

Distraction osteogenesis with subperiosteal devices in edentulous mandibles

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Abstract

Nine patients with severely atrophic edentulous mandibles were treated by distraction osteogenesis with subperiosteal distractors for vertical augmentation of the anterior alveolar bone before insertion of implants. All the patients had severe complications and we conclude that the use of subperiosteal devices for vertical augmentation of edentulous mandibles is hazardous and offers no advantage over other surgical methods. © 2005 The British Association of Oral and Maxillofacial Surgeons. Published by Elsevier Ltd. All rights reserved.

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Introduction

Vertical augmentation of bone is a prerequisite before insertion of endosseous implants in severely atrophic mandibles^{1–5} (Cawood types V and VI⁶; <10 mm in height) because endosseous implants perform poorly when they are shorter than 10 mm.⁷

Most current techniques require transplantation of bone, which causes morbidity at the donor site.⁸ Another option is distraction osteogenesis that can create sufficient volume of bone in both partially edentulous and edentulous patients.⁹

Distraction osteogenesis results in the formation of new bone between bone segments that are separated gradually by incremental traction. Tension in the callus and in the surrounding soft tissues results in expansion of both, and the callus is replaced by bone.^{10,11}

Distraction osteogenesis can be achieved by intraosseous^{12,13} or extraosseous devices.¹⁴ Extraosseous devices for vertical distraction of the mandible are usually placed subperiosteally.

Patients and methods

Nine edentulous women (mean age 55.9 years, range 44.3–72.7) with severely atrophic mandibles (Cawood types V and VI⁶; mean height in the canine region measured on panoramic radiographs: 7.9 mm, range 5–10) and unable to wear conventional dentures, were operated on under general anaesthesia. The mandibular ridge between the mental foraminae was exposed by an interforaminal incision in the buccal fold and raising of a full thickness mucoperiosteal flap. The mental nerves were carefully located and preserved. The interforaminal osteotomy was delineated, the subperiosteal distraction device (KLS Martin, Tuttlingen, Germany) was mounted and removed, and the osteotomy completed.

In all patients, the cranial segment had a minimum height of 3 mm and was mobilised, preserving the lingual periosteal attachment. The distraction device was reinserted and activated to its maximum distance to identify obstacles in the path of distraction. The transport segment was then brought again in full contact with the base. The wound was closed in layers with interrupted sutures.

Standard perioperative antibiotic and analgesic drugs were given to all patients, who were not allowed to wear mandibular dentures until the distraction device was removed.

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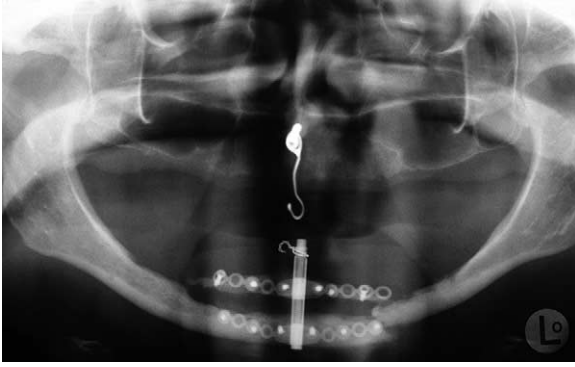


Fig. 1. Fracture of basal bone (Track 1.5 distractor, KLS Martin, Tuttlingen, Germany), maxillomandibular fixation hooks ("Ottenhaken" in place, Case No. 2).

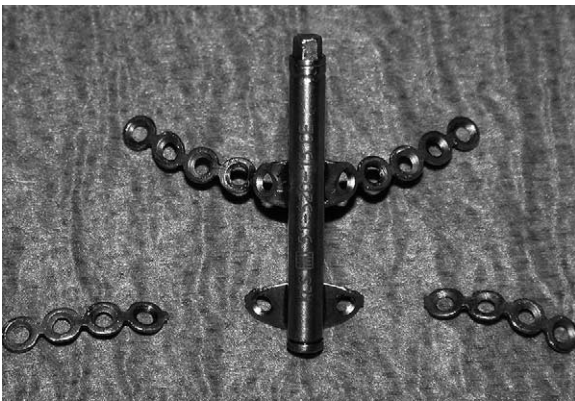


Fig. 2. Breakage of distractor device at both ends of the basal plate (Track 1.5 distractor, KLS Martin, Tuttlingen, Germany, Case No. 7).

After a latency period between 6 and 14 days, depending on the extent of wound healing, distraction was started at a rate of $3 \text{ mm} \times 0.3 \text{ mm}$ a day (a daily distraction of 0.9 mm). The distraction was continued until the desired height was achieved. Thereafter, the distractor was left in place to allow time for ossification. The distractors were removed after 1.5–5.0 months (mean 2.9 months) and, whenever possible, implants were placed at that time.

Clinical and radiographic examinations were made before and after insertion of the distractor, at the end of distraction, and before and after its removal.

The mean period from the operation to insert the distractor until placement of implants was 5.8 months (from 2.0 to 14.0 months).

Results

The 9 patients had a total of 19 complications (Table 1).

Complications included severe tilting of the transport segment ($>30^\circ$) ($n = 3$), fracture of the basal bone ($n = 3$) (Fig. 1), fracture of the transport segment ($n = 2$), breakage of the distractor ($n = 2$) (Fig. 2), ptotic chin ($n = 1$), defective formation of bone ($n = 1$), immature bone at time of removal of the

distractor ($n = 1$), unfavourable position of implants ($n = 1$), infection ($n = 1$), reverse activation of the distraction device ($n = 1$) and dehiscence of the soft tissue ($n = 3$).

For osseous fractures, treatment was either clinical observation¹⁵ or immediate surgical repositioning and osteosynthesis.

In one patient, implants had to be removed the day after insertion because of their unfavourable position, which was detected in the postoperative radiographs. After 11 months, implants were inserted with simultaneous onlay bone grafting from the hip. The implants were successfully loaded and the follow-up is now 17 months in this patient.

In two patients, secondary augmentation operations were necessary at the time of placement of the implants.

One patient had plastic surgery to correct a ptotic deformity of the chin, which was the result of excessive denudation of the mandible and insufficient refixation of the mentalis muscle at the time of insertion of the distractor.

Overall, four additional operations were required in three patients and four additional surgical steps were required during pre-planned operations in another three patients.

Minor complications such as wound dehiscence, infection, and reverse activation of the distraction device were treated and did not have an influence on the outcome of distraction.

Dental implants were successfully placed and loaded prosthetically in seven patients with a mean follow-up after loading of 26.8 months (11.4–39.2 months). None of the implants was lost.

One patient was given dental implants, but loading is not yet possible because of the patient's financial problems. Another patient could not be given implants because of severe tilting of the distraction segment.

Discussion

Surgical attempts to augment the height of the edentulous mandible originated from the need to supply enough bone to retain mandibular overdentures. At first, operations were devised to gain vertical height not only in the anterior but also in the posterior mandible. The various osteotomy techniques described by Harle,¹⁶ Schettler and Holtermann,¹⁷ and Stoelinga et al.,¹⁸ are therefore of historical interest only. The main complications of these techniques were paraesthesia of the lower lip¹⁹ and fracture of the mandible from 5%²⁰ to 20%.²¹ Alveolar nerves were dissected from the mandibular canal because it was assumed that this would reduce postoperative numbness; vestibuloplasties had to be done to seat overdentures adequately, but this increased disturbances of sensation all the more.¹⁷ Operations to augment the height of the mandibular arch were given up in the mid-1980s, when even the most elaborate techniques produced poor results in terms of side effects.

Other techniques were at least as problematical as osteotomy. Up to 89% of autologous overlay bone grafts from the ilium or the rib were found to have been absorbed after

Table 1
Complications in nine patients

Case No.	Complications		Implants inserted	Treatment	Prosthetic loading	Consequences
	During distraction	After distraction				
1		Tilting of transport segment	4 IMZ ^a	None	Bar; overdenture	None
2	Fracture of basal bone		4 IMZ ^a	Maxillomandibular fixation; miniplate osteosynthesis after removal of distractor	Bar; overdenture	Extended treatment; additional surgical steps during removal of distractor, insertion of miniplate and insertion of dental implant (removal of miniplate)
3	Temporary reverse activation of distraction device		4 IMZ ^a		Stud attachments; overdenture	None
4	Dehiscence of soft tissue	Defect in bone formation		Secondary augmentation		Additional surgical step during implantation
		Unfavourable position of implants in radiological controls	(3 IMZ ^a) 4 Xive ^a	Local	Bar; overdenture	None
5	Transport segment fractured during operation		4 Frialit II ^a	None	Bar; overdenture	None
		Immature bone at time of removal of distractor		Delay of insertion of implants by 4 months		Extended treatment; additional operation
6	Broken distractor		4 Xive ^a	None	Bar; overdenture	
		Infection		Intravenous antibiotic		Readmission to hospital
7	Fracture of basal bone		4 Frialit II ^a	None	None	
8	Broken distractor			None		
	Tilting of transport segment		None	Revision to upright transport segment	None	Additional operation
	Fracture of basal bone			Osteosynthesis		No implant placement
	Fracture of transport segment					
	Dehiscence of soft tissue			Secondary suture		Additional operation
		Dehiscence of soft tissue		Soft laser		
9	Tilting of transport segment		4 Frialit II ^a	None	Bar; overdenture	None
		Ptotic chin		Corrective plastic surgery		Additional operation while uncovering of implants

^a IMZ[®], Xive[®], Frialit II[®] are registered trademarks of Friadent Mannheim, Germany.

three years.²² Hydroxyapatite augmentation led to incorrect position or excessive increase of the width of the ridge, diffusion of material with irregular distribution, and migration of the material.²³

The problem is that most operations for vertical augmentation of edentulous mandibles are unpredictable in their side effects and long-term results. This has not changed with the

introduction of more conservative measures and insertion of dental implants at the time of augmentation operations.

Vermeeren et al.⁵ published a five-year follow-up of one-step reconstruction of severely atrophic mandibles with onlay bone grafts and endosteal implants. They reported 31 patients with Cawood class VI severely atrophic mandibles who were given corticocancellous bone grafts with Straumann implants

in a one-step operation. The extent of bone absorption was almost 50% and 8 of 78 implants were lost. They concluded that the technique that they described could no longer be recommended.

Verhoeven et al.⁴ described the combined use of endosteal implants and iliac crest onlay grafts in severely atrophic mandibles. Their longitudinal study included 13 patients who had 30 implants. Eight implants developed peri-implantitis during the mean observation period of 877 days and there was a mean absorption rate of 36% of the grafted bone height. They concluded that the operation that they described should be used only if there were compelling indications.

Joos and Kleinheinz² described the placement of implants in 24 mandibles simultaneously with bone grafting or at a second stage. The implants functioned as lag screws to fix the grafts. Four implants were placed in each patient. Complications included soft tissue infections in 8, complete loss of the graft in 1, partial loss of the graft in 3, absorption of the graft in 2, and loss of 7 of 96 implants affecting 7 patients.

Similar findings were reported by Schliephake et al.³ in their survival analysis of endosseous implants in bone grafts used for the treatment of severe atrophy of the alveolar ridge. In 5 years, 89.3% of mandibular implants survived.

Bell et al.¹ described the staged reconstruction of severely atrophic mandibles with autogenous corticocancellous bone grafts and endosteal implants in 14 patients. Five endosteal implants were placed in each patient after a delay of 4–6 months after bone grafting. The median preoperative bone height in the mandibular midline was 9 mm (range 7–10 mm). The mandible was approached by a submental incision. Corticocancellous bone was placed along the superior and lateral aspects of the mandible extending as far back as the retromolar region. The bone graft was firmly packed into a mucoperiosteal tunnel without encroaching on the lingual tissues. Side effects, such as sensory disturbance, were not reported. The mean loss of vertical bone height during the 4–6 months before placement of implants was 33%. Loading took place 4 months after insertion of implants and implant survival was 100%.

Choi et al.²⁴ described the use of a sandwich osteotomy with an interpositional allograft for vertical augmentation of the edentulous alveolar ridge. While Choi et al. used bovine collagen matrix without fixation, Ewers et al.²⁵ used a mixture of autogenous bone and a porous hydroxyapatite, and fixed the cranial segment with microplates. Both methods led to minimal bone absorption and seem to be valid augmentation procedures.

In recent years, distraction osteogenesis has been described for vertical augmentation of alveolar bone in partially edentulous patients. In severely atrophic mandibles the Groningen distraction device was successfully used for vertical distraction followed by the insertion of two implants in a series of 10 patients.⁹

One of the advantages of the Groningen distraction device may be its endosseous location and prevention of untoward stress at the buccal surface of the mandible. Our results with

subperiosteal devices have clearly not been as favourable as those with endosseous devices.

In conclusion, the use of subperiosteal devices for vertical augmentation of edentulous mandibles is hazardous and is no more advantageous than conventional methods. We think that the design of a subperiosteal distractor should be optimised by including features to prevent stress such as more stable and longer basal plates, as well as protection from reverse activation by the patient, and mechanisms to prevent lingual tilting. However, it remains doubtful whether subperiosteal devices will have a place for vertical alveolar distraction in edentulous patients in the future.

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