional surgical procedures like advancement sliding genioplasty was done in 3 cases and Post surgical orthodontic correction in all cases. Satisfactory facial features – frontal and profile, were achieved in all cases with functional harmonious occlusion. Burstein et al41 (2005) developed a new class of neonatal and infant mandibular bone distraction devices to relieve upper airway obstruction in infants and children with Pierre Robin sequence. It requires a single operative procedure for placement and no operative removal is necessary. Fifteen infants (mean age-3 months) and five children (mean age- 5.5 years) were treated with the mandibular infant devices over a 24-month period. There were no major complications and no structural device failures. Walker42 (2005) documented the creation of adequate height and volume of bone in complete or partial edentulous ridges for placement of an endosseous implant - supported dental restoration. Gurgan et al42 (2005) evaluated the alterations that occurred in the gingival dimensions of canine teeth following dentoalveolar distraction (DAD) during a 12 month follow-up period. There were significant differences between pre- and post-DAD in all sites, with the highest at the distal site. The buccal sites showed no significant changes at any time point. Iseri et al44 (2005) studied to investigate the long-term skeletal effects of mandibular symphyseal distraction osteogenesis (MSDO) with a tooth- and bone-borne distraction device, analyzed using the metallic implant method. The long-term findings of this study indicated that MSDO provides an efficient and stable non-extraction treatment al ternative, mainly by increasing the anterior mandibular skeletal and dental arches. Singare et al45 (2006) investigated the effect of latency on the development of bone lengthening force and bone mineralization during mandible distraction osteogenesis in 36 rabbits using internal unilateral distraction. Ismet et al48 (2006) demonstrated a study to evaluate microscopically the newly formed hard tissue after a consolidation period of mandibular symphyseal distraction osteogenesis.The newly distracted area was not complete immediately after the consolidation period. The newly formed bone also had a membranous structure, which indicated continual maturation. Ortakoglu et al 52 (2007) treated an adult patient who had severe mandibular hypoplasia with an extraoral multidirectional distractor. The Cephalometric analysis revealed ANB angle decreased from 13° to 6°.Boccaccio et al 55 (2008) analysed the displacement field and the level of stability for a human mandible that had symphyseal distraction osteogenesis. He found that tooth - borne and hybrid devices allow orthodontists to better control the effective displacement transferred to the mandible by the distractor.

Uckan et al56 (2008) compared the technique, complications and implant survival rates in localized alveolar deficiencies reconstructed by alveolar distraction osteogenesis (ADO) and autogenous onlay bone grafting (ABG). Bianchi et al57 (2008) compared bone gain, implant survival, implant success, bone resorption, and complication rate in patients who underwent distraction osteogenesis (DO) and inlay bone grafting (Inlay) for preprosthetic issues in the atrophic posterior mandible. Molina et al58 (2008) first reported a case of mandibular In the future, prophylactic mandibular distraction may prevent the need for tracheostomy in this group of patients.

Gokal p et al59 (2008) studied to evaluate the effect of symphyseal distraction osteogenesis on the position of the mandibular condyle and the disc of an asymptomatic adolescent patient by using magnetic resonance imaging and computerized tomography. The patient was treated successfully. Tamer et al60 (2009) conducted a study demonstrating the effects of mandibular symphysis advancement At the end of treatment, increases of SNB angle, effective mandibular length, SN/Go Gn.

Conclusion: reconstruction of maxillofacial deformities and deficiencies is making headway progress. And distraction osteogenesis is an integral part of the future trends in reconstruction. But, more detailed study and research needs to be carried out to establish the critical parameters. In future, craniofacial distraction osteogenesis may perhaps be the answer and the solution to bring out smiles in those affected by various craniofacial deformities**.**

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