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British Journal of Oral and Maxillofacial Surgery 51 (2013) e234–e238

BRITISH Journal of Oral and Maxillofacial Surgery

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# The animal experiment of a new optimised distraction implant

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Accepted 7 March 2013
Available online 17 April 2013

**Abstract**

Our aim was to evaluate the function of a new optimised distraction implant. Six dogs with alveolar bone defects had a total of 18 distraction, and 6 normal, implants inserted into edentulous mandibular ridges after osteotomy. Five days after insertion the distraction implants were activated at a rate of 1 mm/2 days to achieve a distraction height of 6 mm. Radiographs were taken at 0, 1, 2, and 3 months after distraction. Two dogs were killed after 1, 2, and 3 months, respectively, and 12 distraction implants taken from the different time points were evaluated by microcomputed tomographic (MicroCT) scanning and histological examination. The other 6 distraction, and the 6 normal, implants were compared after osseointegration with a fatigue test. The results showed that all the distraction implants had successfully distracted the bone to the anticipated height. Radiographs showed that the density of the regenerated bone increased steadily during the consolidation period. MicroCT showed that the regenerated bone was comparable with the native bone 3 months after distraction. Both native and regenerated bone had osseointegrated histologically by 1 month and 3 months after distraction. The experiment successfully confirmed the usefulness and feasibility of this new distraction implant, and suggests interesting clinical uses.


*Keywords:* Distraction implant; Distraction osteogenesis; Radiographs; Micro-computed tomography; Histology; Animal experiment

## Introduction

Dental implantation has long-term functional and aesthetic consequences, and has become one of the most common and efficient dental practices. However, the inadequate height of alveolar bone that can result from tooth extraction, trauma, periodontal disease, or resection of a tumour can make insertion difficult, and cause aesthetic defects or even failure.

In such cases augmentation of the alveolar ridge may be required to restore adequate height and to create an appropriate environment for the insertion of endosseous implants. Many methods have been proposed for the reconstruction of the alveolar ridge, including onlay or sandwich bone grafting,[1–3] guided regeneration of bone,[4] and alveolar distraction osteogenesis. The latter has attracted considerable interest since 1996, when Block et al.[5] and Chin and Toth[6] reported its first experimental and clinical applications, respectively. It has many advantages over other methods including simultaneous augmentation of hard and soft tissue, no need to harvest bone, avoidance of donor site morbidity, and less resorption of bone than after a free bone graft.[7–10]

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0266-4356/$ – see front matter 
http://dx.doi.org/10.1016/j.bjoms.2013.03.003

However, conventional alveolar distraction osteogenesis comprises 3 steps: placement of a distractor, removal of the distractor, and insertion of one or more implants 8–16 weeks after distraction. After insertion, another 4–6 months of bone-implant osseointegration are needed before the prostheses can be attached.[7,11,12] This has disappointed both dentists and patients, and a new technique is urgently needed to simplified the procedure. The new device, called a distraction implant and designed by Gaggl et al., acts as both a distractor and an implant, and has shortened the treatment time considerably.[13–15]

Although the distraction implant had special advantages, the complicated structure of the first prototype limited its clinical use. First, the coronal part was the main load-bearing part, but it was too short to support the occlusal force. Secondly, the central distraction screw was easily broken by long-term stress. Thirdly, it was difficult to take out the apical support part in case the implantation failed. To promote the clinical application of distraction implants, therefore, it was necessary to optimise and evaluate their use.

We have aimed to examine the feasibility of a new optimised distraction implant used to correct inadequate alveolar height in adult mongrel dogs by radiographs, microCT, and by histological and biomechanical examinations.

## Materials and methods

### *Components of the new optimised distraction implant*

An optimised distraction implant was developed at the department of Oral and Maxillofacial Surgery, School of Stomatology, The Fourth Military Medical University, Xi'an, China. The implant has 3 main components that are used during active distraction, all of which are made of titanium (Fig. 1). First, there is the coronal function part, which is 8 mm long with external threads in the coronal 5 mm; the 3 mm apical surface is smooth so that it can move during distraction. Secondly, there is an apical support part that is 2 mm long; and thirdly there is a central distraction screw 2 mm in diameter, which is available in different lengths. Before distraction, the function part and the support part are connected to make one 10 mm piece with a connection screw. The distraction screw can be activated with a screwdriver; a right turn of 360° corresponds to a rise of 0.4 mm in the implant function part.

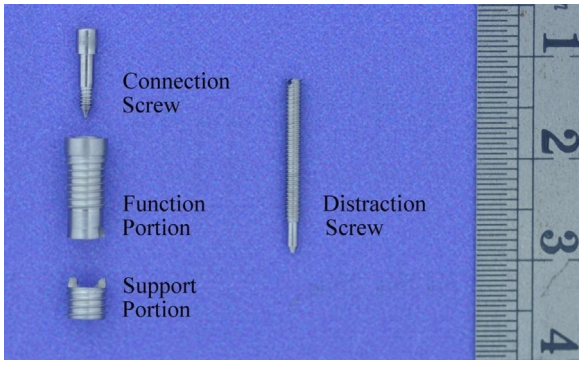


Fig. 1. Components of the distraction implant.

### *Establishment of an animal model of insufficient alveolar height*

Six adult mongrel dogs about 2 years old were used. The study was organised according to the Guidelines for the Care and Use of Laboratory Animals, as set out by the Institutional Animal Care and Use Review Committee of The Fourth Military Medical University. The operations were all done with the animals under general anaesthesia (by an intramuscular injection of sodium pentobarbital, 30 mg/kg). All mandibular premolars were extracted and an alveoloplasty constructed. The bone was allowed to heal for 3 months and the model of insufficient alveolar height was ready.

### *Procedure for insertion and distraction osteogenesis*

The 6 dogs were divided into three groups of 2 each. In each group, one dog had 2 distraction implants inserted into each side of the mandible, and the other dog had 2 distraction implants and 2 normal implants inserted into each side of the mandible. A horizontal incision was made in the vestibule 10 mm lower than, and parallel to, the alveolar crest, and the upper mucoperiosteum was detached to 5 mm below the alveolar crest to expose the osteotomy area. We made a horizontal osteotomy using an ultrasonic osteotome (Woodpecker, China). Two distraction implants were inserted into the alveolar crest parallel to each other. Finally, we made vertical osteotomies to create a transport segment 5 mm × 30 mm. The dogs were given ampicillin (0.5 g twice daily) for 3 days postoperatively. Five days later the initial connection screw was replaced by the distraction screw, and the bone distracted at a rate of 1 mm every 2 days for 12 days to achieve a height of 6 mm.

### *Evaluation*

#### *Clinical evaluation*

The dogs in the 3 groups were allowed to heal for 1, 2, and 3 months before they were killed. The dogs were sacrificed by overdose of anesthetic. The vertical distances from the middle point of the crest between the 2 distraction implants to the linked line of the highest mesial and distal cusps of the teeth were recorded with a Vernier calliper before osteotomy and after the animal had been killed. The actual height of augmentation of the ridge was defined as the difference between the height before osteotomy and that after death.