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Potential complications and precautions in vertical alveolar distraction osteogenesis: A retrospective study of 40 patients

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ABSTRACT

The aim of this retrospective study was to analyse the outcome of 44 cases of vertical alveolar distraction osteogenesis (ADO) and to investigate the complications, precautions, and treatment associated with ADO. The 44 alveolar distractions were performed on 40 patients. Extraosseous distraction was used in all cases. Complications associated with the intraoperative, postoperative, distraction, and consolidation periods were recorded and evaluated. Intraoperative complications were noted in two patients (4.5%) where fracture of the basal bone was evident. Three (6.8%) complications were recorded postoperatively, and 12 (27.3%) complications were recorded during the activation period. During the consolidation period, 4.5% of the patients ($n = 2$) were affected. The total prevalence of complications was 43.2% ($n = 19$), and the success rate of the ADO was 95.5%. Most complications occurred in the anterior mandibular region. Although complications associated with vertical ADO were not rare, the use of this procedure for maxillofacial defects results in satisfactory outcomes. Early diagnosis and management of related complications are crucial for increasing the success rate of ADO procedures.

1. Introduction

Alveolar ridge augmentation is carried out primarily by bone grafting, guided bone regeneration, and distraction osteogenesis. In cases of minor augmentations, allogenic materials with membranes have typically been used to achieve membrane-guided bone regeneration. Large defects and severe alveolar ridge atrophy require augmentation with autologous bone graft material, which may be harvested from the intraoral (*i.e.* chin, retromolar region; Misch, 1996; Chavier, 1997) or extraoral (*i.e.* iliac crest, fibula, rib, cranium; Mercier et al., 1987; Bähr, 1996) region. As an alternative to autologous bone grafting, distraction osteogenesis can be used for large defects.

Alveolar distraction osteogenesis (ADO), a biological process for the regeneration of new bone between two divided bone segments by gradual traction, has been applied successfully since 1996 in preprosthetic surgery. Block et al. (1996) reported successful alveolar ridge augmentation in dogs. Chin and Toth (1996) first described the use of ADO in humans for the reconstruction of an alveolar ridge defect following traumatic tooth loss. This technique is used to reconstruct vertical or horizontal alveolar bone defects caused by post-extraction, traumatic avulsion, periodontal disease, senile atrophy, tumour surgery, cyst enucleation, and cleft closure.

ADO allows the alveolar ridge to be augmented through new bone formation. It also enables a significant increase in the surrounding soft tissue, offering a predictable result with low morbidity and infection rates, high reconstruction volume, early healing, and a shorter waiting period before implant placement and prosthetic rehabilitation. The success rate of this procedure is also significantly high. However, despite these advantages, several published articles (Uckan et al., 2002a; Chiapasco et al., 2004; Enislidis et al., 2005a; Mazzonetto et al., 2005; Saulacic et al., 2005) have noted that complications are common during ADO. The aim of this study was to evaluate ADO as a treatment method, observe possible complications, and determine the precautions that could be taken to avoid treatment complications.

2. Material and methods

2.1. Patients

From April 2003 to December 2009, 40 patients with alveolar defects (22 females, 18 males) underwent a total of 44 vertical ADO

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procedures. The mean age of the patients was 43.8 years (range: 19–65 years). This study was approved by the local institutional review board, and written consent forms were signed by all patients. In these patients, insufficient alveolar bone volume was the result of one of the following: atrophy after senile atrophy ($n = 25$); trauma (*e.g.* traffic accident, tooth extraction; $n = 8$); osteomyelitis ($n = 4$); cyst/tumour surgery ($n = 6$); and cleft ($n = 1$; Table 1). ADO was used to reconstruct the patients' dental defects and to obtain aesthetic and functional outcomes. In all cases, extraosseous distraction devices (Modus; Medartis AG, Basel, Switzerland; Track; Gebrüder Martin GmbH & Co., Tuttlingen, Germany) were used for distraction. Thirteen distraction procedures were performed in the maxilla (five anterior, eight posterior) and 31 procedures were performed in the mandible (24 mandible anterior, seven mandible posterior) (Table 1).

Patients were operated on under general anaesthesia or intravenous sedation combined with local anaesthesia. After vestibular incision, the mucoperiosteal flap was raised. Planned osteotomy was completed, and the distractor device was adapted and fixed to the segments with miniplates and screws. The wound was sutured after checking the function of the distractor system. Postoperatively, all patients received amoxicillin trihydrate + potassium clavulanate (1000 mg/12 h for 5 d), naproxen sodium (550 mg/12 h for 5 d), and 0.12% chlorhexidine (3×/d). Following a 7-d latency period, the distraction device was activated at a rate of 2 × 0.5 mm/d. After a consolidation period of 5–14 weeks, the alveolar distractor was removed under local anaesthesia, and 74 dental implants were inserted into 38 patients, using the same procedure. Two implants could not be osseointegrated because of the presence of peri-implantitis during the osseointegration period. These two implants were removed and replaced with new ones. The implant success rate was 97.3% for both groups.

From the onset of the distraction operation to the end of the consolidation period, complications were noted precisely and classified according to the time period in which they occurred (*i.e.* during intraoperative, latent, distraction, or consolidation period).

3. Results

The distractors were adapted successfully in all patients. The ADO success rate was 95.5%. At the end of the consolidation period, sufficient bone volume was gained in all but two distraction sites. In one of these two exceptions, a rod fracture occurred; in the other exception, the plate slid over the rod during activation. For both of these patients, the ADO procedure was discontinued, and the distractors were removed due to mechanical problems. In 38 cases, 77 dental implants were inserted into the distracted sites. Two implants failed during the osseointegration period due to the onset of peri-implantitis.

3.1. Complications, treatments, and precautions

Treatment was divided into four phases, and a total of 19 (43.1%) complications were recorded during all ADO procedures. Intraoperative basal bone fracture was noted in two cases. These fractures were fixed using open reduction, and the distractors were adapted during the same operation. The distraction protocol was completed successfully. Three complications were recorded during the postoperative period. In two patients who underwent anterior mandibular distraction, unilateral paraesthesia occurred as a result of the surgery. These patients were treated with vitamin B. Dehiscence occurred in one case. The wound was refreshed and resutured.

Most ($n = 12$) complications were noted during the distraction period. One patient complained about pain and tension, especially during the first hour after distractor activation. Painkillers were prescribed and the rate of distraction was reduced.

Segment tilting was observed in six cases. All tilting occurred in the anterior mandibular region. In one case, the anchor segment was broken near the end of the activation period. Distraction was stopped, and the distractor was left in the same position through the end of the consolidation period. Breakage of the distractor rod ($n = 1$) requires removal and replacement with a new distractor. However, this patient did not want to continue the treatment, so the distractor was simply removed.

During the distraction period, mechanical problems were recognised in three cases. Breakage of the transport-segment plate occurred in one of these cases. The broken piece was removed, and distraction was continued using the same distractor (Figs. 1, 2). In the second case, the plate slid over the rod during activation. Although the rod was lengthening, the transport segment did not rise (Figs. 3, 4). In such a situation, the distractor system should be changed, and the distraction protocol should be continued using a new distractor. However, in this study, the patient refused to continue the treatment, and the distractors were simply removed after ossification of the bone segments. The third mechanical problem occurred in the anterior maxillary region. The transport segment did not move inferiorly; instead, the anchor segment was raised to the nasal cavity. To resolve this problem, the distractor

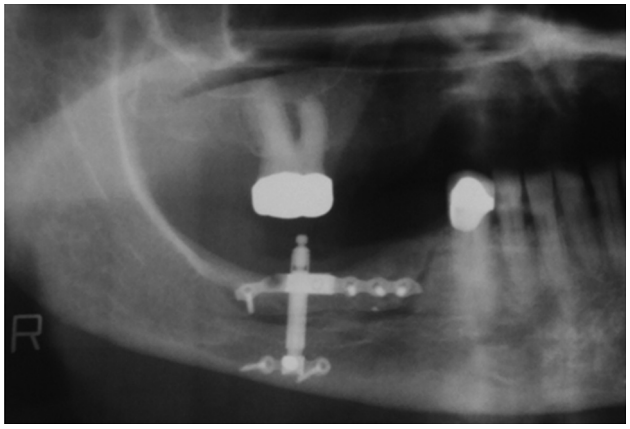

Fig. 1. Radiograph of transport plate breakage during the activation period.

Table 1
Aetiology of the defects, distraction sites, and complications.

Defect aetiology	Number of distraction locations/number of complications				
	Mandibular anterior	Mandibular posterior	Maxillary anterior	Maxillary posterior	**Total**
Senile atrophy	20/11	2/1	0	3/1	**25/13**
Trauma (traffic accident, tooth extraction)	1/1	2	3/1	2/0	**8/2**
Osteomyelitis/bone necrosis	1/1	0	1/0	2/0	**4/1**
Cyst/tumour surgery	2/1	3/1	0	1/1	**6/3**
Cleft	0	0	1/0	0	**1/0**
Total	**24/14**	**7/2**	**5/1**	**8/2**	**44/19**