Timing of Guided Bone Regeneration: A Case Report

Careful diagnosis and timing boost the chances for success of restoration with GBR prior to or in combination with implant placement.

By Michael Sonick, DMD | Debby Hwang, DMD

The introduction and refinement of guided bone regeneration (GBR) allowed clinicians to generate more stable, cosmetically appealing implant-supported prostheses. Although ridge morphology is no longer the sole determinant of implant feasibility due to advancements in bone grafting, it retains a tremendously profound influence on treatment sequencing and end-stage survival. Still accurate is the notion that the more intact the patient’s residual ridge is, the better his or her regenerative and restorative prognosis. Conscientious planning and clinical fortitude, however, may transcend initially inauspicious bone morphology to some extent. When carefully considered and timed, GBR is highly successful, producing new functional bone that anchors implants as well as solid native osseous tissue does. This article reviews the defect types amenable to GBR and illustrates the decision-making process and surgical techniques used to reach a satisfactory implant restoration.

The Therapeutic Phase

The formative stage of dental treatment, related to implants or otherwise, is unquestionably the most crucial therapeutic phase. Planning a case is not always straightforward or logistical, and the best approach may not be the immediately intuited or most expedient one. In spite of ideally executed surgery, a sloppy, rushed, or poorly communicated treatment design exponentially multiplies the risk of failure and patient dissatisfaction. Consider this idea in the context of implant rehabilitation in the esthetic zone, which involves substantial time, physical, emotional, and monetary investments for both the patient and doctor. In order to reach a pleasing, enduring result, the orchestration of cosmetic implant dentistry must be fastidious.

Each step in the process focuses on creating and maintaining enough hard tissue and mucosa for an ideal prosthesis. Because the tooth-to-alveolar bone volume ratio is relatively large in the anterior maxilla, there may be inadequate residual ridge left after dental extraction to support an implant fixture, let alone any surrounding soft tissue. Remodeling creates an average loss of 3 mm to 6 mm horizontally and 1 mm to 2 mm vertically after 4 months, which corresponds roughly to the conventional implantation time.1,2 Notably, the buccal plate is two to three times thinner than its lingual counterpart and, thus, undergoes nearly twice as much lateral reduction as a vertical defect 2 mm greater than the palatal side.1,3,4 The cardinal tenet of tooth removal, then, is to minimize bone loss. Curtailing post-extraction resorption involves an atraumatic surgical technique along with socket preservation, or placement of bone graft material into the void. Socket preservation cuts horizontal deterioration by at least half, reducing the ridge by 1 mm to 1.5 mm instead of the 3 mm to 6 mm seen naturally, and it may prevent vertical resorption entirely.1,5,6

Mere socket preservation, however, may not be enough. True implant site development, particularly in the current state of the field, involves the growth of ridge dimensions beyond those that existed originally. The presence of an implant does not necessarily abate bone loss; indeed, biologic width reformation, occlusal forces, oral hygiene, and medical conditions contribute to osseous remodeling around the titanium fixture. The savvy clinical team foresees the postsurgical regenerative course and compensates by attempting to build extra ridge wherever and whenever possible. For certain defect types, guided bone regeneration (GBR) using a membrane alone or in conjunction with a bone graft accomplishes this reasonably well, achieving success rates above 90% in studies up to 5 years, and augments by 3 mm to 5 mm supracrestally.7,8 Although it relieves supracrestal deficiencies, GBR best resolves space-making defects, which occur within an envelope of bone.9,10 The intact surrounding walls provide viable cells, blood supply, containment for graft particles, and a buttress to support the regenerative barrier and prevent collapse. Predictability of augmentation is directly proportional to the amount of bone that is enclosing the space. Of course, the gross size of the defect itself is also a critical factor. It is evident that the smaller the gap is that needs to be bridged by new tissue, the easier it is to fill. A defect spanning a single tooth or with mild horizontal bone loss has a very good prognosis, while one spanning two teeth or with moderate horizontal or mild vertical deficiency garners a good prognosis. The prognosis of a three-tooth encompassing, moderately resorbed edentulous ridge drops to average; restoration of a four-tooth or severely vertically compromised defect is unlikely. Thus, indications for GBR consequently include mild horizontal and mild vertical defects (less than 3 mm) and small dehiscence/fenestration defects, the latter of which achieve consistent coverage over 90%.11

A more specific treatment protocol is demonstrated here. In the case of a fenestration or dehiscence defect that would allow an implant to lie within the bony envelope, simultaneous implant placement and GBR should commence. Similarly, the same treatment is advised for a horizontal defect that would expose less than 50% of the implant diameter and leaves the implant within the bony envelope. If, however, a portion of the implant would penetrate beyond the envelope of bone via a dehiscence/fenestration defect, the restorative position must be evaluated. A favorable position suggests concomitant fixture placement and regeneration. On the other hand, a less-than-ideal position or horizontal defect that exposes more than 50% of the fixture diameter or leaves a portion uncovered beyond the osseous walls disqualifies implantation, instead designating GBR and an adequate healing period prior to placement. Vertical defects, notoriously difficult to resolve consistently, may benefit from a tenting device placed at the time of GBR—such a mechanism may be a screw, pin, or, in cases when less than 3 mm of height is needed, even the implant itself.
Knowing these limitations when preparing an esthetic implant reha-
binating helps to stage the case properly. After maturation, post-atrau-
matic tooth extraction, and socket preservation (customarily a course of
3 months), the dentist must methodi-
cally evaluate the residual ridge via pal-
pation, bone sounding, conventional radiographic study, and possibly CT
scan analysis. An obvious defect pre-
cludes implantation and instead calls for regenerative therapy first, followed
by later placement (ie, pre-implant
GBR). A more subtle, practically un-
noticeable defect justifies concomitant
fixture placement and GB (ie, peri-
implant GBR) if the following three
prerequisites are met:

- Primary implant stability may be
  attained.
- Ideal positioning for restoration is
  possible.
- Deficiency is space-making and
  self-limiting.

As outlined above, defects treatable
by simultaneous implantation and
GBR include dehiscence/fenestra-
tions confirmed within the envelope
of bone as well as circumferential de-
fects from incomplete healing after
extraction or diameter discrepancies
between the osteotomy site/socket
and fixture. Minor dehiscence/fenes-
tration notwithstanding, any vertical
defect favors a staged grafting plan as
do other deficits that are not space-
making. Certainly, it is important to
note that if the surgeon harbors any
doubt regarding the feasibility of
peri-implant GBR or if there are high
esthetic demands, he or she may opt
for GB and delay implant placement
until after site maturation. Executed
judiciously, GBR creates a ridge that
can achieve an implant survival rate
equivalent to that of native bone.

The following case illustrates deci-
sion-making with respect to the tim-
ing of GB and implant insertion. It
involves a maxillary anterior canine,
tooth No. 6, and therefore requires an
elevated level of esthetics and function.

Case: Pre-Implant Guided
Bone Regeneration
Patient History
A medically and periodontally stable
48-year-old, non-smoking woman pre-
sented with a previously traumatized
tooth No. 6, failing due to internal re-
sorption (Figure 1 and Figure 2).

Treatment Sequence
- Extraction and socket preservation
  of tooth No. 6
- 3-month healing period
- GBR at No. 6 site
- 6-month healing period
- Implant placement in No. 6 site
- 3-month healing period
- Guided soft-tissue growth
- 1-month healing period
- Final implant No.6 crown restoration

Extraction and
vSocket Preservation
After oral sedation with 0.25 mg tri-
zolam 1 hour prior to surgery and lo-
cal anesthetic induction using 2% li-
docaine with 1:100,000 epinephrine and
0.5% bupivacaine with 1:200,000 epi-
inephrine, a sulcular incision was placed
circumferentially around tooth No. 6.
Using a piezoelectric unit, No. 6 was
atraumatically extracted. Degranulation
of the socket with a carbide finishing bur
and irrigation with 0.125 mg chlorhexi-
dine occurred, followed by decortication
of the socket with a round bur to induce
bleeding points. Freeze-dried bone al-
lograft (FDBA) was placed into the
alveolus and covered by an absorbable
soft-tissue graft (in this case, CollaPlug®,
com). The site was closed secondarily
with 5-0 chronic gut suture (Figure 3).

Ridge Assessment
Post-Extraction
Noticeable vertical and mild horizon-
tal resorption was detected 3 months after
extraction (Figure 4). Due to the supra-
crestal nature of the ridge defect, it was
decided to proceed first with GBR and
delay implant placement.

Pre-Implant GBR
After oral sedation with 0.25 mg tri-
zolam 1 hour prior to surgery and local
anesthetic induction using 2% lidocaine
with 1:100,000 epinephrine and 0.5% bu-
 pivacaine with 1:200,000 epinephrine,
a palatally oriented horizontal incision
was made in the edentulous No. 6 ridge
with a sulcular extension to the mesio-
buccal aspect of tooth No. 7 and disto-
buccal aspect of tooth No. 5. To increase
visualization, a vertical incision with a
small right angle coronal modification
was placed at the disto-buccal line angle
of No. 5; a straight vertical cut followed
at the mesio-buccal line angle of No. 7. A
full-thickness flap was elevated past the
mucogingival junction, and periodontal
scoring took place near the base of the
flap to facilitate the coronal advance-
ment necessary for primary closure.
Degranulation of the residual ridge using
a pear-shaped carbide finishing bur and
Prichard curette proceeded. Mild verti-
cal and horizontal defects (±3 mm) were
detected (Figure 5 and Figure 6).

Decortication of the ridge was per-
formed using a round bur to achieve
bleeding points. FDBA was placed on
the ridge to augment it buccally and
coronally. A non-absorbable, titanium-
reinforced expanded polytetrafluoro-
ethylene (ePTFE) membrane (in this
case, Gore®-Tex® Titanium Reinforced,
was trimmed and used to cover the graft-
ed area and secured with two titanium
tacks at its apical aspect (Figure 7). The
area was secured using 4-0 expanded
ePTFE sutures in interrupted and hori-
zontal mattress configurations (Figure
8). Primary coverage was achieved. After
6 months of uneventful healing, Stage 1
implant placement was initiated.
Guided Soft-Tissue Growth
A mucosal discrepancy continued to exist 3 months post-implant placement (Figure 12). In order to enlarge the soft-tissue volume and allow for proper drape around the final prosthesis, guided soft-tissue growth was performed. After oral sedation with 0.25 mg triazolam and local anesthetic induction using 2% lidocaine with 1:100,000 epinephrine and 0.5% bupivacaine with 1:200,000 epinephrine, a flap was created using the same incision design and elevation/dissection method documented above. However, no vertical incision was made at the mesiobuccal line angle of tooth No. 7. Initial exposure of the ridge showed the continued presence of the ePTFE barrier, which was detached using forceps after the tacks were removed (Figure 9). Degranulation of the site with a pear-shaped carbide finishing bur divulged sufficient supracrestal vertical and horizontal bone regeneration. Significant horizontal and vertical regeneration was seen (Figure 10). To preserve and expand the bone laterally, the osteotomy was created using expander drills (Bti®, www.bti-implant.com). A rough-surfaced, internal hex 4-mm (diameter) by 11.5-mm (length) implant was placed into the prepared ridge (in this case, NanoTite® Parallel Walled Certain® Implants, Biomet 3i Implant Systems, www.biomet3i.com) (Figure 11). FDBA was placed on the intact buccal surface to augment the ridge further. Primary stability was achieved, and the flap was primarily closed with 4-0 ePTFE sutures in an interrupted fashion after placement of the cover screw. The area was re-temporized with a resin-bonded fixed partial denture (FPD).

Implant Exposure and Final Prosthetics
Adequate soft tissue was seen 1 month after surgery (Figure 16). A small exposure of the healing abutment occurred but did not appear to cause or reflect infection or dampen results (Figure 17). Using a tissue-punch technique, 2-mm (height) healing abutment and the flap positioned over the abutment (in this case, Certain® EP Healing Abutment, Biomet 3i Implant Systems, www.biomet3i.com) and secured with 4-0 ePTFE suture in a simple interrupted pattern (Figure 13 through Figure 15). This effectively tented up the mucosa, allowing soft tissue to fill in the created void.

CASE PRESENTATION (9) Intact ePTFE membrane in place 6 months after the GBR procedure. (10) Significant horizontal and vertical bone regeneration could be seen. (11) No. 6 implant in place after ridge expansion using special drills. (12) Healing 3 months after implant placement. There remained some soft tissue deficiency. (13) Guided gingival growth performed by laying flap and placing a 2-mm tall healing abutment on the fixture. (14) Increased vertical mucosal dimensions may be seen with the healing abutment underneath the sutured flap. (15) Increased lateral mucosal dimensions may be seen with the healing abutment underneath the sutured flap. (16) Buccal healing of site 1 month after instigation of guided gingival growth. The vertical tissue has been coronally repositioned. (17) Palatal exposure of the healing abutment. No sign of infection was apparent.
a two-piece CAD/CAM healing abutment (in this case, Certain® Encode® 2-PEP Healing Abutment, Biomet 3i Implant Systems, www.biomet3i.com) with dimensions of 4.1 mm (platform) by 5 mm (emergence profile) by 4 mm (height) was placed on the No. 6 implant, after which end-stage restorative procedures began (Figure 18 and Figure 19). Three weeks after the final impression was taken, a temporary crown was placed on the implant to further mold the soft tissue (Figure 20). Due to excessive buccal soft tissue over the temporary prosthesis, mucosal abrasion with diamond burs was utilized to contour the soft tissue.

Roughly 17 months after treatment began, the patient received a final No. 6 implant crown (Figure 21). The marginal height of the No. 6 implant crown closely approximated that detected at original presentation (Figure 22). The patient was satisfied with the functional and esthetic result.

**Postoperative Instructions**
After each surgical procedure, the patient was instructed to take ibuprofen 600 mg every 4 to 6 hours, hydrocodone 7.5 mg/acetaminophen 750 mg every 4 to 6 hours as needed for pain, and doxycycline 100 mg once daily for 10 days. The patient was instructed not to brush at or near the surgical site but to rinse with 0.12% chlorhexidine or warm saline twice daily. The patient was also directed not to chew in the affected area for at least 2 weeks. Suture removal occurred 10 to 14 days after surgery.

**Discussion**

As the case report above demonstrates, it is possible to create stable, esthetically acceptable restorations using GBR prior to or in combination with implant placement. Correct diagnosis and timing boost the chances for success. Along with a well-calculated therapeutic design, success is contingent on the effort and persistence of both the treatment team and the patient. The most promising end result may require multiple surgeries, punctuated by extensive healing periods. In the example of a long span of adjacent implants, there still exists no assurance of ideal mucosal esthetics in the anterior, especially for replacement of large-rooted teeth; “black triangles” may be very difficult to avoid. In terms of function and stability, however, GBR performed pre- and peri-implantation is a favorable, predictable technique.

**Acknowledgment**
Restorative work courtesy of Dr. Joseph Worthington.

**References**

**CASE PRESENTATION (18.)** Placement of 4-mm tall CAD/CAM healing abutment to facilitate final impression. (19.) Acceptable buccal-lingual positioning of the implant may be appreciated from this occlusal view of the new healing abutment. (20.) Temporary prosthesis for No. 6 in place 3 weeks after final impression. (21.) Smile view of the final No. 6 crown in place. (22.) Buccal view of the final No. 6 crown. Papillary discrepancy remains on the mesial and distal; these spaces may fill with tissue as time passes.