Case Report

Implementing Socket Seal Surgery as a Socket Preservation Technique for Pontic Site Development: Surgical Steps Revisited – A Report of Two Cases

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Background: *Tooth removal is always followed by the loss of vital soft and hard tissues. When occurring in the anterior region of the maxilla, the resulting ridge deformation may cause severe functional and esthetic problems. Diverse soft and hard tissue regenerative procedures have been developed for correcting ridge defects with the aim of establishing functional and esthetically pleasing pontic or implant restoration sites. However, these technically demanding procedures may be regarded as non-predictable in the hands of most clinicians. To reduce the need for restoring challenging ridge defects, an alternative exists in the form of a simple, minimally invasive socket-preservation procedure immediately following tooth extraction known as socket seal surgery. This article describes the currently improved surgical steps to be implemented with the objective of achieving a functional and esthetically acceptable pontic site.*

Methods: *Immediately following tooth extraction, the socket bony walls are debrided and decorticated, and the soft tissue walls are deepithelialized by a coarse round diamond bur. The socket is filled with particles of a slowly resorbing bone substitute material except for 2 to 3 mm coronally. A cylindrically shaped soft tissue graft that matches the socket orifice contours is harvested from the palatal mucosa and placed atop the bone graft. The soft tissue graft is usually stabilized with six to eight simple interrupted 6-0 monofilament polyamide or 7-0 polypropylene sutures or, when the case allows, by a broad-based pontic restoration that is placed at a minimal distance from the graft.*

Results: *Two cases, each representing a different technique for stabilizing the soft tissue graft, demonstrate successful graft survival. Clinically and radiographically, successful regeneration of the ridge's hard and soft tissues, including the ability to develop functional and esthetically acceptable pontic sites, was demonstrated.*

Conclusions: *Socket seal surgery is an efficacious procedure for ridge preservation and is effective in providing the necessary conditions for the development of functional and esthetic pontic sites.* J Periodontol 2008;79:945-954.

KEY WORDS

Bone; case report; esthetics; graft; pontic; preservation; socket.

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Removal of a failing tooth results in the creation of a deep open wound in the alveolar ridge, the extraction socket. In most instances, the remaining alveolar bony and gingival housing is deficient as a result of previous trauma or a periodontal or endodontic infection. This poorly protected wound may become contaminated further, chemically or bacterially, resulting in a protracted, poorly controlled healing period. The subsequent loss of vital soft and hard tissues may result in a ridge deformity that is an impediment to reconstruction. This deformity may cause severe functional and esthetic problems in the maxillary anterior region.[1-5]

Several plastic surgical techniques were developed to reconstruct ridge defects using soft tissue grafts. Impressive results can be obtained; however, the surgical procedure might need to be repeated several times to achieve optimal results.[6] The clinically growing demand for adequate bony housing for dental implants has led to the promotion of guided bone regeneration procedures by which ridge defects may be filled predictably with newly regenerated bone.[7-13] These technically demanding procedures, although sometimes demonstrating excellent clinical results, frequently involve complex flap manipulation that may account for some undesirable side effects, such as gingival marginal recession, loss of keratinized gingival tissue, reduced interdental papillary height, and scarring of the soft tissues.

Over time, less traumatic extraction techniques followed by socket-preservation procedures have been implemented and enhanced by the introduction of a variety of bone substitute materials.[14-24] The main emphasis in determining the characteristics of those procedures leans more toward the quality of the regenerated bone as a prerequisite for establishing an adequate implant site and less toward the preservation of the topography and the esthetic contours of the soft tissues of the ridge.

Socket seal surgery, a simplified, minimally invasive regenerative approach, was introduced more than a decade ago as a tool for optimizing the preservation of the hard and soft tissue components of the alveolar ridge immediately following tooth extraction.[25]

The introduction of the socket seal technique was followed by the publication of case reports, clinical studies, and multiple case presentations highlighting its implementation in a variety of clinical applications: ridge preservation,[26-28] pontic site development,[29] late implant placement,[25,30-33] and immediate implant placement.[32-37] Yet, some confusion remains as to the surgical steps and the conflicting results relating to the survival rate of the soft tissue grafts used in this procedure.[26,27,32,34]

In the past 15 years, >100 cases of socket preservation using socket seal surgery have been performed by the author. In the intervening period, the basic surgical steps have been retained, while incorporating

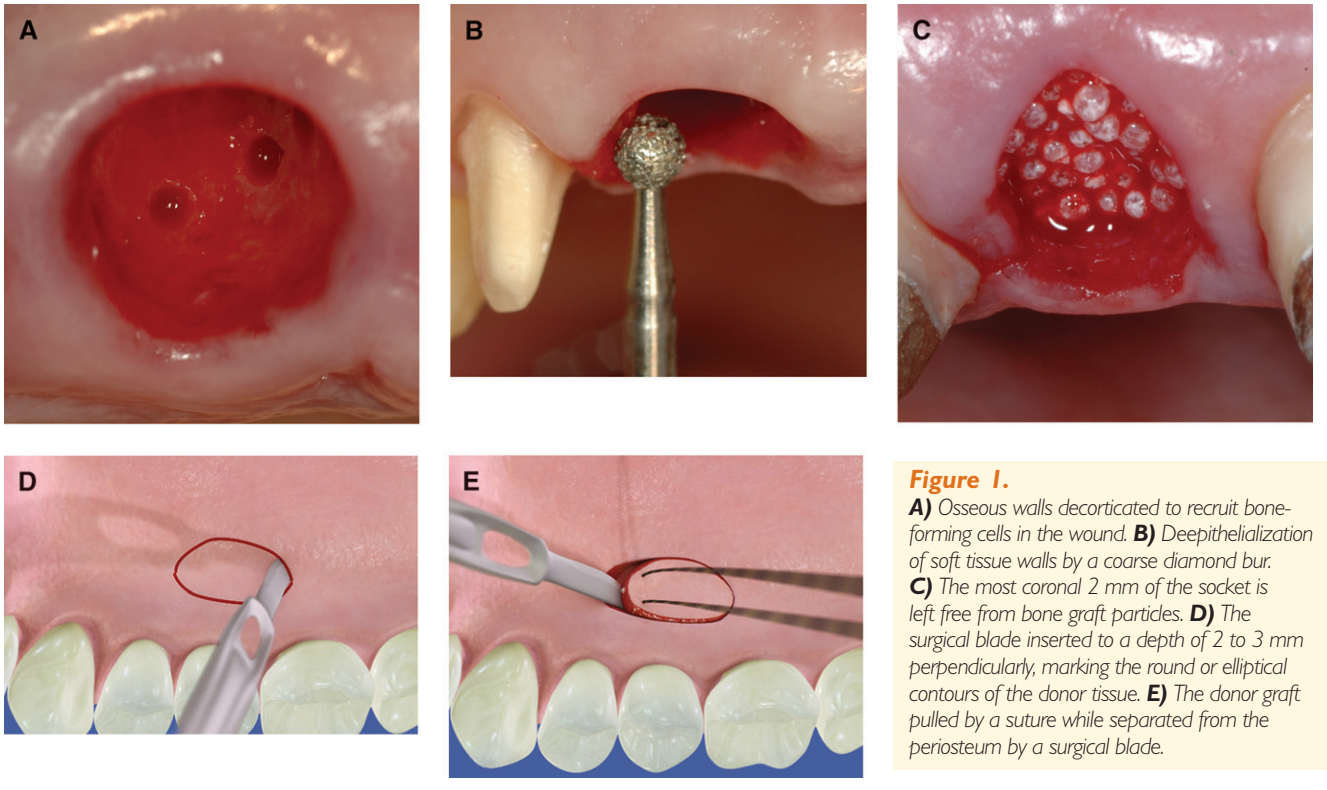

Figure 1.
A) *Osseous walls decorticated to recruit bone-forming cells in the wound.* ***B)*** *Deepithelialization of soft tissue walls by a coarse diamond bur.* ***C)*** *The most coronal 2 mm of the socket is left free from bone graft particles.* ***D)*** *The surgical blade inserted to a depth of 2 to 3 mm perpendicularly, marking the round or elliptical contours of the donor tissue.* ***E)*** *The donor graft pulled by a suture while separated from the periosteum by a surgical blade.*

some recently developed modifications relative to materials and methods for improving the clinical outcomes. This article describes in detail the surgical steps of socket seal surgery used in two cases in which the objective was the development of an esthetic pontic site.

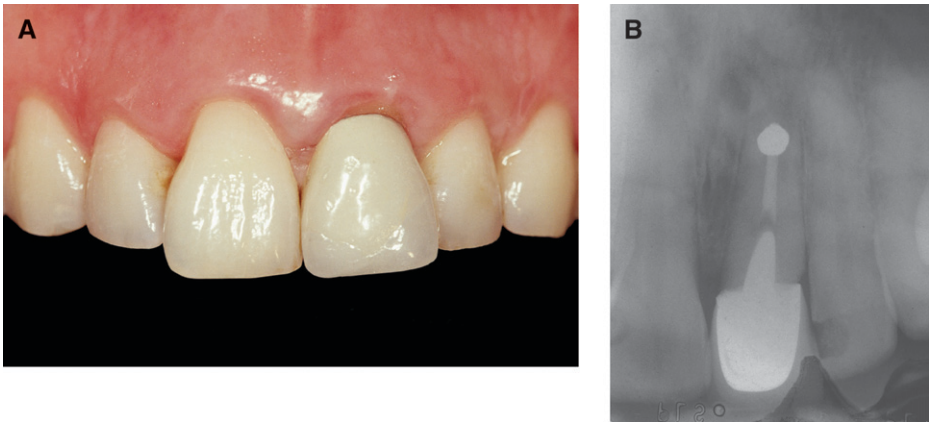

Figure 2.
A) *Tooth #9 associated with chronically inflamed gingiva and an inadequate crown.* ***B)*** *Tooth #9 presenting a periapical resorptive process and bone radiolucency.*

CLINICAL PROCEDURE

Preoperative Protocol

Examination and assessment of the surgical site. Because no flap elevation is performed during the entire procedure, the topography and quality of the ridge should be evaluated thoroughly clinically and radiographically, and occasionally by computerized tomography. If, for example, one of the socket bony walls is resorbed significantly because of trauma or periodontal or endodontic infection, a more conventional treatment modality is preferred (see Discussion).

Preoperative medication regimen. Prophylactic antibiotics (amoxicillin, 875 mg + clavulanic acid, 125 mg)† are used 1 day presurgery and 4 days post-surgery. Anti-inflammatory analgesics (naproxen sodium, 500 mg)‡ are given 1 hour presurgery and four times daily post-surgery, as needed. The patient is sedated with diazepam 1 hour before surgery, if needed.

Following thorough cleansing of the teeth, the patient is instructed to use 0.2% chlorhexidine as a mouthrinse. To minimize vasoconstriction, a local anesthetic (lidocaine 2%), with no or minimal epinephrine concentration, i.e., a maximum of 1:100,000, is administered in the extraction site and the palatal soft tissue donor site.

Tooth Removal

Careful and gentle tooth removal is mandatory for preventing any loss of soft or hard tissue as a result of trauma. A sharp 15 or 15-c surgical blade is used to sever the dento-gingival and dento-alveolar connective tissue fibers. Where the tooth crown is intact, extraction forceps might be the only instrument needed to remove the tooth. Extra care should be taken not to pull the tooth out forcefully. To achieve a forceless extraction, a slow, gentle rotational-pulling force is preferred until the periodontal ligament fibers are torn completely.

If the crown is decayed or destroyed, removal of the remaining root becomes more challenging. Approaching with care, a periotome, preferably in the palatal aspect, is used as a wedge that slowly releases the tight connection between the root and the alveolar bone until the root is considered ready for a forceless removal. To prevent accidental trauma to the thin labial bony plate and to the integrity of the soft tissue walls, any tooth removal should be accompanied by thumb support against the labial aspect of the alveolus and a check on the state of the soft tissue walls of the fresh extraction socket which should be completely intact.

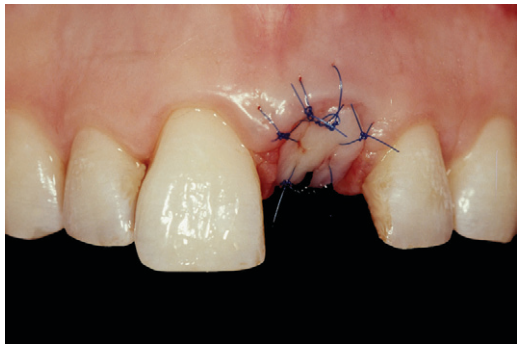

Figure 3.
The soft tissue graft placed atop the bone graft and stabilized by six polypropylene 7-0 sutures.

Socket Preparation

The fresh socket is debrided thoroughly of granulation tissue and residual periodontal ligament fibers followed by a thorough evaluation of the remaining bony housing. A socket having a complete, intact bony housing is the preferred site for the described procedure, although reasonably good results may be

† Augmentin, SmithKline Beecham Pharmaceuticals, London, U.K.
‡ Naxyn, Teva Pharmaceutical Industries, Petah Tikva, Israel.

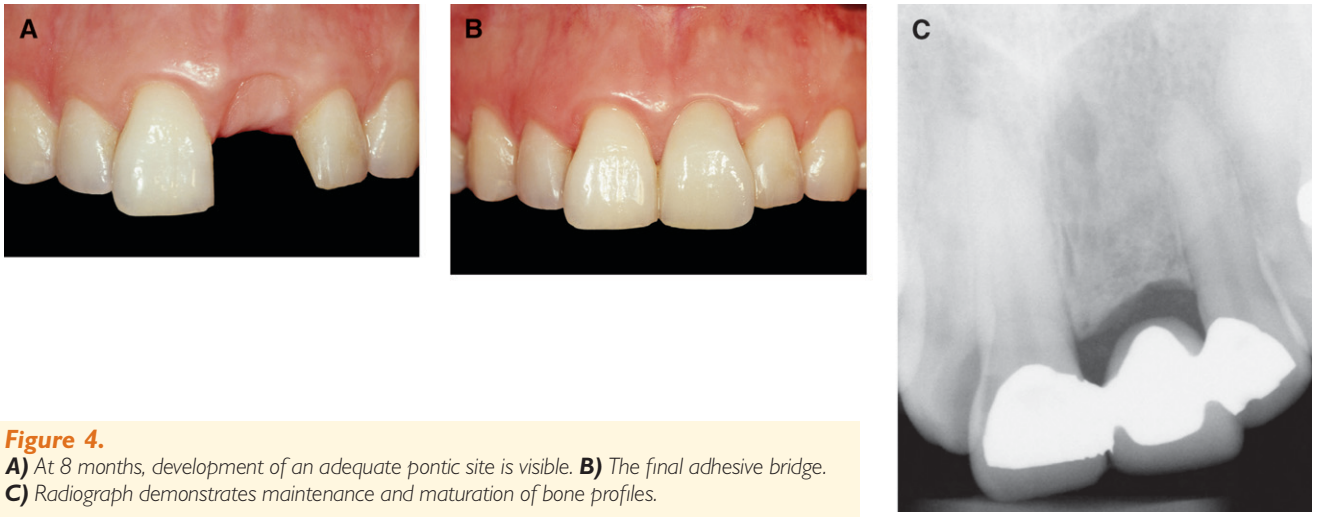

Figure 4.
A) *At 8 months, development of an adequate pontic site is visible.* ***B)*** *The final adhesive bridge.*
C) *Radiograph demonstrates maintenance and maturation of bone profiles.*

achieved in sockets having minor residual bony defects, such as a slightly resorbed crestal bone or a small bony fenestration. The socket bony walls are decorticated further in their apical part (except for the labial wall) to increase the participation of endosteal bone-forming cells in the wound (Fig. 1A). The epithelialized inner layer of the gingival walls at the socket orifice is removed gently by a sterile water–cooled high-speed coarse diamond bur (Fig. 1B) to expose the vascularized lamina propria responsible for nourishing and revascularizing the soft tissue graft to be placed at the socket orifice. Removal of the epithelial inner lining of the gingival cuff with a surgical scalpel probably would not suffice.[38,39]

Bone Grafting

A slowly bioabsorbing bone substitute material is placed inside the socket carefully. Condensation of the bone graft is not advocated because this action may block or inhibit vascularization and mesenchymal cell participation inside the healing socket. Except for the most coronal 2 mm, the bone material is used to fill the socket (Fig. 1C). This allows appropriate space for the soft tissue graft that is to be placed atop the bone graft.

Soft Tissue Grafting

Preparation of the donor tissue. The donor tissue is a partial-thickness graft, which contains the full epithelial layer, the connective tissue, and possible remnants of fatty submucosa, and is typically obtained from the palatal masticatory mucosa in the area adjacent to the second premolar and the first molar. It is preferable not to include any palatal ruggae because these usually compromise the esthetic result. The outline of the graft should mimic the outline of the socket orifice, extending its diameter by 1 mm. Because most anterior sockets are elliptical in shape, a circular punch biopsy may not outline the donor area adequately. Therefore, in most cases, a #15 surgical blade is used for this purpose. To increase the surface area between the periphery of the donor tissue and the soft tissue walls at the socket orifice, the donor tissue must assume a straight cylindrical configuration. This configuration is achieved by two incisions. The first incision is made by inserting the blade tip 2 to 3 mm perpendicular to the palate surface, following the elliptical or circular outline (Fig. 1D). A secondary, diagonal insertion of the blade tip creates a slightly larger outline on the mesio-buccal aspect of the donor tissue. This diagonal insertion is advanced to the undersurface of the graft to release it from the periosteal palatal tissue. Pulling the graft with a suture may enhance this step of the procedure (Fig. 1E). It is advisable to perform the initial round incision before bone grafting and to release the cylindrical soft tissue graft from the donor site only after the bone graft has been placed in the socket properly. Following graft procurement, it is transferred immediately to a saline solution. A hemostatic collagen agent[§] is placed at the donor site, and a single mattress suture is used to hold the hemostatic material in place to compress and stop bleeding vessels. A periodontal dressing is used to prevent accidental trauma during mastication.

Stabilization of the soft tissue graft. Stabilization of the soft tissue graft atop the grafted bone may be achieved by suturing the graft to the surrounding socket walls (case 1), by supporting the graft with a pontic (case 2), or a combination of the two.[33]

Positioning the base of a pontic at a minimal distance from the graft underneath may obviate suturing that could compromise the revascularization of the graft. However, in cases in which the preparation of

§ CollaTape, Integra Lifesciences, Plainsboro, NJ.

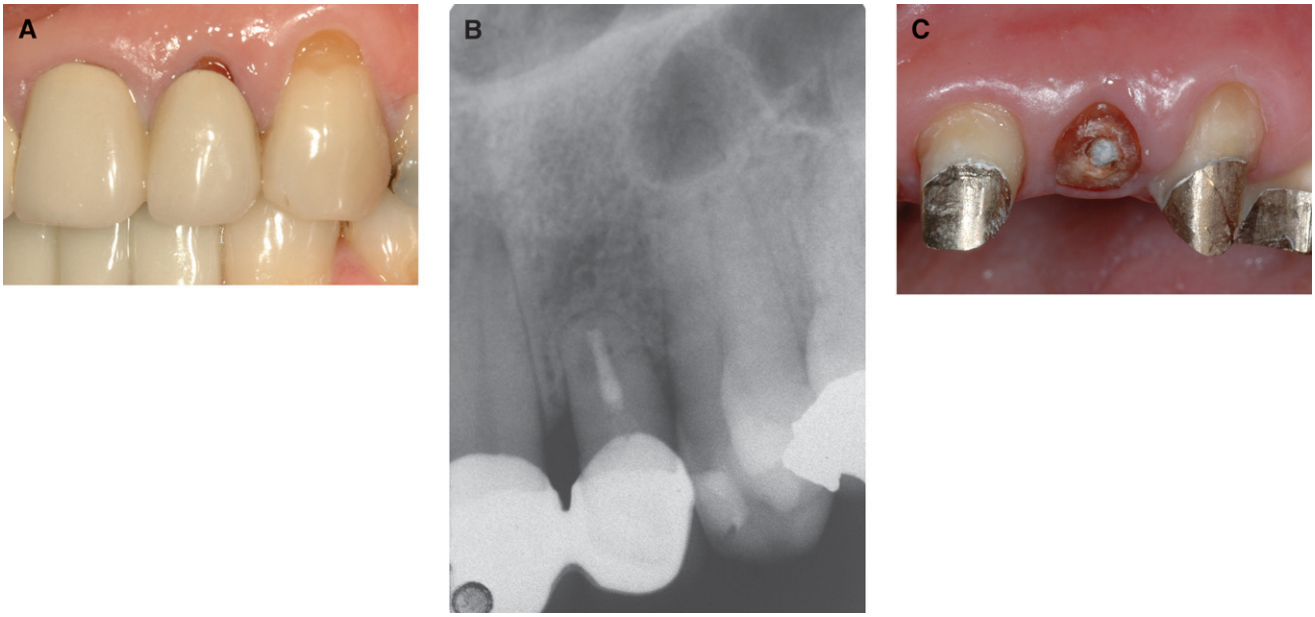

Figure 5.
A) *The ill-fitting crown of tooth #10.* ***B)*** *Tooth #10 presenting root resorption associated with periapical radiolucency.* ***C)*** *Tooth #10 ground off to the gingival level.*

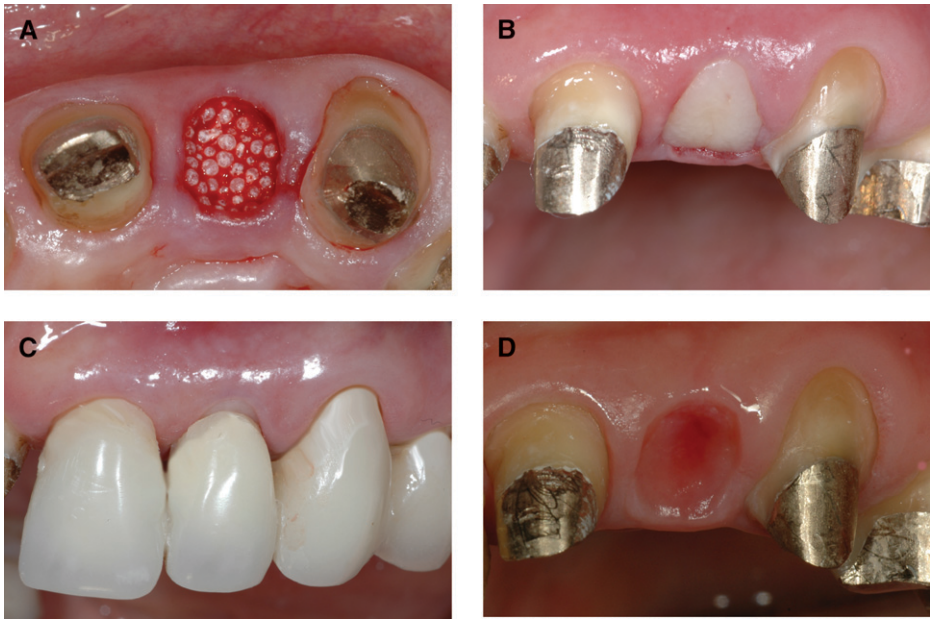

Figure 6.
A) *Bone substitute particles placed to fill the socket, except for the most coronal 2 to 3 mm.* ***B)*** *The soft tissue graft placed atop the bone graft but not sutured.* ***C)*** *The pontic base of the provisional bridge positioned close to the graft, ensuring stable contact with the surrounding socket walls.* ***D)*** *At 3 weeks postgrafting, the soft tissue graft is almost completely rekeratinized.*

a conventional pontic does not constitute a part of the prosthetic treatment plan, stabilizing the graft with sutures might be necessary. To allow adequate revascularization of the graft, no more than six to eight simple sutures are placed at the periphery of the graft. A monofilament polyamide or 7-0 polypropylene suture material is preferred to prevent infection.

Postoperative Treatment

The patient is instructed to follow the prescribed presurgery medication protocol, and a chlorhexidine mouthwash is prescribed for a 3-week duration post-surgically. No toothbrushing or mechanical cleansing is allowed at the surgical area. Only a soft diet is advised for the first 2 weeks of the healing process.

If the graft is supported by a pontic of a fixed bridge, the bridge is to be removed once weekly in the first month for cleaning, graft evaluation, and adjusting the pontic in redesigning the desired pontic site anatomy through light tissue pressure. If sutures were used, they are removed 7 to 14 days post-surgery.

Two cases are described, each representing a different approach for stabilizing the soft tissue graft.

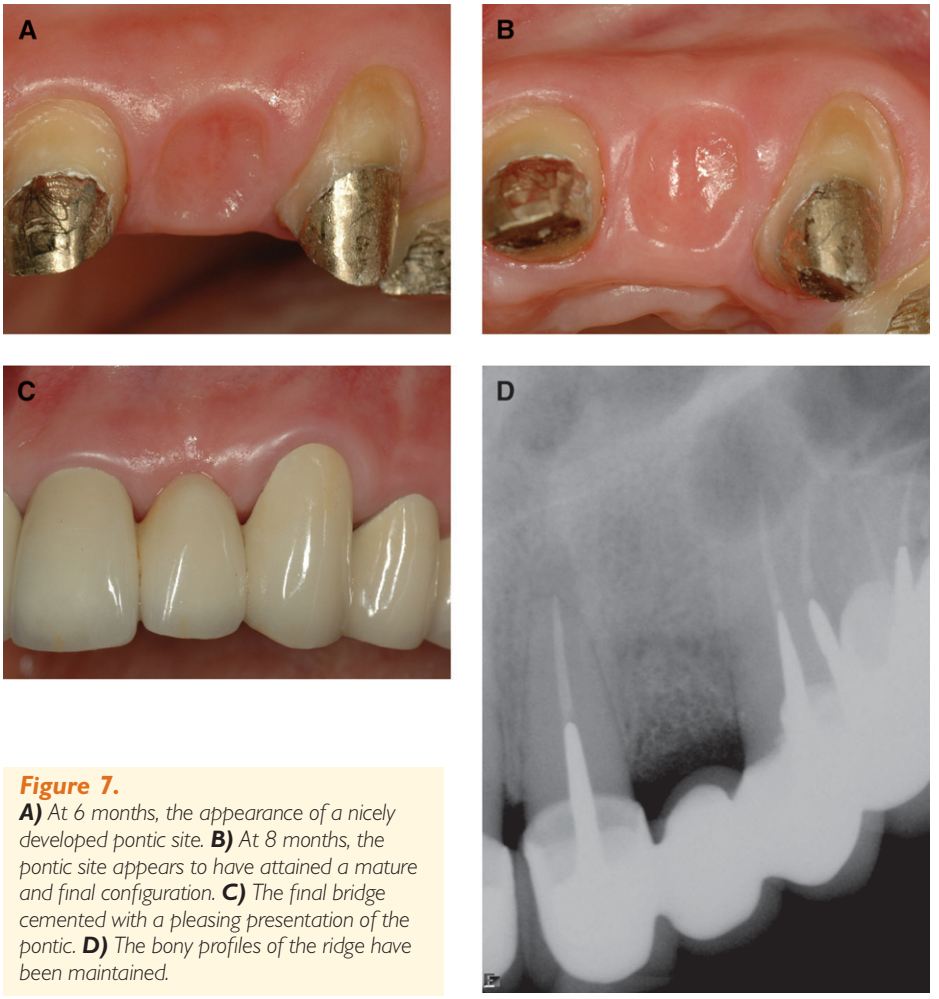

Figure 7.
A) *At 6 months, the appearance of a nicely developed pontic site.* ***B)*** *At 8 months, the pontic site appears to have attained a mature and final configuration.* ***C)*** *The final bridge cemented with a pleasing presentation of the pontic.* ***D)*** *The bony profiles of the ridge have been maintained.*

CASE DESCRIPTIONS AND RESULTS

Case 1

The patient, aged 28 years, presented to the clinic in August 1999 with pain associated with tooth #9. She described having undergone two apicoectomies on the tooth in the past year. Clinical examination revealed an ill-fitting ceramo-metal crown on tooth #9 associated with chronically inflamed recessed gingival margins and interdental papillae. Minor gingival recession was also noted on tooth #8 (Fig. 2A). Tooth #9 was sensitive upon vertical percussion or vestibular palpation. Radiographic examination revealed a radiopaque retrograde filling on tooth #9 with an associated periapical root resorptive pattern and bone radiolucency (Fig. 2B). The patient voiced her disappointment regarding the previous treatment and opposed any additional intervention to save the tooth. Consequently, two main options were discussed: replacing the tooth with an implant and replacing the tooth with an adhesive bridge. The patient opted for an adhesive bridge. Following gentle tooth extraction and socket degranulation, it was revealed that the socket bony walls remained intact except for a residual, relatively small apical fenestration. Following adequate preparation of the socket, a bone substitute material (demineralized freeze-dried bone)‖ was placed inside the socket. (The author prefers the use of bovine bone mineral; see Discussion). An elliptical-shaped soft tissue graft was placed atop the bone graft and stabilized by seven simple interrupted 7-0 polypropylene sutures¶ (Fig. 3). A transitional adhesive bridge with a short pontic was inserted immediately. The short pontic allowed for typical swelling of the soft tissue graft. Three weeks post-surgery, the swelling of the graft appeared to have reached its maximal volume and began to decrease. Over the course of the next 3 months, the acrylic pontic was lengthened and gradually reshaped in its cervical aspect, with the aim of supporting the surrounding soft tissue and redesigning its desired topography. The final adhesive bridge was cemented at 8 months post-surgery because no further changes in the ridge were anticipated (Fig. 4).

Case 2

The patient, aged 39 years, presented to the clinic in April 2005 with a desire to improve the esthetic appearance of her teeth. The following report focuses on the treatment of tooth #10. The tooth presented clinically with an ill-fitting crown (Fig. 5A) and radiographically with an apically resorbed short root and periapical radiolucency (Fig. 5B). The tooth presented a poor prognosis and was scheduled for extraction. With the aim of developing an appropriate pontic site, it was decided to implement socket seal surgery as the socket-preservation technique.

Following abutment teeth preparation, which included reducing tooth #10 to the gingival level (Fig. 5C), a provisional bridge with a broad-based pontic was prepared. The residual root was removed, the socket was degranulated and its bony walls

‖ Miami University Tissue Bank, Miami, FL.
¶ Ethicon Prolene, Johnson & Johnson, New Brunswick, NJ.

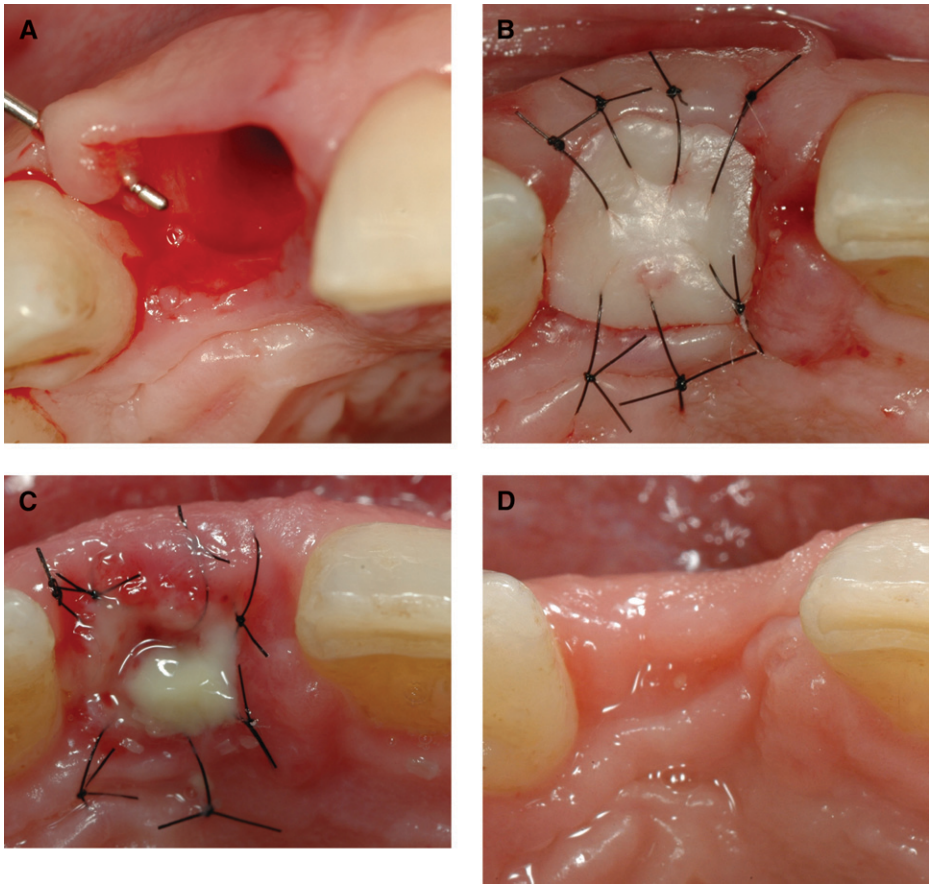

Figure 8.
A) *A tear in the papilla between tooth #7 and the extraction socket of tooth #8 and a thin biotype gingiva with a partially missing labial plate are impediments for successful socket seal surgery.* ***B)*** *An oversized soft tissue graft stabilized with simple interrupted 6-0 polyamide sutures.* ***C)*** *Compromised graft vascularization is expressed by partial graft necrosis.* ***D)*** *Significant horizontal bone resorption is evident at 6 months.*

decorticated, and a bone substitute material (CaOH-coated polymer)# was placed inside the socket (Fig. 6A). An elliptically shaped soft tissue graft was placed atop the bone graft, pushing slightly against the surrounding socket walls (Fig. 6B). The provisional bridge was cemented with the base of the pontic facing the entire surface of the soft tissue graft but not touching it (Fig. 6C). The patient was instructed not to use any mechanical toothbrushing in the surgical area but, instead, to use a chlorhexidine solution mouthrinse twice daily for the next 2 weeks. One week later, a slight swelling of the surrounding socket walls appeared, and removal of the bridge revealed a living grafted tissue fully integrated with the surrounding socket soft tissue walls. At 3 weeks, the graft appeared almost fully rekeratinized (Fig. 6D), at which time the patient was instructed to use an interdental floss subpontic and interproximally. From months 6 to 8 following the procedure, no further noticeable dimensional change of the ridge was apparent (Figs. 7A and 7B), and the case was completed with a fixed ceramometal bridge (Figs. 7C and 7D).

DISCUSSION

The resorption of the bony socket walls that follows tooth extraction is unavoidable.[1-5] The magnitude of this resorption depends mainly on the morphology and state of health of the tooth to be extracted and of its neighboring soft and hard tissues, as well as the surgical measures used to remove the tooth. Even the smallest ridge defect that may result following tooth extraction could alter the esthetic expression of the mouth significantly. As a rule, the chromatic or morphologic changes that may occur cannot be masked, even by the most masterful esthetic restorations fabricated in the dental laboratory. In addition, the most advanced surgical methods used to correct ridge defects are not sufficiently predictable.[40,41] Consequently, it might be advantageous to consider implementing socket seal surgery to prevent those changes from occurring immediately following tooth extraction.

Socket seal surgery is a sensitive procedure that should be used if the fresh extraction socket is relatively intact and no previous inflammation is evident. Hence, in cases in which the gingival or bony walls are damaged because of trauma or chronic inflammation, socket seal surgery should be avoided or approached with caution (Fig. 8). This explains the relatively limited number of cases (112) performed by the author in the last 15 years, reflecting the scarcity of sockets having the adequately retained bony housing. Successful results of the described procedure depend much on adhering to the described surgical protocol (Table 1).

Maintaining the width of the ridge depends greatly on the characteristics of the bone substitute material used. In addition to being tolerated well by the tissues and having osteoinductive and/or osteoconductive properties, it preferably should be a slowly resorbing

Bioplant, Kerr, Orange, CA.

Table 1.

Summary of Surgical Protocol

1. Use **no or low concentration** of epinephrine at donor and recipient sites.
2. Extract the tooth as gently as possible.
3. Deepithelialize the soft tissue walls with a high-speed, round, coarse diamond bur.
4. Complete the round vertical incision at the palatal donor site **(as the first step in harvesting the soft tissue graft)**.
5. Decorticate the bony sockets while leaving the labial wall intact.
6. Fill the bone graft material inside the socket.
   a. Do not aggressively condense the graft material.
   b. Leave no single graft particle in the most coronal 2 to 3 mm of the socket.
   c. Use a slowly absorbable material **(bovine bone is preferred by the author)**.
7. Release beneath the graft until it is separated from the palatal periosteum **(as the second step in harvesting the soft tissue graft)**.
8. Fit the soft tissue graft to the socket orifice.
   a. The graft outline should mimic the outline of the socket orifice.
   b. The graft diameter should be approximately 1 mm wider than the diameter of the socket orifice.
   c. The graft should assume a straight cylindrical configuration.
9. Stabilize the graft by sutures and/or **by the base of the pontic**.
   a. Use between six to eight simple interrupted, 6-0 monofilament polyamide or 7-0 polypropylene sutures.
   b. Leave a small space between the base of the pontic and the soft tissue graft.

Surgical steps or materials that have evolved over time are in bold type.

material such as bovine bone mineral, bioactive glass, or mineralized/demineralized freeze-dried bone. This may prevent significant immediate and delayed volumetric changes of the ridge. In cases in which the aim is solely to preserve the ridge for a pontic site, and no additional surgery is desired, the prevention of short- and long-term dimensional changes of the ridge is of the utmost importance.

In the past, the author used a variety of materials that once were considered "slowly resorbing enough," such as demineralized freeze-dried bone allograft or freeze-dried bone allograft.[42-44] However, for the last 3 years, the author has favored the use of other grafting materials, with a preference for bovine anorganic bone matrix** that has a slower resorption rate[45-48] and, although not proven scientifically, seems to retain the buccal lingual dimension of the ridge better.

The contribution of the soft tissue graft to the overall result cannot be overemphasized. Its complete survival depends greatly on establishing the appropriate conditions for prompt and efficient revascularization, the source of which is mainly, if not solely, the surrounding soft tissue walls of the socket. Hence, the use of anesthetic solutions that contain vasoconstrictors should be minimized throughout the procedure. Care should be taken to harvest a graft with a uniform thickness of 2 mm because there is a tendency for the periphery to be too thin. The thickness of the periphery is an important aspect of graft survival and integration at the eventual recipient site. It is essential to try to achieve complete deepithelialization of the inner part of the soft tissue walls and to maintain tight, protected circumferential contact between the graft and the socket walls over the first 7 days until an initial organic union is established. It is also advocated to stabilize the graft with no more than six to eight simple interrupted sutures because multiple sutures may block the revascularization process. 6-0 polyamide or polypropylene sutures are preferred because of their delicate, inert, and non-infective characteristics. However, if the case allows, the avoidance of suturing seems to provide the best conditions for graft survival.

Further investigative studies (currently underway) will enhance our perception of the clinical behavior of the tissues grafted in the described technique and provide more scientific data for establishing the indications and contraindications for its continued use.

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** BioOss, Geistlich Pharma, Wolhusen, Switzerland.

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