



# DISTRACTION OSTEOGENESIS: A SURGICAL OPTION FOR RESTORING MISSING TISSUE IN THE ANTERIOR ESTHETIC ZONE

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## ABSTRACT

Common causes of alveolar defects include bone resorption due to loss of teeth, infection, or trauma. There is often insufficient height or width of residual bone, and ridge augmentation may be required prior to implant placement. These defects range from small alveolar deficiencies to more complex, extensive bony defects.

Various techniques are available for reconstructing alveolar ridges. Without augmentation, dental implants may have to be placed in anatomically unfavorable positions or have adverse angulations. These position/angulation compromises can lead to esthetic dissatisfaction, mechanical overload, and possibly implant loss. Both bone grafting and distraction osteogenesis are predictable methods for restoring missing tissue.<sup>1-17</sup>

**D**istraktion osteogenesis is the technique of forming new tissues by gradually expanding existing tissues (bone and overlying soft tissue). By utilizing the body's own capacity to heal itself, new tissues can be created. Applying tension forces across an osteotomy site induces bone growth. Distraction osteogenesis can be used to reconstruct a variety of alveolar defects. An advantage of this technique is that both hard and soft tissues are recreated, "distraction histiogenesis." This differs from traditional methods of reconstruction such as bone grafts, which only replace the missing bone.

The anterior esthetic zone is often the most difficult area in the mouth to obtain cosmetically acceptable results.<sup>18-24</sup> This is especially true in patients exhibiting a high smile line. Distraction



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**Figure 1a.** Traumatic injury to central incisors with root fracture of tooth No. 9.



**Figure 1b.** Alveolar defect with missing tissue.



**Figure 1c.** Distraction device in place. Note the incision in keratinized tissue.



**Figure 1d.** Removable prosthesis in place. The crowns on the prosthesis were shortened (arrow) to provide room for the transported bone.



**Figure 1e.** Postoperative result.

osteogenesis is an option for restoring tissue in this area.

### Treatment Planning

Patient evaluation proceeds in a stepwise manner. An algorithmic approach is helpful during the treatment planning process and aids in determining the ideal method for restoring missing tissue.<sup>1</sup> The clinical exam focuses on evaluating the characteristics, including size and geometry of the defect. It is important to note any hard and/or soft tissue deficiencies on exam and by examining the dental models. This data is compiled and a treatment plan is devised based on the characteristics of the defect.

### Surgical Procedure

After careful preoperative planning, an osteotomy is created in an area requiring bone augmentation. The bone cut is created at the base of the alveolus where there is sufficient thickness of bone. A distraction device is then secured into place and the incision is closed. Alveolar devices are currently either endosseous or extraosseous. Both devices require removal prior to implant placement.

Typically, a period of no bone movement (seven-day latency period) is observed prior to activating the device. During the next phase, activation phase, the patient turns the distractor daily, which causes the bone

segments to separate, approximately 1 mm per day. After the bone is distracted the desired amount, the patient stops activating the device. During this time, it is important to maintain the correct vector. It is left in place to stabilize the distracted bone for a period of typically two to three months (consolidation phase). After the regenerate has ossified, the distractor device is removed and osseointegrated implants are placed.

### Case 1

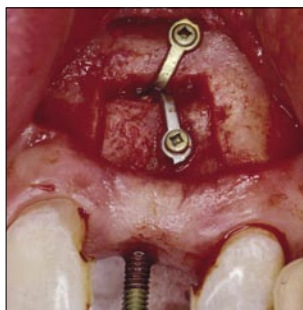
An 18-year-old patient sustained a fall with trauma to her maxillary central incisors (Figure 1). She developed progressive bone loss and presented for treatment. On examination, she was noted to have adequate soft tissue but insufficient bone tissue for implant support. She underwent distraction osteogenesis prior to implant placement. The active phase of distraction lasted 10 days. The distraction device was removed three months later.

### Case 2

A 28-year-old patient underwent repair of her alveolar cleft deformity with an iliac crest bone graft at age 8 (Figure 2). She underwent distraction



**Figure 2a.** Incision is placed in attached mucosa.



**Figure 2b.** Intraosseous distraction device in place. Note the activation rod exits at the anticipated site of the future dental implant.



**Figure 2c.** Removable prosthesis provides vector control during the activation phase.



**Figure 2d.** Postoperative result.

osteogenesis with an intraosseous distraction device prior to implant placement to provide additional bone for a more esthetic result. The initial incision was made in keratinized tissue in order to regenerate more keratinized tissue. The distraction device was activated for eight days. This was followed by 10 weeks of consolidation.

#### Case 3

A 51-year-old patient had had trauma from a motor vehicle collision and undergone multiple failed grafting attempts (Figure 3). She was missing both hard and soft tissue, and had extensive scarring from the previous surgeries. The area was reconstructed using distraction osteogenesis followed

by dental implant placement. The active phase of distraction lasted 12 days and was followed by three months of consolidation prior to distractor removal.

#### Case 4

A 73-year-old patient had undergone a maxillary sinus lift followed by implant placement (Figure 4). She presented for further reconstruction of her anterior maxilla. On clinical examination, she was noted to have two separate defects in this region. One area, both horizontal and vertical defect, was amenable to distraction osteogenesis whereas the other, knife-edged ridge, was more suited for an onlay bone graft. This case illustrated the importance of identifying

the characteristics of a defect including both the size and geometry of the area. The active phase of distraction lasted 12 days. The distraction device was removed three months later.

#### Discussion

Distraction osteogenesis can be applied to the dentoalveolar area to create new bone and mucosa. Esthetic and functional compromise can be prevented by ridge augmentation procedures and enhanced emergence profiles of the implants can be obtained. Because of the abundant blood supply, a large amount of bone can be generated in the facial region. This allows the clinician to overgrow bone and then remove the excess, e.g. knife-edge ridge, to develop an ideal bony bed into which implants can be placed.

There are many advantages of distraction osteogenesis over other methods for reconstructing missing tissue. It is less invasive, less time intensive and associated with less morbidity than harvesting bone grafts. It often eliminates the need for a bone graft and can expand the soft tissue matrix. Another significant advantage is that both hard and soft tissues are reconstructed with this technique. An important disadvantage is that the technique takes time and the patients must be monitored closely during the activation period. Careful patient selection is important for success of this procedure.

Distraction osteogenesis is ideally suited for reconstructing defects in the anterior esthetic zone and has advantages over bone grafting especially in this region.<sup>1,19,20</sup> To achieve tension-free closure over a bone graft, extensive undermining of the labial mucosa and the lip mucosa is often required. This results in loss of vestibular height and

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**Table 1****Analysis of studies regarding implants placed in distracted bone.**

Authors (Yr)	Procedure (# of Pts.)	Type of Alveolar Distraction Device	Latency	Rate & Rhythm	Distraction (Mean)	Consolidation
Chiapasco et al <sup>16</sup> (2001)	Maxilla (1) Mandible (7)	Extrabony	7 days	0.5 mm 2x per day	6-15 mm (8.75 mm)	2-3 mos.
Jensen et al <sup>17</sup> (2002)	28 pts, 30 sites Maxilla (28) Mandible (2)	Intrabony (screw device) (implant device)	7 days	1mm 3x per wk.	3-15 mm (6.5 mm)	2 mos.
Feichtinger et al <sup>11</sup> (2003)	(35)	Intrabony (dental implant distraction)	7-10 days	0.25-0.5 mm per day	4-6 mm	4-6 mos.
Rachmiel et al <sup>12</sup> (2001)	14 pts Maxilla (6) Mandible (8)	Intrabony	4 days	0.4 mm 2x per day	8-13 mm (10.3)	2 mos.
Uckan et al <sup>5</sup> (2002)	10 pts Ant. Mand (7) Ant. Max (2) Mandible (1)	Intrabony	7 days	0.4 mm 2x per day	5-15 mm (8.7 mm)	3 mos.
Garcia et al <sup>14</sup> (2002)	Post Mand (6) Ant. Mand (1)	Intrabony	7 days	0.5 mm 2x per day	Not reported	12 wks.
Raghoobar et al <sup>3</sup> (2002)	Ant. Mand (10)	Extrabony	5 days	0.5 mm 2x per day	6-8 (6.8)	2 mos.
Urbani <sup>15</sup> (2001)	(5)	Intrabony (implant distraction)	5-7 days	0.8 mm per day	4-7 mm (5.2)	73-165 days (87)
Zaffe et al <sup>4</sup> (2002)	Mandible (10)	Extrabony	5 days	0.5 mm 2x per day 0.25 mm 4x per day	10-15 mm (12)	8 wks.
Uckan <sup>6</sup> (2002)	Mandible (3)	Intrabony	7 days	0.4 mm 2x per day	11-13 mm (12)	12 wks.
Millesci-Schobel <sup>16</sup> (2002)	Mandible (4)	Extrabony	7 days	0.3 mm 3x per day	6-9 mm	10 wks.
Chiapasco et al <sup>13</sup> (2004)	(37)	Extrabony	7 days	0.5 mm 2x per day	4-15 mm (9.9)	2-3 mos.

<b># of Implants Placed (Mean)</b>	<b># of Implants Lost</b>	<b>F/U (Mean)</b>	<b>Implants Placed? (Time after Distraction)</b>	<b>Complications</b>
26 implants (3.25)	0/26	12 to 18 mos. (14 mos.)	Yes (2 to 3 wks.)	None reported.
84 implants (2.8)	8/84	3-4.4 yrs.	Yes (2 mos.)	8 implants failed to integrate; 19/30 required bone graft; 4/30 require soft tissue grafting; 7/30 had device failure; 14/30 segment relapse.
62 (1.8)	2/62	9 mos.	Yes (4-6 mos.)	2 distraction implants failed to osseointegrate; 2 pts with premature bony union; 1 pt had over-correction; 3 implants with > 3 mm probing depths.
23 (1.6)	1/23	0.25-0.5 mm per day	Yes (60 days)	Loss of 1 implant due to instability of distracted bone segment; One fracture of distractor; 1 pt with temporary hypoesthesia of mental nerve.
20 (2)	3/20	10-36 mos. (1-8 yrs.)	Yes	5 pts (50%) with displacement of the distraction segment; 3-lingual displaced; 1-palatal; 1-fracture of distracted segment; 1-intraoperative study.
14 (2)	0/14	Not reported	Yes	7/7 (100%) rate of complications; excessive length of distraction rod (1); Fx of transport segment (1); difficulties in completing lingual osteotomy (7); incorrect vector (2); perforation of the mucosa by transport segment (2); bone defect (4); less than ideal restoration (3/7).
20 (2)	1/20	6-20 mos. (11.2 yrs.)	Yes	2 pts with relapse caused from backward rotation; dehiscence (1); Implant lost (1).
11 (2.2)		Not reported	Yes (46 days)	Lingual displacement of the bone segment (1).
Not reported	Not discussed	Not reported	Not reported	Loss of depth of vestibule (3/5 edentulous pts); 1/10 incorrect vector.
8 (2.7)	1/8	19-36 mos. (27.5)	Not reported	One implant lost.
Not reported	Not reported			One fracture of distractor (1/4).
138	0/138	15-55 mos. (34 mos.)	2-3 mos.	Mandible fracture; lingual inclination; incomplete distraction; palatal inclination

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apical repositioning of the keratinized tissue in order to cover the graft during graft consolidation. A secondary procedure such as soft tissue grafting and/or vestibuloplasty may be required to achieve acceptable results. The technique of distraction osteogenesis avoids this extensive undermining and avoids altering the normal tissue architecture of the labial mucosa. It also generates new mucosa, thus avoiding the need for later soft tissue grafting.

Several studies have evaluated implant success in distracted bone (Table 1).<sup>3-6,10-17</sup> Collectively, in these studies, 406 implants were placed and 16 were lost for an overall implant loss rate of 4 percent. No long-term studies have evaluated the effect of implants in maintaining the distracted bone height. Implants are effective in decreasing the amount of resorption when placed in grafted bone.<sup>26</sup> This is true of both loaded and nonloaded dental implants. Distracted bone likely responds in the same way.

The timing of removal of a distraction device typically is between two to six months after the completion of distraction osteogenesis. Earlier removal of a device may result in inadequate ossification during the consolidation phase with significant relapse. Often, the implants are placed during the same surgical procedure. The authors consider removal of the distraction device at two to three months and placement of implants if sufficient basal bone, nondistracted, is present to provide for primary stability of the implants. If the majority of stabilization for the implant is provided by newly formed bone, then the authors will wait six months prior to implant placement.

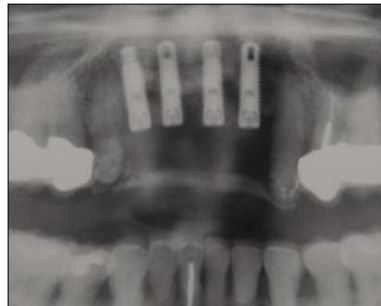
It is preferable to make the initial incision in keratinized tissue if possible (see Case 2). This is especially true in



**Figure 3a.** Anterior defect with extensive tissue loss and scarring. The prosthesis aids in counteracting the strong palatal pull during distraction osteogenesis.



**Figure 3b.** Implants are placed in the regenerated bone.



**Figure 3c.** Radiograph of dental implants.



**Figure 3d.** Postoperative result.

the anterior esthetic zone. This leads to regeneration of keratinized tissue rather than movable mucosa.

It is important to maintain the desired vector during the distraction process. This will ultimately lead to the desired location of the transported bone and therefore the ideal location for placement of the implant. There are many techniques for maintaining the correct vector.<sup>18</sup>

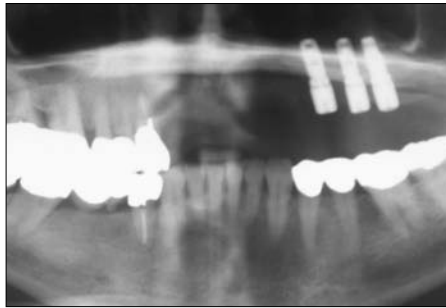
**Conclusion**

Alveolar distraction osteogenesis is a predictable method for restoring alveolar ridges prior to implant placement. Distraction osteogenesis is ideally suited for recreating missing tissue in the anterior esthetic zone. **CDA**

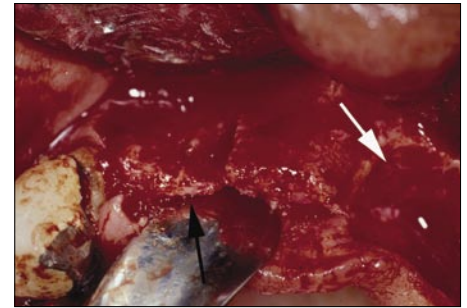
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**Figure 4a.** Maxillary defect. Note the adequate soft tissue.



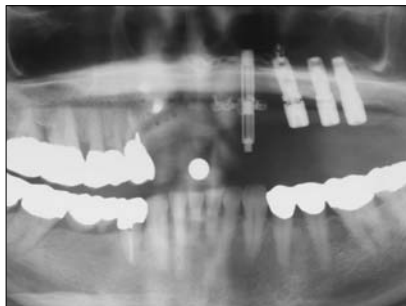
**Figure 4b.** Radiograph showing the inadequate bone for implant support.



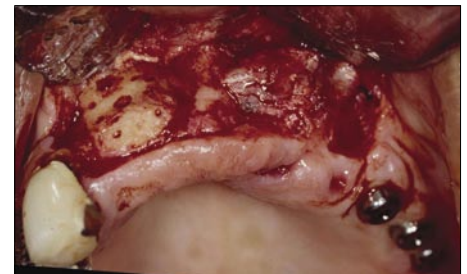
**Figure 4c.** Two separate types of defects adjacent to each other. Knife-edge (black arrow) defect and horizontal and vertical defect (white arrow).



**Figure 4d.** Block graft secured in place and distraction device placed.



**Figure 4e.** Radiograph showing the regenerated bone.



**Figure 4f.** Regenerated bone prior to implant placement.

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