

# Hard and Soft Tissue Regeneration for Implants in the Esthetic Zone



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**I**mplants work. They integrate. Because of this, implants are now part and parcel of the routine clinical practice of dentistry. The overall success rate for dental implants varies between 88% and more than 98%.<sup>1</sup> This rate of success rivals almost every other aspect of dental treatment in predictability.

Patients are happy that they can get a “third” set of teeth.

However, many still want more. Today’s patients want their teeth not only to eat with, but also to augment and improve their appearances. The demand on dentists is to provide ideal function and ideal esthetics all at once. This frequently presents a unique challenge. Implants have a success rate that is upwards of 90%. However, implant procedures require adequate alveolar

**TABLE 1—SEQUENCES OF IMPLANT PLACEMENT**

- Teeth are extracted, bone is allowed to heal, and adequate bone exists for implant placement.
- Teeth are extracted and implants are placed simultaneously (the immediate implant) with or without bone grafting, membrane placement, and soft tissue grafting.
- Teeth are extracted and allowed to heal. Inadequate bone is present for implant placement. The site is developed independently of implant placement (site development). Bone is allowed to heal and implants are then placed conventionally.
- Teeth are extracted and allowed to heal for 2 or more months. Inadequate bone is present for ideal implant placement. Implants are then placed in conjunction with bone regeneration.

bone. Dentistry has fortunately evolved to the state where ideal rehabilitation of the smile is predictably attainable in many cases.

While two decades ago, predictable implant placement was

not thought possible, today dentists can make teeth look and feel natural with the newer generation of porcelain restorations. Surgeons can achieve predictable osseous integration and, when



**Figure 1**—Tooth No. 8 had endodontic therapy and two failed apicoectomies. Note the grayish discoloration cervical to the crown, as well as the recession.



**Figure 2**—Note the amount of alveolar bone loss present on the labial of tooth No. 8 once the flap is reflected. The vertical incisions were made at the line angle of tooth No. 8 to avoid any lost papilla.



**Figure 3**—Tooth No. 8 was extracted and 7 mm to 8 mm of the labial plate of alveolar bone had been lost. At this point, it was decided that the placement of a dental implant would be too unpredictable.



**Figure 4**—A combination of autogenous and freeze-dried bone was packed into the extraction socket. A Resolut membrane was placed over the bone graft. The membrane was stabilized with two BioTacks®.



**Figure 5**—A connective tissue graft harvested from the palate was placed superior to the graft. The connective tissue graft would obliterate the hole from the extraction site as well as plump up the ridge.



**Figure 6**—Six months after the extraction bone graft and connective tissue graft, the alveolar bone had regenerated and was ready for implant placement.



**Figure 7**—Osteotomes were used during the surgical placement of the dental implant. Note that the osteotomes come in different diameters, depending on the amount of alveolar bone present and the size of the implant that is to be placed.



**Figure 8**—An osteotome is shown preparing the implant site. The osteotome not only expands the bone, thereby increasing the buccal-palatal width, but also improves the quality of the bone by increasing its density.

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## Case Study continued

adequate bone and soft tissue are not present, these frequently can be regenerated.

This article explores the sequence and techniques of implant placement in patients with inadequate amounts of bone and compromises in their soft tissues. There are numerous variances in the sequence in

which implants can be placed, based on the author's recommendations, and are summarized in Table 1.

The scope of all of the multiplicity of bone regeneration and implant placement is too great for one article. Therefore, this discussion remains limited to stage IV implant placement.

Nuances of soft tissue and cosmetic plastic surgery are also discussed. The discussion is limited to the simultaneous placement of implants in conjunction with bone regeneration.

### IDEAL IMPLANT PLACEMENT

The placement of dental implants requires one to think



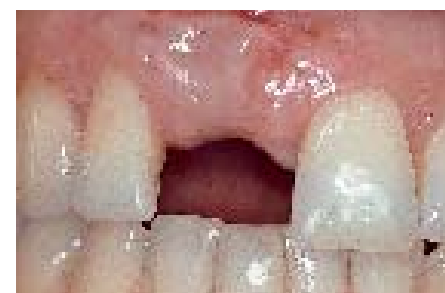
**Figure 9**—Three months after the placement of the dental implant, the discolored, keratinized epithelium was removed in anticipation of placement of a free gingival graft.



**Figure 10**—A free gingival graft was harvested from the palate. The discolored grayish epithelium was used as a template to determine the proper size of the graft.



**Figure 11**—The newly harvested free gingival graft was sutured into place with 5-0 gut sutures.



**Figure 12**—After a few months of healing, an esthetic color blend was achieved and no grayness existed. Note that, despite the fact that no tooth was present in the area of No. 8, papillae appeared to already be regenerating. This was a result of the fact that bone was regenerated beneath the soft tissue.

three-dimensionally: mesial-distally, facial-palatally, and incisal-apically. Since the focus of this article is esthetics, we will focus on the maxillary anterior teeth.

**Mesial-distal inclination**—The average implant diameter is 4 mm. Ideally, dentists like 3 mm

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**Figure 13**—Second-stage surgery was performed. The initial incision was made palatally from line angle to line angle of the adjacent teeth. This allowed placement of the palatal tissue labially, thereby increasing the amount of soft tissue over the implant. A protective screw was placed in the implant so the bone could be profiled and a proper emergence profile obtained.



**Figure 14**—The temporary healing abutment was screwed into place and the area sutured in second-stage surgery. Please note the buccal root prominence over the labial surface of tooth No. 8.



**Figure 15**—The final prosthesis was now in place. Note the nice symmetry between teeth Nos. 8 and 9. (Restoration courtesy of Dr. Mark Samuels.)



**Figure 16**—A closer view of the completed implant restoration for tooth No. 8. Note the lack of gingival discoloration and the complete regeneration of the papilla between teeth Nos. 7 and 8 and 8 and 9.

of space between an implant and the adjacent teeth. This helps prevent damage to the periodontal ligament and allows enough room for papilla regeneration.<sup>2</sup> Adding together the implant size (4 mm) and an additional 3 mm on either side, this gives a mini-

mum of 10 mm of space in a mesial-distal direction for placement of a single implant. One rarely encounters this much space. It is possible to achieve ideal esthetics—without harming the adjacent teeth—with 8 mm of space and a 4-mm implant. In the author's opinion, when a patient undergoes orthodontics, the orthodontist should

be urged to create at least 8 mm of space from adjacent root cementoenamel junctions (CEJs) to root apices when completing the case.

**Facial-palatal direction**—This direction is a little more controversial. With a screw-retained restoration, dentists would probably want the access hole in the

cingulum area, so as not to show any metal. However, most restorations today use custom abutments with cement-retained restorations. It is therefore advisable to angle the long access of the center of the implant slightly palatal to the incisal labial line angle of the maxillary anterior teeth. This allows a nice emergence

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## Case Study continued

profile and minimizes soft tissue resection.

**Incisal-apical direction**—The author prefers to use a 4-mm-diameter implant in the esthetic zone, as this allows for sufficient running room to establish adequate restorations and also minimizes the amount of

postcementation recession. For ideal esthetics, the implant should be placed approximately 3 mm to 4 mm apical to the anticipated CEJ. In this way, the implant can have adequate running room from its seating platform to the restoration. It has also been shown that 4-mm implants exhibit less recession

than 5-mm implants at 6-month postoperative examinations.<sup>3</sup>

### LESS-THAN-ADEQUATE BONE VOLUME

Frequently, enough bone exists to place a dental implant. However, the amount of bone may not be ideal to create an esthetic restoration. This creates



**Figure 17**—In Case 2, tooth No. 9 exhibited external and internal resorption. An acute abscess was seen interproximally between teeth Nos. 9 and 10. The abscess became acute within the previous 3 weeks.



**Figure 18**—A radiograph of tooth No. 9 revealed external and internal resorption despite previous endodontic therapy. Horizontal bone loss had already occurred interproximally between teeth Nos. 9 and 10.



**Figure 19**—Tooth No. 9 was extracted atraumatically in two pieces. Note the soft tissue that replaced the root structure.



**Figure 20**—Approximately 2 months after the extraction of tooth No. 9, the extraction site had healed. Note the loss of vertical dimension, the labial concavity resulting from loss of alveolar plate, and recession that occurred on tooth No. 10 as a result of the loss of bone mesially.

a surgical dilemma. Three questions are then often posed, as follows:

1. Should bone first be regenerated and the implant placed after bone regeneration? This is the most conservative approach.
2. Should the implant be placed in conjunction with bone regeneration? This is perhaps the most technique-sensitive approach.

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3. Should the implant position be altered to fit the bony architecture? When asked by their restorative colleagues why the implant is not in an ideal position, surgeons frequently lament, "Well, that is where the bone was."

The following two cases demonstrate implant placement in less than adequate bone. Bone regeneration is performed before implant placement in Case 1. Case 2 shows simultaneous implant placement with bone regeneration.

### CASE 1

The patient was referred for periodontal therapy of tooth No. 8 in preparation for a new crown (Figure 1). Dental evaluation of this healthy 40-year-old woman revealed that tooth No. 8 had received endodontic therapy and two apicoectomies. The crown-to-root ratio was less than 1:1 and the tooth was deemed hopeless. In addition, the keratinized attached gingival tissue was discolored from the previously performed apical surgery.

The goal of therapy was to remove the tooth, rebuild the alveolar ridge, reobtain normal cosmetic keratinized tissue, and have well-integrated implant-supported crown. The sequence of therapy was as follows:

### Atraumatic Tooth Extraction

A full-thickness mucoperiosteal labial flap was elevated and the tooth was extracted atraumatically, preserving what remained of the alveolar bone (Figure 2). Two vertical incisions were made at the line angle of tooth No. 8, so the adjacent papilla would be preserved.

### Hard and Soft Tissue Regeneration

The remaining alveolar bone was deemed inadequate for the predictable placement of a dental implant (Figure 3). Seven millimeters of the labial plate were not present. It was decided that a bone graft would be placed. Autogenous bone was harvested from the area of the anterior nasal spine and mixed with 50%

demineralized freeze-dried bone graft and placed into the alveolar defect. In addition, a Gore-Tex® Resolut membrane (distributed by Nobel Biocare) was trimmed and placed superior to the graft and stabilized with two Bio Tacks® (3i Implant Innovations Inc.) (Figure 4). A connective tissue graft was harvested from the palate and placed superior to the

Resolut membrane (Figure 5). It was secured with 5-0 gut sutures (ETHICON, INC.). The purpose of the graft was twofold. First, it created a sterile environment in which the graft could heal unmo- lested by oral bacterial infection. Second, the soft tissue added to the volume of the potential implant recipient site. It is the author's experience that over-

building the soft tissue in the esthetic zone by 25% is advisable to achieve ideal esthetics.<sup>4</sup>

### Implant Placement

Six months were allowed to pass before the implant was placed. The implant site was anesthetized and reentered (Figure 6). While bone regeneration is obvious, it was deemed

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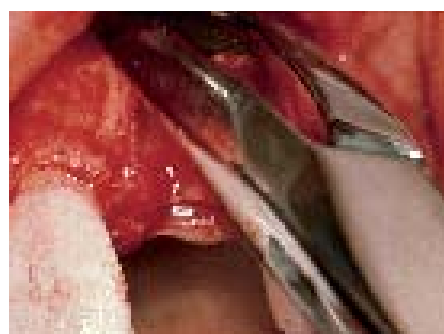
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**Figure 21**—A full-thickness flap was reflected from the distal line angles of the adjacent teeth. Using a trephine, autogenous bone was harvested from the anterior nasal spine.



**Figure 22**—A bone trap was attached to the high-volume suction. These are used when the osteotomy sites are prepared, to collect cancellous bone. Using a molt curette, autogenous bone chips were removed from the bone trap and placed into sterile saline.



**Figure 23**—A ronguer was also used to gather additional autogenous bone to be used to graft around the dental implant.



**Figure 24**—After preparation of the osteotomy site, an Osseotite® implant was placed in an ideal position in the area of tooth No. 9. Note that seven threads of the implant were exposed on the labial. Also note the amount of bone loss on tooth No. 10 that occurred because of the infection that was previously present.

still inadequate for ideal implant placement. The Resolut membrane dissolves in approximately 8 weeks. This would probably not be sufficient time to achieve adequate bone regeneration. To preserve the remaining alveolar bone, **Summers Osteotome Kit** (3i Implant Innovations, Inc.) was used to prepare the implant

formed. The amalgam-discolored epithelium was removed surgically and a bleeding connective tissue bed remained (Figure 9). A free gingival graft was harvested from the palate, and removed tissue was used as a guide to size the free gingival graft (Figure 10). The free graft was then sutured into place with 5-0 gut

excess bone that grew over the implant, an **EP Temporary Healing Abutment®** (3i Implant Innovations, Inc.) was placed (Figure 14). Note the soft tissue protuberance over the labial of the edentulous site at No. 8, which mimics the natural root prominence (Figure 14). The entire complex of palatal soft tissue was moved labially during this procedure.

#### The Final Restoration

Four weeks of soft tissue maturation was allowed before the implant was temporized. In some cases it may take another 2 to 3 months before satisfactory soft tissue esthetics is achieved around the implant. The final result mimicked the natural dentition (Figures 15 and 16). Ideal parameters of esthetics were achieved, including complete papilla regeneration; ideal color match of the attached gingiva; adequate bone volume; ideal implant position; proper emergence profile; and ideal color match.<sup>6</sup>

#### CASE 2

Case 2 presented a slightly different challenge. This 32-year-old woman presented with internal and external root resorption of tooth No. 9 (Figures 17 and 18). In addition, she had already experienced vertical bone loss of the interradicular bone between Nos. 9 and 10 (Figure 18). The problem was similar to that of Case 1. However, the author had the added complication of redeveloping a soon-to-be-lost papilla.

#### Extraction of the Infected Tooth

Tooth No. 9 was abscessed and would have to be extracted as soon as possible. A flap was made and the tooth extracted atraumatically (Figure 19).

#### Harvesting of Autogenous Bone

Two months passed to allow for soft tissue healing and resolution of the infection (Figure 20). It was decided that the implant would be placed with autogenous bone grafting in conjunction with Gore-Tex® tissue augmentation. A full-thickness mucoperiosteal labial flap was elevated from the distal line angles of the adjacent teeth

**A multiplicity of implant techniques are available to the clinician today to get an acceptable result.**

site (Figures 7 and 8). Osteotomes provide three important benefits. They preserve bone, for no bone is drilled away; the bone is expanded to allow the placement of a large implant as a result of the osteotome's tapered design; and the osteotome can improve the quality of bone by increasing its density. Bone density is probably the most important factor in assuring an implant's success. After the preparation of the osteotomy site, the implant was placed and allowed to heal subgingivally.

#### Cosmetic Soft Tissue Correction

One of the patient's chief concerns was the apical discoloration of the soft tissue secondary to the apicoectomy. It was decided to correct the discoloration before second-stage implant surgery. Three months of healing were allowed before the free gingival graft was per-

formed. The amalgam-discolored epithelium was removed surgically and a bleeding connective tissue bed remained (Figure 9). A free gingival graft was harvested from the palate, and removed tissue was used as a guide to size the free gingival graft (Figure 10). The free graft was then sutured into place with 5-0 gut

#### Second-Stage Surgery

At the 3-month postgingival grafting and 7-month postimplant placement appointments, excellent tissue maturation was seen (Figure 12). Note the presence of papilla adjacent the edentulous space at tooth No. 8, despite the absence of a tooth. This will occur when adequate bone is present beneath the soft tissue. Soft tissue usually follows the underlying bone.<sup>5</sup>

Second-stage surgery allows another opportunity to enhance the cosmetic result. The initial incision is made from the palatal line angles of the adjacent teeth (Figure 13). A full-thickness flap is then reflected labially. This augments the already present soft tissue to an even greater extent.

After trephination of the

**B one density is probably the most important factor in assuring an implant's success.**

(Figure 21). Using a **Treph-4 trephine drill** (Salvin Dental Specialties, Inc.), autogenous bone was harvested from the anterior nasal spine and placed into sterile saline. An osteotomy site was then prepared for the implant for tooth No. 9. A bone trap (**Osseous Coagulum Trap, Quality Aspirators**) was attached to the end of the high-volume evacuator to aid in the collection of additional autogenous bone (Figure 22). Cortical

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## Case Study continued

and cancellous bone was easily collected from the resterilizable bone traps (Figure 22). A large molt curette (Molt #4, Ace Surgical Supply Co., Inc.) was used to collect the bone. In addition, a ronguer (Beyer Ronguer, Salvin Dental Specialties, Inc.) was used to harvest additional bone from adjacent alveolar bone (Figure 23).

### Implant Placement With Simultaneous Bone Regeneration

The implant (Osseotite®, 3i Implant Innovations, Inc.) was inserted (Figure 24). Note that the coronal six threads of the implant were exposed and bone would have to be regenerated. An e-PTFE membrane (Gore-Tex® oval 6, distributed by Nobel Biocare) was placed apical to the

defect. Two titanium tacks (IMZ Titanium Tacks, Nobel Biocare) were used to stabilize the Gore-Tex® membrane (Figure 25). The membrane was reflected and autogenous bone was placed between the implant and membrane (Figure 25). The membrane was trimmed so that at least 1.5 mm of space existed between the membrane



Figure 25—A Gore-Tex® membrane was stabilized with two titanium tacks. The tacks were placed apically into alveolar bone beneath the nasal sinus. After placement of the membrane, autogenous bone chips were placed over the dental implants.



Figure 26—The membrane was then trimmed so it covered the implants but did not impinge on the adjacent teeth. The membrane was cut back 1.5 mm from the adjacent teeth to minimize postoperative infection. Note a Gore-Tex® suture on the palatal aspect, used to secure the membrane palatally.



Figure 27—Six months later, a flap was reflected and the Gore-Tex® membrane removed. Complete bone regeneration had been achieved and the implant was completely covered with bone.



Figure 28—A temporary crown was placed on the implant in the area of tooth No. 9. Please note the lack of papilla between teeth Nos. 9 and 10.

and the adjacent teeth (Figure 26). This would minimize the potential for postoperative infection by diminishing the egress of bacteria (personal communication with Dr. Allan Meltzer,

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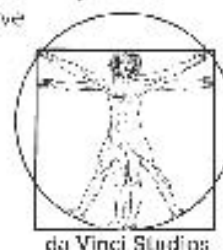
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## Case Study continued

Stanford, Connecticut, 1999). Note the close adaptation of the membrane to the bone graft and adjacent bone. A tacking **Gore-Tex® CV-5 suture** was placed palatally to stabilize the graft (Figure 26). Six months were allowed to pass before the implant was exposed at second-stage surgery. Note the complete bony regeneration around the

implant (Figure 27). All seven threads were then covered with newly regenerated bone.

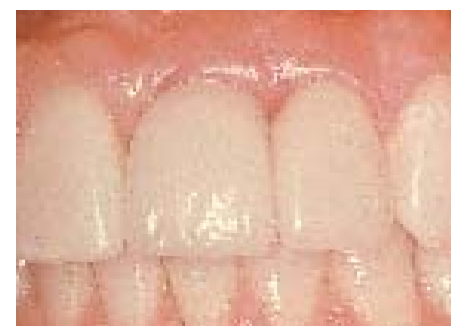
### Temporization and Papilla Regeneration

At the time of implant exposure, a temporary healing abutment was placed. The author recommends that the restorative dentist wait 4 weeks before placing a

permanent abutment and temporary crown. The initial temporary crown is shown in Figure 28. Note the recession on tooth No. 10, a result of the previous loss of alveolar bone caused by the external root resorption and infection. Over the next 2 months, acrylic was slowly added to the distal contact point on tooth No. 9 and bonding agent was slowly added



**Figure 29**—Over the next 2 months, the contact point was slowly moved in an apical direction. This was achieved by adding acrylic to tooth No. 9 and adding a slight amount of bonding material to the cervical third of tooth No. 10. Note how the papilla has reformed between teeth Nos. 8 and 9 and 9 and 10. The patient was now ready for final impressions. The provisional restoration would be a dress rehearsal for the final restoration.



**Figure 30**—The final crown was placed on tooth No. 9. Note that the soft tissue profile in this photograph mimics the soft tissue profile in Figure 29. The final restoration is a recapitulation of the provisional. Compare to the initial presentation in Figure 17.



**Figure 31**—Final view of the completed case. Overall esthetic harmony has been achieved with regeneration of papilla and underlying bone. (Restoration courtesy of Dr. Keith Rudolph.)



**Figure 32**—Photograph of the final restoration when the patient is smiling. Ideal esthetics has been achieved. (Restoration courtesy of Dr. Keith Rudolph.)

to the mesial of tooth No. 10 (Figure 29). Note the complete regeneration of the papilla. Figure 28 is a frontal shot of the temporary, 2 weeks after it was

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The provisional should be a recapitulation of the final result.

placed. Compare this to the temporization 2½ months later, as shown in Figure 29. The provisional should be a recapitulation of the final result. It is the author's opinion that an ideal result should first be obtained in the provisional, before impressions are made for the final restoration.

### Final Restoration

The final restoration can be seen in Figures 30 through 32. Compare the initial presentation of the infected tooth in Figure 17 to the final restoration seen in Figures 31 and 32. Harmony, symmetry, and good esthetics are evident. It is evident that the papillae have regenerated; there

is bone beneath them.

### CONCLUSION

These two cases show only one approach that can be taken to achieve an ideal esthetic result. A multiplicity of implant techniques are available to the clinician today to get an acceptable result. This is what makes the practice of implant esthetic regenerative dentistry so exciting. ○

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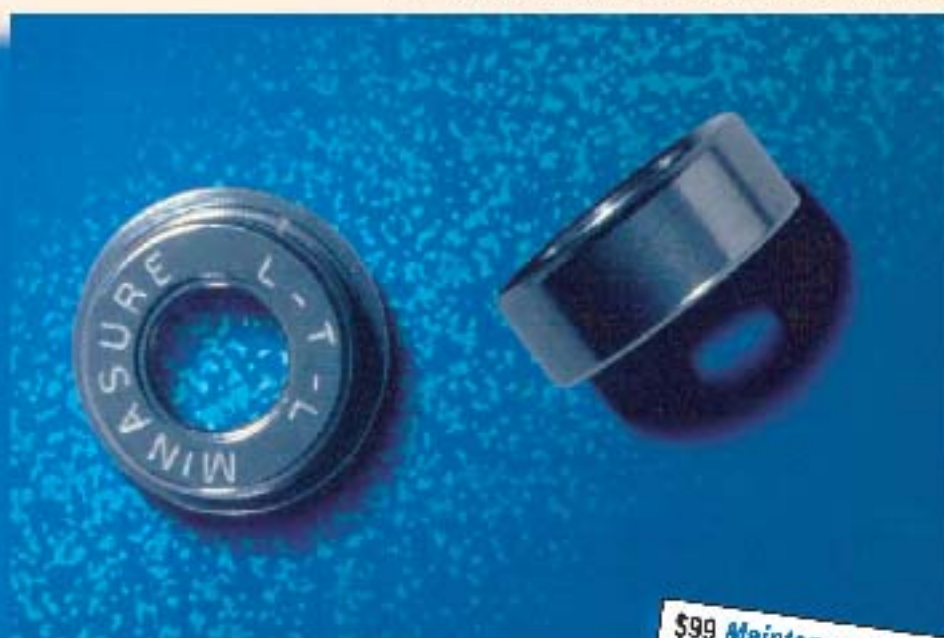
### Product References

- Product:** Gore-Tex® Resolut Membrane, Gore-Tex® oval 6, Gore-Tex® CV-5 suture  
**Manufacturer:** W. L. Gore & Associates, Inc.  
**Distributor:** Nobel Biocare  
**Address:** 22895 Eastpark Drive, Yorba Linda, CA 92887  
**Phone:** 800.891.9191  
**Fax:** 800.451.9047
- Product:** 5-0 gut suture  
**Manufacturer:** ETHICON, INC.  
**Address:** US Route 22 West, Somerville, NJ 08876  
**Phone:** 800.255.2500  
**Fax:** 732.562.2212
- Product:** BioTacks®, Summers Osteotome Kit, EP Temporary Healing Abutment®, Osseotite® threaded implant,  
**Manufacturer:** 3i Implant Innovations, Inc.  
**Address:** 4555 Riverside Drive, Palm Beach Gardens, FL 33410  
**Phone:** 800.342.5454  
**Fax:** 561.776.1272
- Product:** Treph-4 trephine drill, Beyer Rongeur  
**Manufacturer:** Salvin Dental Specialties, Inc.  
**Address:** 3450 Latrobe Drive, Charlotte, C 28211  
**Phone:** 800.535.6566  
**Fax:** 704.442.5424
- Product:** Osseous Coagulum Trap  
**Manufacturer:** Quality Aspirators  
**Address:** 1419 Godwin Lane, Duncanville, TX 75116  
**Phone:** 800.858.2121  
**Fax:** 972.298.6592
- Product:** Molt Curette #4  
**Manufacturer:** Ace Surgical Supply Co., Inc.  
**Address:** 1034 Pearl Street, Brockton, MA 02301  
**Phone:** 800.441.3100  
**Fax:** 800.583.3150
- Product:** IMZ Membrane Tacks  
**Manufacturer:** Nobel Biocare  
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