Alveolar Width Distraction Osteogenesis for Early Implant Placement

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Distraction osteogenesis for correction of horizontal alveolar width deficiency was performed for 9 patients by using an alveolar crest widening device. Four prototypes were used during the course of the study until a final protocol was achieved. Under local anesthesia, a blind crestal osteotomy was carried out with minimal periosteal reflection. The horizontal distraction device was placed percutaneously. Distraction proceeded from the seventh postoperative day at a rate of 0.4 mm/day for 14 to 18 days. Seven to 10 days later, dental implants were placed. Distraction osteogenesis occurred in all 9 patients and increased alveolar width from 4 to 6 mm. Twenty implants successfully osteointegrated of 21 placed. Marginal bone resorption was not observed after 12 months' follow-up. The advantages of horizontal distraction over block grafting include simultaneous expansion of soft tissue, high degree of dimensional stability, abbreviated overall treatment time, and no graft requirement.

The indications for alveolar ridge augmentation are acquired or congenital alveolar defects. Acquired alveolar bone loss may be caused by post-extraction defects, traumatic avulsion, periodontal disease, and/or prolonged denture wear with subsequent disuse atrophy. In most of these cases the most significant loss is in the horizontal dimension. Traumatic tooth avulsion with loss of the buccal bone plate is a typical example of a situation leading to a horizontal defect.¹

Modalities to augment horizontal bone defects include autogenous onlay bone graft,²,³ guided bone regeneration,⁴,⁵ alloplastic augmentation,⁴,⁵ and alveolar split grafting.¹ Each of these modalities has its advantages and disadvantages. Use of an autogenous bone graft has donor site morbidity⁶ and graft resorption is expected.⁷ While guided bone regeneration has been extensively documented,⁴,⁵ it is often difficult to provide optimal space for the regeneration of the desired bone volume and is therefore better suited for limited defects. Alloplastic materials⁴,⁵ used in quantity are not reliable for implant osseointegration.

Alveolar widening by distraction osteogenesis (DO) is an alternative method for reconstructing alveolar atrophy,⁸⁻¹¹ that is similar to alveolar split grafting but without the graft. The combination of vertical DO and osseointegration has produced a stable esthetic reconstruction of the alveolar bone and attached mucosa,¹² but the use of distraction to gain alveolar width, first reported by Aparicio and Jensen,¹³ has not been fully established clinically.¹⁴

Block et al¹⁵,¹⁶ confirmed isotropic augmentation by DO for alveolar bone in animal studies. But, clinical studies¹⁷,¹⁸ have only established efficacy of alveolar distraction in the vertical dimension because there are few reports on the use of DO to gain width for dental implants.¹⁵,¹⁴,¹⁹,²² The purpose of this clinical study was to establish, in a consecutive series of horizontal alveolar distractions using the Laster Crest Widener (Surgetek Inc, Brussels, Belgium), that dental implant restoration could be consistently accomplished to an optimized alveolar width morphology.

Materials and Methods

During the development of alveolar width distraction, 4 prototype devices were used on 9 patients aged 18 to 52-years-old who presented with moderately deficient alveolar bone in the horizontal dimension.

The Laster Crest Widener consists of 4 sharp arms, 2 on each side connected with guide pins and an activating distraction screw. By rotating the activating...
screw, the pair of arms move apart, thus engaging each side of the osteotomy site to spread it apart.

**SURGICAL TECHNIQUE**

Under local anesthesia, a crestal mucoperiosteal incision is made followed by buccal vertical mucoperiosteal incisions placed anterior and posterior to the distraction zone (Fig 1). The crest itself is minimally exposed, otherwise there is no flap reflection. A round burr is used to make a small trough along the crest. Bone cuts are made through the trough, and through the anterior and posterior vertical incisions without stripping mucoperiostium using a sagittal micro saw, a reciprocating scalpel saw, or piezoelectric ultrasonic bone cutter (Fig 2). An osteotome is introduced crestally and the buccal plate is “green-stick” fractured bucally (Fig 3). The distractor is tapped into place and the wound is approximated with sutures. A provisional prosthesis is then placed (Figs 4, 5). Distraction begins 1 week later by turning the activating screw 2 and 1/2 turns per day (0.4 mm). This is done by the patient at home (Fig 6). After a 7- to 10-day retention period for early bone “consolidation,” the distraction device is removed and 1 week later implants are inserted percutaneously. In 1 case (no. 3) the periostium was stripped buccally to make a stop cut in the vestibule before out-fracturing the segment (Fig 7). Pressure or mastication on the distraction site by a temporary denture is avoided during distraction, consolidation, and osseointegration. The exposure of dental implants is performed 3 to 4 months after insertion, and prosthetic rehabilitation completed thereafter (Fig 8). Panoramic and periapical x-rays are taken following distraction, after implant placement, and at 1-year intervals.

**Results**

Nine patients underwent horizontal expansion of the alveolar process by DO followed by dental implant placement. The distraction was evident clinically and radiographically. Alveolae increased in width between 4 and 6 mm (Table 1). The attached mucosa at the top of the alveolar crest increased simultaneous to increased bone mass.

No infections resulted from treatment. Of 23 threaded implants placed, 22 implants osseointegrated. The post-distraction follow-up period was from 6 to 24 months. No significant marginal bone resorption was observed after implant placement, except in case no. 3, where reflection of a mucoperiostium was made to create a stop cut in the vestibule before out-fracturing the segment. Pressure or mastication on the distraction site by a temporary denture was avoided during distraction, consolidation, and osseointegration. The exposure of dental implants was performed 3 to 4 months after insertion, and prosthetic rehabilitation completed thereafter (Fig 8). Panoramic and periapical x-rays were taken following distraction, after implant placement, and at 1-year intervals.
teal flap was performed. This resulted in loss of bone and exposed screw threads in 2 implants that were prosthetically rehabilitated.

One implant failed to integrate because of inadequate primary stability but was successfully replaced 8 weeks later. All implants were loaded with dental prostheses.

**Discussion**

Reconstruction of the deficient alveolar process should address deficiency of both bone and attached mucosa. Experimental distraction studies have reported lamellar bone formation as well as histogenesis of soft tissue. This process has also been verified clinically.

Because DO provides a simultaneous and generalized histogenesis it eliminates the need for both bone and soft tissue grafting in implant cases. Horizontal distraction is especially useful in moderately narrow alveolar ridges which still have sufficient vertical height.

Nosaka et al performed an experimental study on narrowed alveolar ridges in 6 beagle dogs, widening the alveolus by distraction. Twelve days after completion of distraction, during consolidation, screw-type endosseous implants were placed into the distracted area. After 24 weeks the implants were found to be embedded in mature bone. Direct bone contact with the implant surface was observed without scar forma-
tion, admixture of dead bone, or evidence of vascular embarrassment as found in bone graft settings.

This study shows that horizontal alveolar ridge distraction is a reasonable adjunct for placement of implants in the moderately atrophic alveolus. Osseointegration is achieved despite implants being placed into regenerate during the early stage of consolidation. Providing there is primary implant stability, osseointegration occurs without significant disruption of the regenerative process. And, resorption of the superior aspect of the alveolar ridge was not observed when the flap procedure was minimal.

HORIZONTAL DISTRACTION OSTEOGENESIS PROTOCOL

Despite alteration of the distraction protocol during this clinical study, there was no significant difference in final outcome, with the exception of case no. 3. The following summarizes a proposed best technique for horizontal distraction:

1) Under local anesthesia, a crestal incision is made, followed by vertical incisions anteriorly and posteriorly. Flaps are not reflected, instead the crest is minimally exposed and by using a small round burr a trough is made mid-crestally.
2) A bone cut follows the trough to a depth of at least 10 mm using a reciprocating saw or piezoelectric knife. Bone cuts are made through the anterior and posterior vertical incisions using a sagittal micro saw (Figs 9, 10).
3) A thin osteotome is used to out-fracture the buccal plate and then the wound is closed (Fig 11).
4) One week later the Laster Crest Widener is tapped into place percutaneously (Fig 12).
5) A titanium safety wire is threaded through the hole in the arm (this is best performed before the insertion of the device) (Fig 13).
6) Two counter-clockwise rotations are made with the activation screw to engage the device in bone and confirm mobilization of the transport.

Table 1. DEFICIENT ALVEOLAR BONE, PRIMARY DATA OF PATIENTS

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Area of Widening</th>
<th>Length of Expansion (mm)</th>
<th>No. of Implants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z.I. (M)</td>
<td>45</td>
<td>34, 35, 36, 37 (Lt mandibular body)</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>G.Y. (M)</td>
<td>40</td>
<td>13, 14, 15, 16 (Rt maxilla)</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>M.O. (F)</td>
<td>33</td>
<td>46, 47 (Rt mandibular body)</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>G.S. (M)</td>
<td>50</td>
<td>32, 42 (Anterior mandible)</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>P.D. (F)</td>
<td>52</td>
<td>46, 47 (Rt mandibular body)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Z.Y. (F)</td>
<td>48</td>
<td>46, 47 (Rt mandibular body)</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>D.L. (M)</td>
<td>18</td>
<td>11, 12 (Anterior maxilla)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>E.E. (M)</td>
<td>38</td>
<td>11, 12, 21 (Anterior maxilla)</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>T.Y. (F)</td>
<td>25</td>
<td>46, 47 (Rt mandibular body)</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

7) Activation begins immediately at a recommended rate of 0.4 mm per day (½ a turn twice a day.) The patient should be examined by the surgeon every 4 days.

8) Once sufficient width is achieved (10 to 14 days), activation is stopped. (Overdistraction of 1 to 2 mm is recommended.) The Laster Crest Widener is left in for a brief 7- to 10-day consolidation. The device is then removed under local anesthesia without soft tissue closure (Fig 14). Dental implantation is performed immediately or 7 to 10 days after removal of the crest widener despite incomplete mineralization (Fig 15). Implant placement is performed transgingivally (Fig 16).

Advantages of Distraction Osteogenesis Over Bone Grafting

The advantage of DO is that there is little or no bone resorption as typically occurs in bone graft reconstruction. Although relapse of the distraction may occur, it is likely within the regenerate (away from the buccal bone plate that establishes alveolar form and provides osseous coverage of the implant).

Another advantage of distraction is the concomitant proliferation of attached gingiva, obviating the need for soft tissue augmentation. Therefore, DO avoids donor site morbidity associated with both hard and soft tissue harvest.

There may also be less relapse with alveolar distraction over other approaches. Rachmiel et al, in a 1-year
follow-up experimental study, found a 7% relapse after a 40-mm total maxillary advancement. The relapse for small dimension horizontal distraction is negligible because the regenerate is quick to mature into lamellar bone. The process of bone graft incorporation and creeping substitution is completely avoided.

Another advantage to distraction is timing for implant placement. Early regenerate mineralization proceeds by thickening of bony trabeculae. Implants placed during this relatively short time frame (4 to 8 weeks postoperative) heal in about half the time required for a staged block graft.

Therefore, DO for width enhancement is relatively simple to perform, quicker to heal than bone grafts, minimally traumatic, and dimensionally stable.

One disadvantage, however, is the second procedure required for device removal, although it is easily performed without the need for an incision.

In general, the result of the distraction process for width enhancement resulted in an esthetic and functional prosthetic reconstruction, with a more favorable axial implant placement and improved orthoalveolar inter-arch relation.

Summary

A pilot study was performed using horizontal alveolar distraction to treat edentulous sites with moderate horizontal atrophy. Sufficient generation of new bone allowed stable dental implant restorations. Soft tissue proliferation added to the hard tissue augmentation.

Alveolar distraction may be useful for augmenting the atrophic alveolus in select cases providing the advantage of less overall treatment time than standard staged bone grafting techniques as well as avoiding second site surgery.

Further study of the technique with long-term follow-up to confirm bone and implant stability as it relates to alveolar width is needed.

References