**Intra-alveolar distraction osteogenesis in preparation for dental implant placement combined with orthodontic/orthognathic surgical treatment: A case report**

B Baker,* S Gibbons,† M Woods‡

**Abstract**

The use of implants has become a routine part of restorative dental treatment. The placement of implants requires a sufficient quantity of bone in which to place implant fixtures. Where such bone does not exist, a number of methods have been used to augment the affected area of the alveolar ridge. This case report describes the use of the relatively new distraction osteogenesis procedure to increase bone volume in a patient who required post-traumatic restoration of several missing teeth, as well as comprehensive orthodontic and orthognathic surgical treatment.

**Key words:** Distraction osteogenesis, orthodontics, orthognathic surgery, implants, case report.

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**CASE REPORT**

**Presentation and initial routine orthodontic treatment**

A 17-year-old male was seen in the Orthodontic Unit at the University of Melbourne. He presented with a Class II Division 2 buccal occlusion, and severe maxillary crowding (Fig 1). Comprehensive orthodontic treatment was commenced with the placement of fixed appliances and the extraction of maxillary first premolars and mandibular second premolars. Approximately one year into active treatment, the patient was involved in a severe motor vehicle accident. His injuries included comminuted fractures of the left anterior body of the mandible and the right condylar neck. The mandibular left and right lateral incisors and left canine were avulsed. Much of the alveolar ridge in this area was also avulsed, with the subsequent significant loss of sulcus depth. Both mandibular central incisors were extremely mobile and considered to have a very poor prognosis (Fig 2a and 2b).

**Transfer of patient and revised treatment plan**

The patient was then referred to the orthognathic surgery clinic in the Orthodontic Unit, where the treatment plan was reassessed in light of his facial injuries. Consultation involved orthodontists as well as an oral and maxillofacial surgeon and a prosthodontist. The following revised plan was agreed upon: (1) continue maxillary and mandibular alignment closing posterior extraction spaces; (2) it was considered that the patient’s overjet had increased to such a degree that it could not be corrected with conventional orthodontic treatment alone (e.g., Class II elastics). Removal of any additional maxillary teeth was also deemed undesirable, due to the likely detrimental effects to the patient’s facial profile. It was thus decided to correct the patient’s overjet with a surgical mandibular advancement. All third molars were to be extracted at the same time; (3) in considering the restoration of the anterior mandibular area, it was considered that both

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*Orthodontist, Melbourne, Victoria.
†Oral and Maxillofacial Surgeon, Melbourne, Victoria.
‡Associate Professor and Head of Orthodontics, The University of Melbourne, Victoria.

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**INTRODUCTION**

The use of implants has become a routine method of replacing missing teeth. However, the placement of implants requires sufficient volume of sound bone in which to place the fixtures.1,2 Where there is insufficient bone, a number of methods have been described to augment the existing alveolar ridge. These include bone grafts and the use of guided bone regeneration.3-5 The concept of distraction osteogenesis was brought to the fore by Ilizarov6,7 who used the technique to lengthen long bones. The process has been used in the treatment of craniofacial deformities8-9 and recent articles have described the adaptation of distraction osteogenesis to increase the volume of bone within an edentulous area of an alveolar ridge.10-16 This case report will describe the use of distraction osteogenesis within the alveolar ridge, in order to increase the amount of bone available for implant placement.
mandibular central incisors were unsuitable as abutments, and that these teeth should also be extracted at the time of surgery. It was thought ideal to replace these teeth, as well as the three avulsed teeth, with an implant-retained prosthesis. However, the loss of bone from the alveolar ridge meant that some form of ridge augmentation would be required prior to implant placement. Thus, it was decided to place two intra-alveolar distractors in the edentulous mandibular region. This would also be done at the time of the mandibular advancement; (4) intra-alveolar distraction would proceed over the next full week at the rate of 1mm per day (two complete turns of the distraction heads); (5) when sufficient alveolar bone height and density had been achieved, the distractors were to be removed and implants placed in the lower anterior region for the subsequent prosthetic replacement of the four mandibular incisors and left mandibular canine; (6) continued orthodontic detailing of the occlusion for approximately six months, while waiting for the total integration of the implant fixtures; and (7) removal of the orthodontic appliances in conjunction with placement of a semi-permanent acrylic implant-retained prosthesis, as well as a routine maxillary orthodontic retainer. A semi-permanent restoration was to be placed initially due to the patient’s relatively young age and the possibility of further injury through his passion for skateboarding. This restoration would ideally be replaced with a restoration that would be more aesthetic and durable when the patient was older.

**Treatment progress and surgery**

Treatment continued as planned, with mandibular advancement surgery taking place approximately two years after initial placement of orthodontic appliances. The Leibinger Endosseos Alveolar Distraction (LEAD) system (Stryker Leibinger, Michigan, USA) was chosen to provide the distraction required. The intra-alveolar distraction devices were placed according to the manufacturer’s instructions. This involved surgically releasing a block of bone in the edentulous area of the mandible between the 34 and 43. Two vertical holes were drilled through the block, allowing placement of a vertical, threaded rod in each hole. Two horizontal plates, the base plate and the transport plate, were screwed to the mandibular body and sectioned block respectively. When the threaded rod was turned, the sectioned, edentulous block of bone would be transported occlusally, leaving a space that would eventually be filled-in by new bone; thus increasing the vertical ridge height in the edentulous area and permitting implant placement. Each full turn of the screw represented a half millimeter vertical movement of the sectioned block. The patient turned the screw twice a day for seven days, beginning two days after surgery. This produced a seven-millimeter increase in alveolar height (Fig 3a).

At the same operation, the patient also underwent a 5mm mandibular advancement and the mandibular central incisors and all third molars were removed. Surgical recovery and healing were uneventful.

**Completion of active treatment**

Three months after surgery, an orthopantomogram confirmed that considerable new bone had filled the
distracted area (Fig 3b). Under local anesthetic, the distraction rods were removed and three implant fixtures placed (Fig 3c). Six months later, immediately prior to the removal of the fixed orthodontic appliances, the mandibular arch wire was sectioned, to facilitate the placement of a semi-permanent, acrylic, implant-retained prosthesis to replace the missing mandibular incisors and canine (Fig 4).

Following removal of the fixed appliances, maxillary Hawley and mandibular Dohner retainers were placed. The total duration of active treatment had been 36 months.

DISCUSSION

Since the reports of Ilizarov, much research has focused on the possible uses of distraction osteogenesis. Recent reductions in the size of distraction devices have made intra-alveolar distraction now possible in day-to-day practice. This method of increasing both alveolar bone height and labial sulcus depth may be preferable to other methods, such as autogenous bone grafting with its associated donor-site morbidity. Several other reports have described the use of intra-alveolar distraction as an adjunctive procedure prior to implant placement. Rachmiel et al. also used the LEAD system for alveolar ridge augmentation. They described 14 patients aged from 18 to 55 with alveolar defects due to trauma, post-extraction after severe periodontitis or due to anodontia. Six cases involved the maxilla, and eight involved the mandible. Two of the mandibular cases involved the posterior region. Similar to the case we have described, Rachmiel et al. used two distraction devices when the space consisted of more than three single-rooted teeth, or two molars. These authors made several interesting points about the process of ridge augmentation using distraction osteogenesis. The first was that as a result of distraction, the crestal bone remains cortical and mature and may be expected to undergo less resorption than grafted bone. They also discouraged the use of a temporary denture following distraction and prior to implant placement. They felt that any pressure on the transport segment could lead to eventual resorption. They also suggested that the transport block should be at least 5mm in height, and this may preclude the use of distraction in the posterior region where there may be insufficient bone covering the inferior alveolar nerve.

One problem encountered by several authors is the vector of distraction. Urbani found that a lingual displacement of the bone fragment occurred during the distraction. This was corrected by placing an orthodontic arch wire and attaching a rubber band from the distraction device to the arch wire, pulling the distracted fragment labially. Jensen et al. found that 11 of 28 distracted anterior maxillary segments required ‘anteriorisation’.

A number of different distraction devices have been described. These include the Dis-Sys Distraction Implant (Sis Inc, Klagenfort, Austria) and the 3i Implant Distractor (Implant Innovations, West Palm Beach, Florida, USA) both of which not only serve as distractors, but have the advantage of also being used as a restorative implant, and thus do not need to be removed after the distraction phase. The Ace
Osteogenic Distractor (Ace Surgical Supply, Brocton, Massachusetts, USA) consists of a distraction implant fixture that is positioned in the transport block, a base plug that rests on the mandibular bone and axial distraction screws of various lengths. The screws are progressively replaced until the desired alveolar bone augmentation is achieved. This distractor must be replaced by a restorative implant. Urbani et al.\textsuperscript{13} found that the use of these distraction implants produced technical problems, because the active implants were not placed in the positions required for the final restorative implants. They therefore had to be removed 30 days prior to the placement of the final restorative implants. Thus, three surgical stages were required. Urbani\textsuperscript{19} later wrote that rarely could the final implants be placed at the time of the removal of distraction implants because the distractors have to be placed according to the anatomical and functional conditions existing at the time of inserting the devices to obtain optimal distraction. However, these conditions are often quite different from the anatomical, functional and aesthetic conditions needed for ideal prosthesis placement. This may also mitigate against the use of those distraction implants that also serve as final restorative implants. The use of thinner distraction rods, on the other hand, would appear to allow greater flexibility in positioning. Being relatively narrow, they should not prevent definitive implant placement at the time of their removal, as was done in this case, and in others.\textsuperscript{12,13,14}

There have been few studies that have looked at the long-term success of implants placed within distracted bone. Rachmiel et al.\textsuperscript{12} in a follow-up of 6-20 months after distraction, found that 22 of 23 implants placed had successfully integrated. Jensen et al.\textsuperscript{14} used one of two distraction techniques in 28 patients. Of 84 implants placed following distraction, eight were found to have failed prior to restoration. Six of these were replaced, and all implants were then followed for at least three years post-restoration. During this period, all implants maintained stable bone levels. Interestingly, all of the failed implants had been placed in trauma cases. Jensen et al.\textsuperscript{14} also found that most of the restorations were judged to have satisfactory aesthetics, though none were considered to be ideal.

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REFERENCES


Address for correspondence/reprints:
Dr Bruce Baker
19 Regent Street
Elsternwick, Victoria 3185
Email: brucebaker66@hotmail.com