Distraction Osteogenesis for regeneration of vertical alveolar defects: A technical review.

By

Simona C. Arcan, DMD, MD, Bach T. Le, DDS, MD
USC Oral and Maxillofacial Surgery
January 28, 2001

Introduction

Distraction osteogenesis has recently become a popular topic for reconstruction of vertical alveolar defects. The use of bone grafts to correct vertical defects in the atrophic edentulous alveolar ridge leads to donor site morbidity and the results can be unpredictable.

Distraction osteogenesis is a biologic process of new bone formation between the surfaces of bone segments that are gradually separated by incremental traction. The process is initiated when distraction forces place tension on the callus between the bone segments, and continues as long as these tissues are stretched. This tension stimulates new bone formation parallel to the vector of distraction.

Distraction osteogenesis was described in 1905 by Codivilla (6) to increase the length of the femur, but it wasn't until 1988 when Ilizarov published the *Principles of the Ilizarov Method*, which described the biologic basis for healing and a surgical distraction device (3). Ilizarov described a technique for distraction osteogenesis involving only a corticotomy – interruption of the cortical bone alone, with minimal disruption of the periosteum and endosteum, hence reducing the incidence of morbidity.

Orthodontists have used mechanical forces in the dentoalveolar complex for centuries to induce new bone in sites of tension. This has been extended to the palatal suture and new bone formation after rapid maxillary expansion is well documented. McCarthy et al. (4) and Takato et al. (7), first described distraction osteogenesis in Maxillofacial surgery for the correction of facial malformations using extraoral devices. In 1973, Snyder et al.(5), used a surgical device for the osseous distraction of a dog mandible. Since 1990, distraction osteogenesis has been described in the maxillofacial surgical research literature using human and animal studies.

More recently this technique has been used to lengthen the mandible, advance the midface and augment the mandibular alveolar ridge (1). The possibility of this latter approach provides a much-needed development in the treatment of inadequate mandibular bone where height and width restrict the placement of implants. The only options for a severely resorbed alveolar ridge prior to distraction osteogenesis were the use of bone grafts, guided bone regeneration, maxillary sinus lifts and alveolar nerve

transpositions. All of these procedures tend to be lengthy with unpredictable results, and have the potential to cause unwanted side effects, including donor site morbidity, parasthesia, chronic sinus problems and may require several operations. These options may correct the hard tissue defect, but there is no change in the soft tissue volume and may require further soft tissue grafts.

Patient Selection

A thorough medical history, head and neck and dental examination need to be performed in order to assess the patient's ability to withstand surgery. The patient's psychological compliance and maintenance is of utmost importance for this procedure to be successful. An in depth treatment plan must be devised with the surgeon and restorative dentist to determine the site of the ridge augmentation necessary for implant placement. Some of the indications for this procedure are vertically deficient implant patients due to traumatic tooth loss, long term partial dentures, previously failed implant or bone graft, alternate treatments not successful or available, reconstruction following resection with placement of implants and mandibular discontinuity defects due to trauma (Figure 1-3).

Technique

The purpose of this article is to familiarize the reader with this technique. After giving adequate local anesthesia to the surgical site, a vestibular incision is made below the mucogingival junction with a 15 blade. This incision is carried through the periosteum and a mucoperiosteal flap is elevated to expose the crest of the ridge, taking care not to extend the flap lingually. This flap is elevated to expose the entire buccal crest in the edentulous and deficient alveolar ridge. Using either a thin fissure bur, a U-shaped osteotomy is marked in the buccal cortex according to a previously determined segment size to be transported. At this time, one may choose to drill the holes needed to secure the metal distractor for ease of placement after the osteotomy is complete. Once the position of the distractor is determined, this can be removed and using the same thin fissure bur or a sagittal saw the corticotomy is made in the buccal cortex. The lingual cortex is osteotomized using thin osteotomes, and care must be taken not to disrupt the lingual blood supply of the transport segment. Once the segment is mobile, the metal distractor is fixated with mini-screws in the previously determined site. The distractor is activated to ensure free movement of the transport segment and any interferences are eliminated. The distractor then is returned in its inactive state and the site irrigated and the flap closed primarily with sutures. The patient is placed on a soft diet until consolidation is complete.

After the surgical technique there is a latency period (5-7 days), which is the time between when you first create the osteotomy and when you begin movement (Figure 4). The distraction period is the time when you are transporting the bone and this rate should not exceed that of 1 mm per day with 0.25-0.33 mm/turn 3-4 times a day done by the patient (Figure 5). The total amount of distraction depends on the vertical defect and the size of the distractor. The consolidation period is at least 2 month and this is the time needed for the bone to heal prior to removing the device (Figure 6-8). It has been

recommended that the distractor be removed at least 1 month prior to placement of the implants to allow for adequate soft tissue healing. Placement of implants can therefore be accomplished as early as three months from the start of this bone regeneration process.

Discussion

Distraction osteogenesis is a valid alternative to guided bone regeneration and bone grafts when used for vertical augmentation of alveolar ridges. The literature on distraction osteogenesis has shown that bone formation at the distracted site involves two cellular processes. The first is the formation of a callus and the second is generation of new bone by distraction. McCarthy and co-workers described four distinct components of the distracted zone – initially a radioluscent central zone comprising fibrous tissue – bone formation along the stretched fibrous tissue – remodeling area where bone spicules are lined by osteoblasts and osteoclasts – area of mature bone which remodels for a year of more (4).

Soft tissue is expanded at the same rate as the bone, thus possibly eliminating the need for further soft tissue grafting (2). Age is an equally important consideration in your patient selection, as older patients tend to grow bone at a slower rate. Careful, precise, well-planned surgery with maintenance of the blood supply to the transported segment is necessary for this technique to be successful. A prosthetic guide can be very helpful in maintaining the vector of the transport segment and prevent unwanted movement in the palatal or lingual direction. Close follow-up of these patients is necessary at an interval of every 2-3 days during the critical period of distraction. Transport the segment no faster than 1 mm/day usually at the rate of 3-4 daily increments. Studies have shown that rates below 0.5 mm each day may lead to premature union and above 1 mm each day may lead to non-union.

Conclusion

In summary, distraction osteogenesis may be demanding technically, but it is the best option for vertically deficient ridges, especially because the soft tissue expansion follows the augmented hard tissue, and can decrease treatment time resulting in faster placement of the implants. Predictability of the technique is good and unquestionably superior to that of other bone grafting or guided bone regeneration techniques, however, further research is needed to demonstrate a generalized trend.

REFERENCES

1. Urbani G, Lombardo G, Santi E, Consolo U. Distraction Osteogenesis to Achieve Mandibular Vertical Bone Regeneration: A Case Report. *Int J Periodontics Restorative Dent* 1999; 19: 321-31.
2. Davies J, Turner S, Sandy J R. Distraction osteogenesis – a review. *British Dent Journal* 1998; 185: 462-7.
3. Ilizarov GA. The principles of the Ilizarov method. *Bull Hosp Joint Dis Orthop Inst* 1988; 48: 1-11.
4. McCarthy J G, Schreiber J, Karp N, Thorne C H, Grayson B H. Lengthening the human mandible by gradual distraction. *Plast Reconstr Surg* 1992; 89: 1-8.
5. Snyder CC, Levine GA, Swanson HM, Browne EZ. Mandibular lengthening by gradual distraction: Preliminary Report. *Plast Reconstr Surg* 1973; 51: 506-508.
6. Codvilla A. On the means of lengthening in the lower limb, the muscles, and tissue which are shortened through deformity. *Am J Orthop Surg* 1905; 2: 353-369.
7. Takato T, Harii K, Hirabayashi S, Komuro Y, Yanehara Y, Susami T. Mandibular lengthening by gradual distraction. Analysis using accurate skull replicas. *Br J Plast Surg* 1993; 46: 686-693.