

# A Distraction Abutment System for 3-Dimensional Distraction Osteogenesis of the Alveolar Process: Technical Note

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*To date, distraction osteogenesis has been carried out exclusively with devices that allow distraction in one given direction only. However, the new distraction abutment system described in this article allows distraction in any functionally or esthetically desired direction following osseointegration of 1 or several implants, provided that there are adjacent teeth or other osseointegrated implants. With this abutment system, an implant fixed in a position dictated by available bone volume can be moved into a prosthetically desirable position following segmental osteotomy. Accordingly, it also allows correction of the position of implants that were placed at an early age but whose position has changed as the result of jaw growth. Compared with conventional augmentation techniques carried out before or after implant placement, this method should lead not only to a shorter overall treatment time, but also to reduced strain on the patient and better long-term prognosis for success of implants. (INT J ORAL MAXILLOFAC IMPLANTS 2000;15:731-737)*

**Key words:** dental abutment, dental implant, distraction osteogenesis, segmental osteotomy

Distraction osteogenesis is a surgical process involving new bone formation between vascularized bone surfaces following osteotomy or corticotomy as a result of regular distraction achieved by means of functionally stable devices. This technique was first described by Ilizarov,<sup>1</sup> who developed it further experimentally<sup>2</sup> and perfected it clinically.<sup>3</sup> It was first used mainly to lengthen long bones. The reliability of this method has been examined by several authors.<sup>4-6</sup> Karp and coworkers,<sup>7</sup> McCarthy and colleagues,<sup>8</sup> Block and associates,<sup>9</sup> Chin and Toth,<sup>10</sup> and others have also introduced this therapeutic principle to craniofacial surgery both experimentally and clinically so as to displace portions of the facial skull or the jaws. Chin,<sup>11</sup> Gaggl and

coworkers,<sup>12</sup> and Hidding and associates<sup>13</sup> also demonstrated the suitability of callus distraction for vertical augmentation of atrophic portions of the jaw in preprosthetic surgery.

It is widely believed that new bone formation occurs more or less in the same way as intramembranous ossification.<sup>13</sup> Stretching of soft tissue is possible without any problems at a distraction rate of 1 mm per day.<sup>2</sup> All the methods mentioned allow callus distraction in only one direction, which is determined by the device used. However, the possibility for multidimensional distraction, ie, distraction in different directions, is considered desirable.<sup>14,15</sup>

The distraction abutment to be described in this report is a device that allows augmentation of an atrophic alveolar process in several planes, depending on functional and esthetic requirements. The clinical application of this distractor facilitates multidimensional osteodistraction of an edentulous alveolar ridge segment in which 1 or more implants have been placed.

## MATERIALS AND METHODS

### Patients

To date, a total of 6 patients (3 males and 3 females) aged 14 to 48 years have been treated with this

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method. One patient was edentulous, and the others were partially dentate. Three procedures were carried out in the maxilla and 3 in the mandible. Altogether, 11 implants were located in the distracted segments (Nobel Biocare, Göteborg, Sweden, regular platform, length 10 to 15 mm). The longest observation period has been 7 months.

### Devices

The core of this method is a so-called distraction abutment. This implant abutment, which to date has been custom-fabricated but will be prefabricated in the future, consists of a tube-shaped extension matching the respective implant system. This extension is mounted on an osseointegrated implant with a screw. The diameter of the abutment corresponds to the diameter of the implant, while its length is determined by the soft tissue width. The abutment is supplemented by 2 threaded pins that protrude freely into space. One of the 2 pins is oriented exactly along the extended implant-abutment axis, while the other pin is fixed at an angle of 30 to 90 degrees to this axis. These threaded pins jointly protrude through a slit-shaped hole in a custom-fabricated tooth- or implant-supported metal guide splint.

After the pins have been put through the hole in the splint, nuts are mounted, and the pins are shortened accordingly (Figs 1a to 1d). The splint itself is supported not so much by the adjacent teeth, but rather by the entire residual dentition of the affected arch. Possible tilting of the splint upon activation of the nuts on the threaded pins is prevented by punctiform bonding of the splint to individual teeth or osseointegrated implants, which are not positioned in the area of the planned bone-implant block.

### Clinical Procedure

Initially, an impression is made, and the position of the implants, which are osseointegrated in sufficient bone tissue but are malpositioned from a prosthetic point of view, is marked on a diagnostic cast. The future ideal prosthetic position is then determined. The distraction abutment is fabricated, or if a prefabricated distraction abutment is to be used (Figs 2a and 2b), it is selected in accordance with this planned position and the resultant distraction direction. Its position on the implant is then determined. Simultaneously, a tooth- or implant-supported metal splint with the earlier-mentioned slit-shaped hole is custom-fabricated according to the occlusal conditions (Fig 3). The shape of the splint is completely independent from the implants, which are planned to be moved by distraction. It serves as a resistance during turning of the nuts, so that a

mobilized bone-implant block can be moved in the desired direction. Because of the chosen position of the abutment on the implant and turning of the nuts above the splint, traction of the implant is possible in any chosen dimension or direction.

The alveolar process segment area to be osteotomized is normally uncovered by raising a vestibular pedicled trapezoid mucoperiosteal flap. If the implant heads are already exposed, the horizontal incision is carried out along the border between the attached and the unattached gingiva. If uncovering of the implants and osteotomy are carried out simultaneously, the horizontal incision is made at the junction between the occlusal and buccal surfaces of the respective alveolar process region. The starting point of the slightly diverging incisions, which run vestibularly almost in a right angle, is the peripheral margin of the edentulous area.

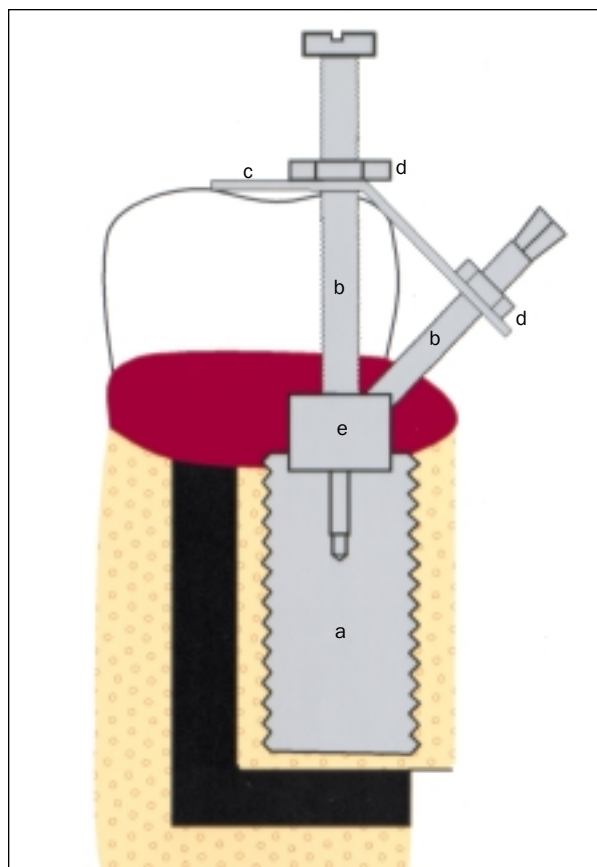
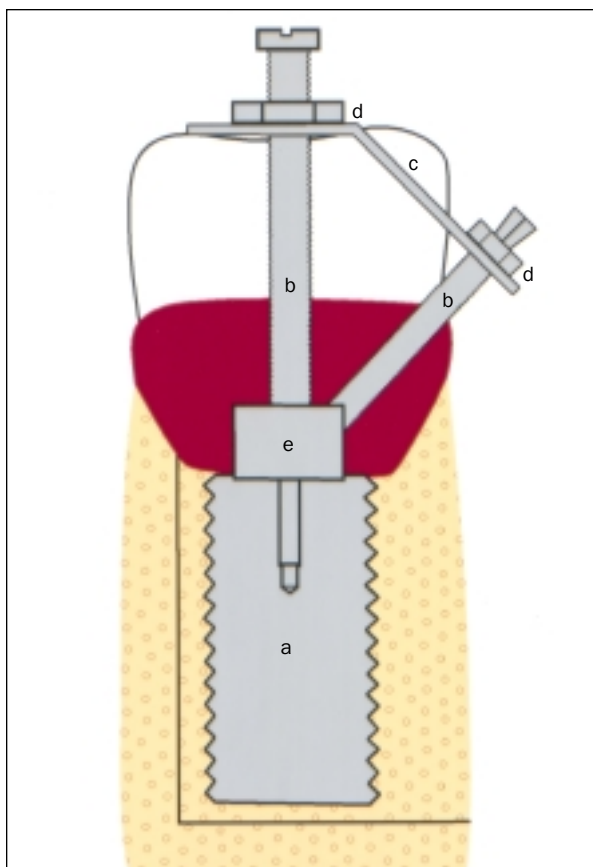
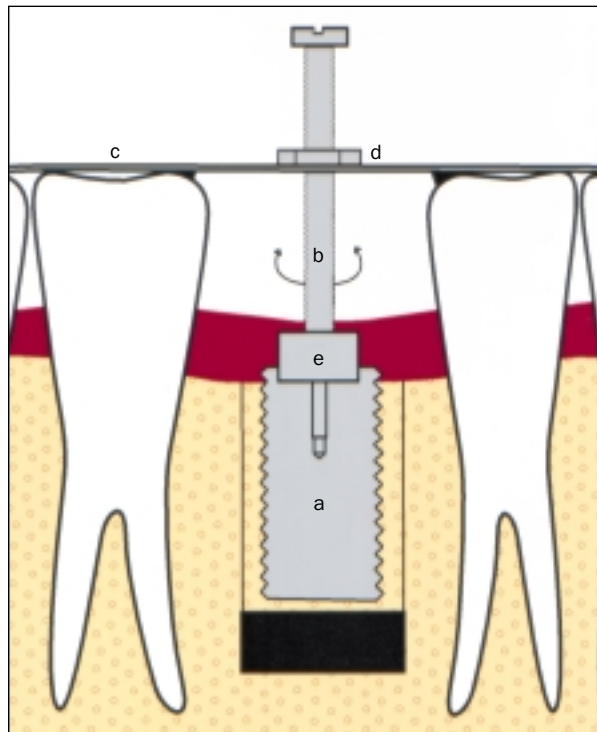
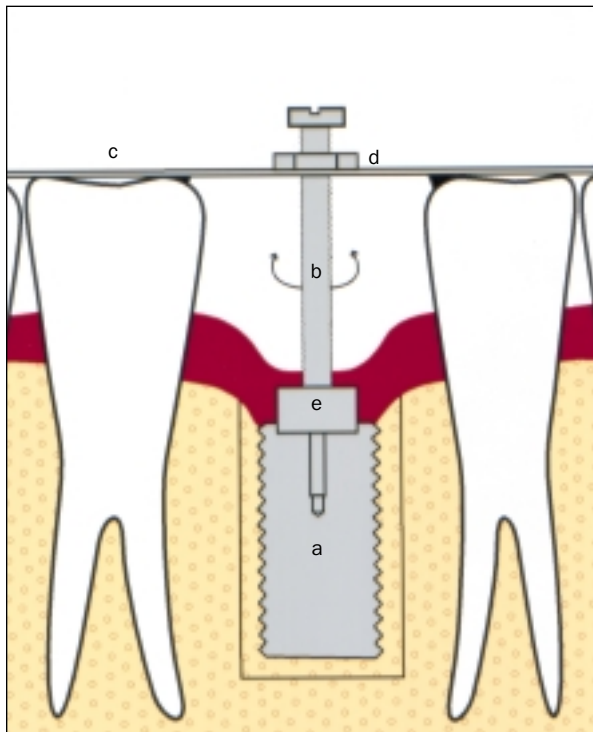
The bone surrounding the implants is then cut through completely with a diamond disc or saw under observance of a distance of at least 1 mm to the implant, under careful preservation of the blood supply and the periosteum (Fig 4). Proper cutting of the bone is facilitated by application of an appropriate implant template (Fig 5), which is attached to the implant immediately before the osteotomy.

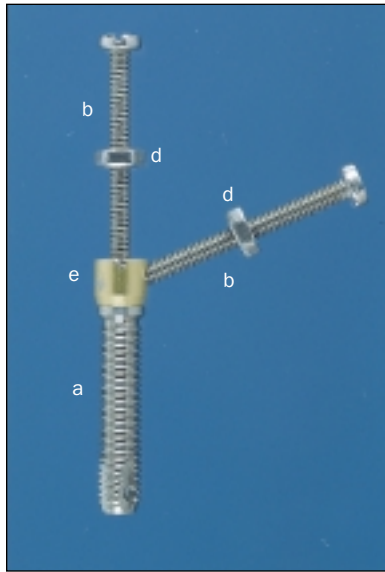
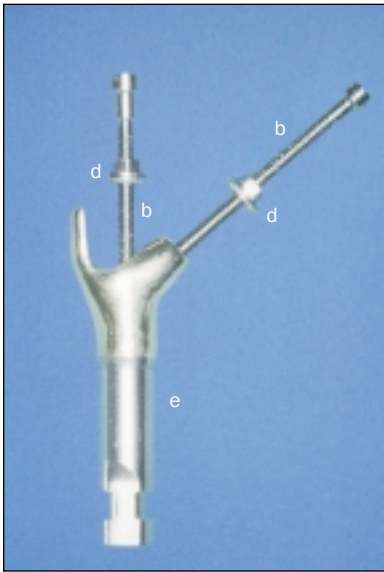
At the end of the procedure, the abutment is inserted together with the splint, as previously described (Fig 1), and is fixed in a stable position. After a 5-day interval, distraction is begun by turning the nuts that are screwed onto the 2 threaded pins and resting on the splint. The direction of movement of the implant-bone segment can be controlled by variable turning of the nuts. Lateral movement occurs in the direction of the transversely oriented threaded pin and can be fixed individually at the beginning of distraction by turning of the distraction abutment and appropriate fixation of the abutment to the implant. Vertical movement is achieved by turning of the nut screwed onto the threaded pin that is oriented in the direction of the implant and constitutes prolongation of the implant. Movements of implants in different directions within one segment cannot be carried out. If this is desirable, the segment must be subdivided.

For edentulous patients, implants that were placed earlier in locations away from the planned operating field serve as a support for the splint and for stabilization of the osteotomized implant-bone block. Transport of the segment by 1 mm per day is considered ideal. The nuts on the 2 pins may be turned to a varying degree, depending on prosthetic planning (Figs 6 to 8).

The distraction process is followed by 8 weeks of stabilization. If necessary for esthetic reasons, the

**Figs 1a to 1d** Schematic drawings of the distraction process showing the principle of vertical movement alone and of combined vertical and lateral movement. The 2 threaded pins fixed to the distraction abutment protrude vertically and laterally through the tooth-supported splint, and distraction can be activated by turning the nuts. a = implant, b = threaded pin, c = tooth-supported splint, d = nut, e = abutment. Black = area of distraction.





**Fig 2a** (Left) Custom-fabricated distraction abutment (e) with inserted threaded pins (b) and nuts (d).

**Fig 2b** (Right) Prototype of a commercially fabricated distraction abutment with connected implant. a = implant, b = threaded pin, d = nut, e = abutment.



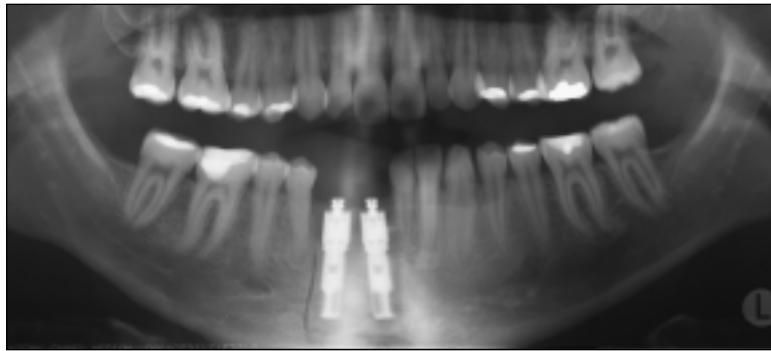
**Fig 3** Distraction abutment in place, with metal removable splint and 2 screws for traction in a caudobuccal direction.



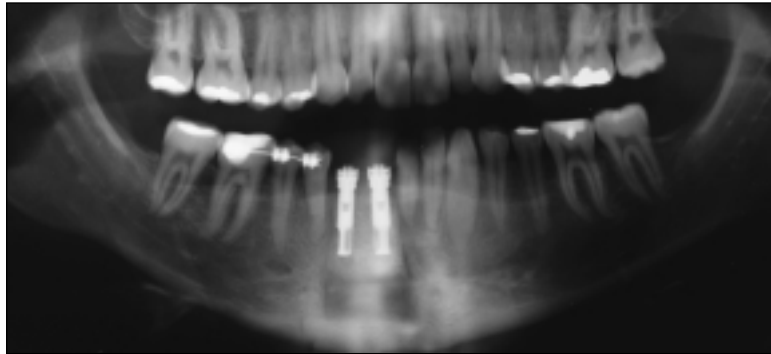
**Fig 4** (Left) Dental film following osseointegration of the implant and peri-implant segmental osteotomy.

**Fig 5** (Right) An implant template to be mounted on the implant.

**Fig 6a** Panoramic radiograph showing a caudal implant position following reduction of a knife-edged ridge and osseointegration, immediately after segmental osteotomy with caudally diverging vertical osteotomy lines.



**Fig 6b** Panoramic radiograph showing prosthetically desirable implant position following distraction.



**Fig 7a** Before distraction.

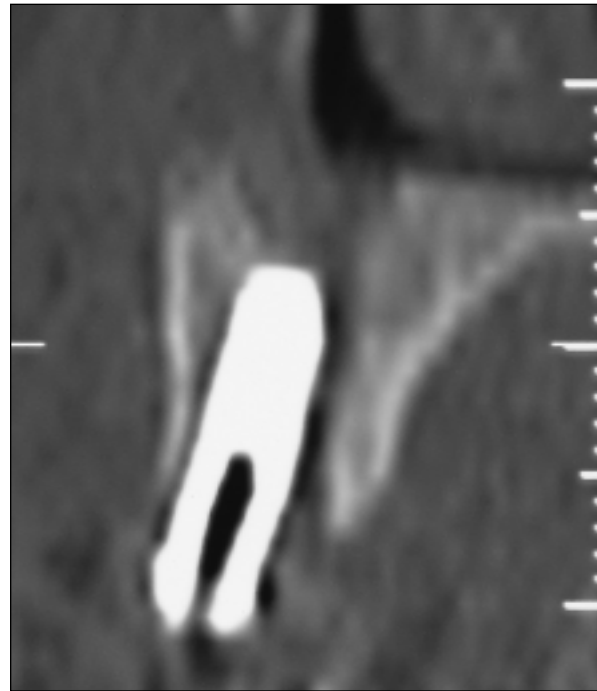
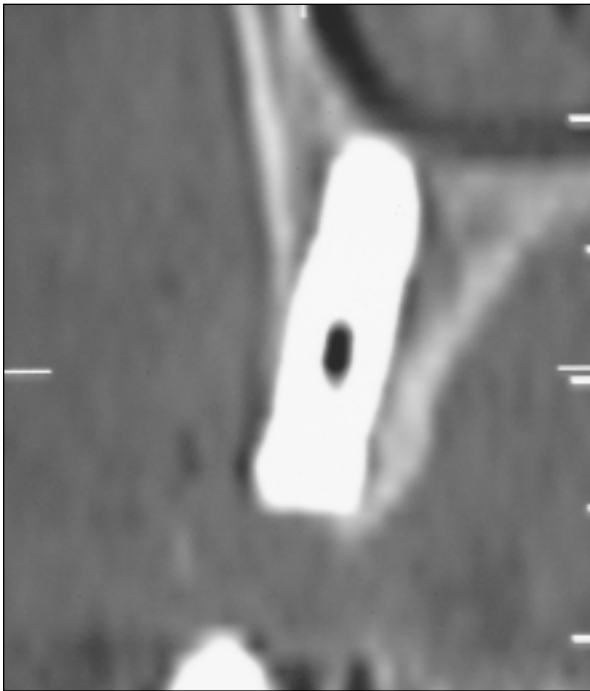


**Fig 7b** Immediately after distraction.

**Figs 7a to 7c** Coronal CT sections showing the extent of buccal movement of the bone segment with the osseointegrated implant.



**Fig 7c** Six months after distraction.



**Figs 8a and 8b** Denta-Scans carried out (*left*) before and (*right*) immediately after distraction demonstrating caudal movement of the bone segment with the incorporated implant.

abutment and the splint can be replaced at this stage by an interim fixed partial denture connected to neighboring teeth or implants. Alternatively, the splint can be reduced to a considerable extent and can be faced with artificial teeth in the edentulous area, if necessary, immediately after distraction, when it serves only for stabilization.

## RESULTS

The ideal position of the implants determined during preoperative prosthetic planning has been achieved in all cases. There have been no healing complications and no implant losses. Computed tomograms obtained pre- and postoperatively showed consistent ossification of the osteotomized and distracted areas. Thus far, the greatest movements of the implant-bone block measured have been approximately 11 mm in the vertical direction, 4 mm in the palatal direction, and 3 mm in the buccal direction.

## DISCUSSION

The described device and procedure make it possible to move an implant that has healed in a bone-dictated position into a position that meets ideal functional and esthetic requirements without any addi-

tional augmentation. Furthermore, the described device can be adapted to any implant system. The bone-implant block can be moved in any desired direction within a few days, and new bone is formed in accordance with the distraction principles described by Ilizarov.<sup>1-3</sup> The system allows precise selection and daily execution of distraction movement in the desired directions. Even if a slightly diverging osteotomy line is made, movement of the segment, and thus callus distraction, can be achieved by application of (possibly very high) traction forces. As a result, osteotomy of the bone at a distance from the tooth or implant is permitted, if necessary.

Clinically assessable movement of teeth or implants loaded by the splint can be excluded and has never been observed, since the splint is supported by the entire residual dentition of the affected arch or by osseointegrated implants and is partly bonded or screwed to individual teeth or implants. Transverse movements of the supporting teeth or implants, for example, following use of crestally diverging osteotomy lines, have not been observed either. On the one hand, this can be explained by the fact that the position of adjacent teeth along the horizontal axis is secured by a closed row of teeth in this area and, on the other hand, by the fact that the splint is supported by and bonded to teeth far from the implant-bone block and by immobile implants integrated in the splint support.

Bone remodeling in the osteotomy gap can obviously follow the high pressure caused by the distraction. Since immediate, functionally stable fixation of the distracted segment is possible, the risk of relapse should be minimal, and the given conditions can also be immediately adapted to cosmetic requirements. An osseointegrated implant can already be provided with a temporary crown 3 to 4 weeks after uncovering, osteotomy, and osteodistraction. However, to prevent relapses, the crown must be supported by the adjacent teeth or implants for a period of 2 months. The overall treatment period is thus much shorter than that of 2-stage augmentation procedures that require a waiting period for bone consolidation. The method also involves comparatively little scar formation in the surrounding soft tissue.

A requirement for the application of this method is sufficient bone volume for placement of an endosseous implant in the area adjacent to the prosthetically ideal implant position. Apart from this, new treatment options are being opened up for patients with oligodontia, as this osteodistraction method also allows correction of the position of implants that have been placed early, but whose position has changed as the result of jaw growth.

Currently, it is still difficult to pass final judgment on the efficacy of this method, to determine indications, and to estimate the overall cost of treatment. If indicated, the described method might not only result in a shorter overall treatment period, but also in reduced strain on the patient and better prognosis for success of implants. Compared with other augmentation methods carried out before or after implant placement, such as guided bone regeneration or augmentation with autologous bone or soft tissue grafts, this procedure could be preferable. However, long-term studies will be needed to make a final assessment of the method and to identify indications.

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