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Distraction Osteogenesis

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Abstract: ***Distraction osteogenesis is a treatment modality for the correction of bone anomalies and abnormalities which are either pathological or developmental in origin. Its use in the field of dentistry began in the late twentieth century. Successfulresults from clinical trials has led to more researchers to explore this field. Its use in dentistry involves the correction of craniofacial anomalies, alveolar ridge for the prosthetic rehabilitation and recently for the regeneration of lost periodontium.***

Keywords: Distraction osteogenesis, dentistry, regeneration

1. Introduction

Bone is a dense, semi rigid, porous, calcified connective tissue composed of a dense organic matrix and an inorganic, mineral component. It undergoes continuous remodelling–resorption and formation. The process is regulated by both local and systemic factors. There is always a balancebetween bone formation and bone breakdown. Bone breakdown in pathological conditions results in loss of bone substance and structure and thus causing bone resorption.(1)

Various techniques have been developed for treating osseous defects like bone graft, guided bone regeneration, tissue engineering. Distraction osteogenesis is an emerging technique in bone regeneration.

Distraction osteogenesis is a procedure that moves two segments of a bone slowly apart in such a way that new bone fills in the gap. [2]

It is defined as the creation of new formed bone and adjacent soft tissue after the gradual and controlled displacement of a bone fragment obtained by surgical osteotomy. Some tissues besides bone have been observed to form under tension stress, including mucosa, skin, muscle, tendon, cartilage, blood vessels, and peripheral nerves.

2. History

An attempt of skeletal traction was described aslong ago as Hippocrates (460-377 B.C.)

In the 18th and 19th centuries correction of deformities by widening of the maxilla ridge by means of expansion arches was described (Fauchard 1728 and Wescott 1859). Kingsley (1866) reported widening the maxilla by extraoral traction.

The middle of the 19th century saw the beginning of a period of osteotomy or corticotomy on the corpus (Hullihen 1849, von Eiselberg 1906), on the ascending ramus (Angle 1897,KosteËka 1931, upar 1964). Pehr Gadd (1906) described step-wise osteotomy, Blair (1907) vertical osteotomy and Obwegesser (1957) sagittal osteotomy.

In 1905 Codvilla first described distraction as a method for correction of deformities. The method was popularised in orthopedic surgery by Ilizarov
(1952, 1988, 1992).[3]

The first attempts of distraction were performed on the mandible of a dog (Snyder 1973), and later on humans (Bell and coworkers 1980).

In 1992, distraction osteogenesis was performed successfully on a human mandible ,and since the mid-1990s, it has been used to treat midface hypoplasia. [4-5]

Distraction osteogenesis consists of five sequential periods:

- Osteotomy
- Latency
- Distraction
- Consolidation
- Remodelling

Latency phase

The latency phase allows the initial trauma response to take place. Granulation tissue replace hematoma formed after osteotomy after several days and this transforms into soft callous.

Distraction phase

During the distraction phase, tensile forces are applied to the callus with a specific rate and rhythm. Fibrous interzone forms. It is rich in chondrocyte-like cells, fibroblasts, and oval cells, which are morphologically intermediate between fibroblasts and chondrocytes. The osteoid are deposited alongwith collagen bundles. They subsequently undergo mineral crystallization forming a zone called the 'zone of microcolumn formation'. The fibrous interzone and microcolumn formation results in a zone of highly proliferating cells, called the 'primary matrix' or 'mineralization front'.

Consolidation phase

Once the desired bone length is achieved, distraction ceases, consolidation phase begins, where bone and extensive amounts of osteoid undergo mineralization and eventual remodelling.

In Dentistry

DO have been used successfully in the surgeries of increase bone rim with diverse purposes. One of the important applications occurs in the extensive oral rehabilitations cases where unsatisfactory prosthetic reconstructions are frequent because of the advanced alveolar rim loss. The DO

technique can be used in the rim increase that makes possible implantations arrangement and increase the possibility to get a better cantilever outline in the anodontics areas. [6-12]

Distraction osteogenesis surgery can be used in many cases to generate sufficient quantity of bone height and width to provide the appropriate foundation for dental implants. In most cases the need for bone grafts is eliminated and the time to dental implant placement is markedly reduced. Distraction osteogenesis surgery also provides the patient with a suitable band of soft tissue around the dental implant and thus, in many cases, eliminates the need for expensive gingival grafting before implant placement.

The procedure is done in the oral surgeon's office under sedation or general anesthesia. The bone is cut to provide a suitable segment of bone to distract and then the distraction device is affixed to the bone.

Approximately 12 weeks after the distraction is completed the dental implants can be placed. Distraction osteogenesis is used in,

- Le Fort I maxillary advancement
- Le Fort III midface advancement
- Mandible distractionto correct vertical defects of the alveolar ridge to improve bone volume for dental implant placement.
- Correction of craniofacial anomalies like maxilla mandibular hypoplasia, facial asymmetry, congenital micrognathia.

Advantages

1) Decreased operating time and hospital stay.
2) Can be applied at a younger patient.
3) It is a relatively simple technique.
4) Does not require blood transfusion and bone grating.
5) The technique is allows simultaneous expansion of associated soft tissue.
6) Distraction osteogenesis permits larger movements and offers greater postoperative stability. [13-19]

Disadvantages

1) Requirement of second surgical intervention for the removal of distraction device.
2) Pain during distraction phase.
3) Does not correct underlying growth disturbance.

3. Recent Advances

Distraction osteogenesis in craniofacial surgery has been developed in recent times. Distraction osteogenesis continues to grow as a leading method of surgical correction for a variety of craniofacial defects.

Some studies have suggested that the FGFR 2 mutation accelerates the growth or differentiation capability of osteoblasts. Biodegradable devices made of polylactic acid have been developed to abridge the second operation for removal and stabilization. [20-21]

In addition, the effects of hyaluronic acid, calcium sulfate, and chitosan on early bony consolidation in distraction osteogenesis have been studied in a canine model. Recent advances in distraction osteogenesis have obviated tracheostomy in most newborns with micrognathia and severe airway obstruction. Applications of this technique to children with airway issues related to micrognathia or retrognathia have been rapidly expanding. In addition, refinements in distraction technique have advanced treatment of nonairway-related mandibular deformities.

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