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Two-stage reconstruction of the severely deficient alveolar ridge: bone graft followed by alveolar distraction osteogenesis

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Abstract. Distraction osteogenesis for the augmentation of severe alveolar bone deficiency has gained popularity during the past two decades. In cases where the vertical bone height is not sufficient to create a stable transport segment, performing alveolar distraction osteogenesis (ADO) is not possible. In these severe cases, a two-stage treatment protocol is suggested: onlay bone grafting followed by ADO. An iliac crest onlay bone graft followed by ADO was performed in 13 patients: seven in the mandible and six in the maxilla. Following ADO, endosseous implants and prosthetic restorations were placed. In all cases, the onlay bone graft resulted in inadequate height for implant placement, but allowed ADO to be performed. ADO was performed to a mean total vertical augmentation of 13.7 mm. Fifty-two endosseous implants were placed. During a mean follow-up of 4.85 years, two implants failed, both during the first 6 months; the survival rate was 96.15%. In severe cases lacking the required bone for ADO, using an onlay bone graft as a first stage treatment increases the bone height thus allowing ADO to be performed. This article describes a safe and stable two-stage treatment modality for severely atrophic cases, resulting in sufficient bone for implant placement and correction of the inter-maxillary vertical relationship.

Key words: alveolar distraction osteogenesis; bone graft; augmentation; pre-prosthetic surgery.

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Bone regeneration is one of the main research fields for craniofacial surgeons, as well as orthopedic surgeons. Current research is aimed at identifying the ideal osteogenic molecule or scaffold and improving tissue engineering techniques for bone regeneration. In the meantime, surgeons have to use the resources that are available.

Since the beginning of the dental implant era, the demand for stable and properly aligned facial and dental prosthetic rehabilitation has increased continuously. Patients with severely deficient alveolar bone are no longer satisfied with tissue-borne dental prostheses and are requesting better solutions.

A few methods for augmentation are available to the surgeon facing mild to moderate deficiencies: autogenous onlay bone grafting[1,2], the interpositional bone graft[3], guided bone regeneration (GBR)[4,5], alloplastic materials[4,5], and inferior alveolar nerve lateralization[6]. However, significant resorption occurs in autogenous

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onlay bone grafts, mostly due to inadequate soft tissue coverage[7]. GBR is used widely for minor deficiencies and is limited in gaining significant bone height and volume[4,5]. Alloplastic materials should be avoided in large vertical defects[4,5].

None of the methods mentioned above is adequate in cases of severe bone deficiency. When used for large vertical defects, the results are inconsistent, not completely predictable, and lack stability. In addition, these methods do not approach the soft tissue deficiency accompanying the bony deficiency. For this reason, distraction osteogenesis (DO) for alveolar bone augmentation has been used in severe cases during the past two decades[8–10].

DO is a method of generating new bone involving a corticotomy or an osteotomy and gradual elongation. The method is based on the tension–stress principle described by Ilizarov[11,12]. Gradual bone elongation stimulates molecular responses, promoting the differentiation of stem cells, angiogenesis, osteogenesis, bone mineralization, and thus bone formation[13–16]. There are four stages to DO: (1) osteotomy and fixation of the distraction device; (2) a latency period of several days for primary callous organization; (3) gradual elongation at a rate of 0.5–1 mm/day; (4) a consolidation period of 4 months for callous maturation and mineralization.

DO has been shown to be predictable in the facial bones in animal studies[13,14]. This method was used clinically for the first time in the maxillofacial region by McCarthy et al. for mandibular elongation in syndromic children[17]. Since then, it has been used in clinical practice for elongation of the mandible, maxilla, and midface[17–22].

Alveolar distraction osteogenesis (ADO) has been applied for bone augmentation of the severely deficient alveolar ridge prior to dental implant placement[8,10,23,24]. ADO in the anterior region has most often been performed in the maxilla[25], but it can also be performed in the anterior mandible to allow inter-foraminal implant placement for an overdenture[26,27]. ADO in the posterior region has most often been performed in the mandible, to improve the crown to implant ratio[28,29].

The generation of new bone during distraction depends on the traction of two bony segments: the transport segment and the basal segment. In order to perform ADO, the crestal transported segment has to have a minimum height of 6 mm. This height is essential for fixation of the device and to avoid fracture of the segment[8,29]. A second important consideration is the integrity of the basal bone on which the lower plate of the distractor is fixed. In the maxilla, disruption of the nasal floor/maxillary sinus should always be avoided. In the authors' practice, it is aimed to maintain a minimum distance of 3 mm of bone below the nasal floor in the anterior maxilla (Fig. 1). In the anterior mandible, sufficient basal bone should be maintained to avoid fractures and to permit fixation of the basal plate; it is aimed to maintain at least 6 mm of basal bone (Fig. 2). In severely deficient mandible cases, another anatomical consideration is the inferior alveolar nerve; it is aimed to maintain a safe distance of 2 mm from the nerve (Fig. 3).

In severely deficient alveolar ridges, where the vertical bone height is insufficient to create a stable transport segment, it is not possible to perform ADO. In these severe cases, a two-stage treatment modality is suggested: onlay bone grafting followed by ADO.

Materials and methods

A retrospective study was performed of patients suffering from severe alveolar bone loss and treated with a two-stage procedure: onlay bone grafting followed by ADO. The cases of all patients treated with the two-stage modality between the

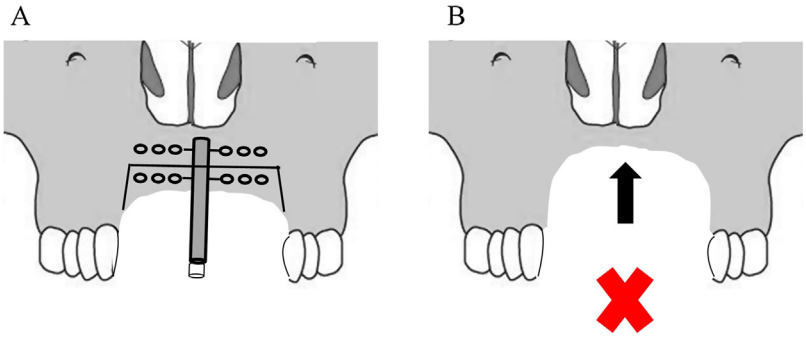

Fig. 1. Alveolar distraction osteogenesis in the maxilla: (A) enough bone to create a transport segment for ADO; (B) the remnant basal bone (arrow) is not adequate for the creation of a transport segment without increasing the risk of fracture of the basal bone.

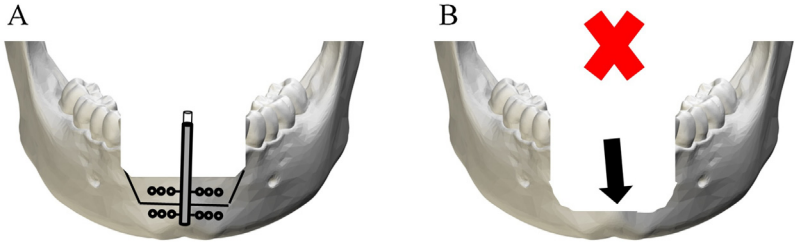

Fig. 2. Alveolar distraction osteogenesis in the anterior mandible: (A) enough bone to create a transport segment for ADO; (B) the remnant basal bone (arrow) is not adequate for the creation of a transport segment without increasing the risk of fracture of the basal bone.

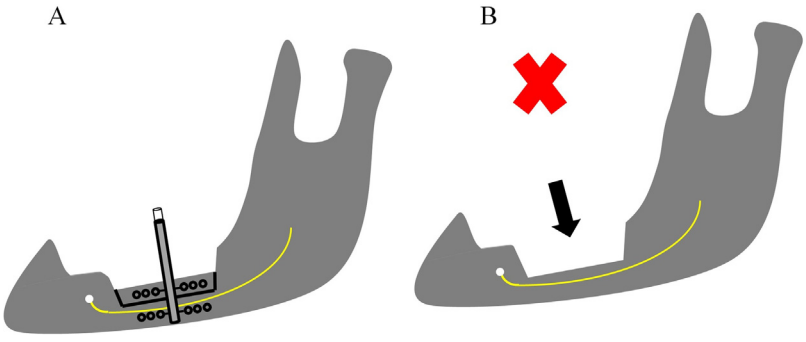

Fig. 3. Alveolar distraction osteogenesis in the posterior mandible: (A) enough bone to create a transport segment for ADO; (B) the bone over the inferior alveolar nerve (arrow) is not adequate for the creation of a transport segment without damaging the nerve.