An Update on Implant Placement and Provisionalization in Extraction, Edentulous, and Sinus-Grafted Sites

A Clinical Report on 3,200 Sites Over 8 Years

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Abstract: Provisionalization of dental implants at placement has become more prominent in the field of implantology over the past several years, especially in the esthetic zone. The benefits of this treatment option include immediate tooth replacement, formation and maintenance of esthetic soft-tissue contours, containment for bone-grafting and tissue-regenerative procedures, and an improved sense of the patient's perception of the implant process. The blending together of the surgical and prosthetic/esthetic phase has never been more important as implant systems, abutment options, and surgical techniques have helped optimize procedures that can be accomplished at the surgical visit. This article reviews the guidelines for surgical success first described by the author in 2003 and expands upon those results. This article highlights the results of more than 3,200 immediately restored implants placed in edentulous, fresh extraction sockets, and sinus-grafted sites, over an 8-year period, and presents a case for each area of placement.

Incorporating dental implants into the treatment-planning process for replacement of missing teeth has become commonplace in the contemporary surgical and restorative practice because of their high success rates. The conventional multistage approach to implant reconstruction has accounted for the bulk of implant protocols that have amassed these success rates. While these procedures are predictable and reliable, because of the multiple surgical procedures they often require, esthetics can be compromised. Additionally, these treatment plans require additional time because each procedure requires time to heal. Further, these protocols often require a removable provisional prosthesis or no provisional is provided.

Advancements in surgical protocols have allowed implant surgeons to provide the restoring dentist and patient with a fixed, nonloaded restoration during surgery. Wohrle, Salama and colleagues, Saadoun and LeGall, and Petrungaro have presented guidelines for surgical protocols that allow the implant team to place predictable and esthetic provisionals during surgery. Placing a fixed provisional at implant placement has been shown to contribute to the early foundation for esthetic final implant-supported restorations by aiding in the creation of esthetic soft-tissue contours and emergence profiles.

Several authors have documented the importance of the dento-gingival-implant complex, describing how parameters for success with restorations on natural teeth, regarding the foundation for soft-tissue emergence profiles along with a healthy, mature biologic width, can be extrapolated to implant-supported restorations placed within the natural tooth space (single-tooth replacement) or implant-implant space (multiple adjacent implant sites). Before the inception of surgical procedures, clinicians must incorporate, with esthetic considerations, the dimension for the final prosthetic restoration. Use of a surgical stent designed to allow the surgeon to translate the dimensions of

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the final restoration to the surgical field have been shown clinically to be effective in fostering this type of communication within the implant team.\textsuperscript{13} Kan and Rungcharassaeng,\textsuperscript{14} and Saadoun,\textsuperscript{15} have presented and established surgical rationales for immediate placement and provisionalization of anterior single-tooth implants. Petrungaro has presented a surgical protocol for posterior implants in the sinus-grafted region as well.\textsuperscript{8,16} This article will review a surgical protocol for the immediate placement and provisionalization of dental implants in single and multiple sites. (The surgical protocol was first described in Petrungaro PS. Immediate implant placement and provisionalization in edentulous, extraction, and sinus grafted sites. \textit{Compend Contin Educ Dent.} 2003;24(2):95-113.) The guidelines presented are applicable to edentulous, extraction, and sinus-grafted sites. Table 1 and Table 2 report the success rates for more than 3,200 implants placed over an 8-year period. Three cases will demonstrate the presented protocol.

### PRETREATMENT PLANNING

The implant team should conduct a complete medical and dental evaluation before performing any surgical protocols. Maxillary and mandibular study models should be obtained and mounted on an articulator. Evaluation of the surgical site involves a prescription to the dental laboratory for a diagnostic wax-up of the hard and soft tissues that need to be replaced. After evaluating the diagnostic wax-up, the laboratory technician converts it to a surgical guide/temporary restoration. The TempStent II\textsuperscript{™} method,\textsuperscript{17} which the author developed, allows the restorative dentist to communicate to the surgeon the parameters necessary for a successful and biologically sound implant-supported restoration. It also enables the surgeon to predetermine the angulation and spatial position of the implant, as well as to visualize the position of the implant collar and its relationship to the sulcular portion of the planned restoration and interimplant bone contours. Additionally, stock titanium or zirconia abutments can be prepared and the temporary approximated before the initial surgical visit. Radiologic analysis should consist of periapical and/or a panoramic radiograph at the site(s) to be treated. Additionally, the incorporation of cone-beam imaging techniques can increase greatly the implant team's knowledge of the type of ridge contours that exist before treatment. Imaging software can allow the implant team to plan appropriate sizes and dimensions of implant fixtures, determine where grafting will be required, and fabricate surgical guides that can simplify the implant surgical process.

### Table 1:

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<thead>
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<th>Immediate Restoration Procedure Success Rates (All Sites)</th>
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### Table 2:

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<td>Implant Sites</td>
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Table 3: Preoperative Antibiotic Administration Protocol

Antibiotic Administration, *day before surgery*

- Combination amoxicillin and clavulanic acid, 875 mg. One tablet every 12 hours.
- If allergic to penicillin derivatives:
  - Clindamycin, 150 mg. One tablet every 8 hours.

Table 4: Substances Released by Degranulation of Platelets

- Platelet-derived growth factor (PDGF)
- Transforming growth factor-beta (TGF-β)
- Platelet-derived epidermal growth factor (PDEGF)
- Platelet-derived angiogenesis factor (PDAG)
- Insulin-like growth factor (IGF)
- Vascular endothelial growth factor (VEGF)

SURGICAL TECHNIQUE

- Preoperative antibiotic administration, Table 3
- Atraumatic tooth removal, sinus elevation, or edentulous site preparation with care given to preserve the facial cortical plate in extraction sockets
- Debridement of existing periodontal/periapical infection and/or periodontal ligament by mechanical and rotary instrumentation (eg, high-speed handpiece with a round No. 6 or 8 surgical diamond using copious water irrigation)

IMPLANT SELECTION AND PLACEMENT

First, the implant of choice for this technique should be one with a self-tapping thread design. Second, the implant should be tapered, which provides the best chance for obliteration of the coronal portion of the socket and mimics the root's natural convergence to the apical portion of the socket. Third, the implant surface should be roughened, with surface enhancements to promote a rapid integration and enhance the initial stabilization of the fixture. Last, as the procedure has continued to evolve, the author has observed that the polished implant collar should be no greater than 1 mm in height. This height allows the final position of the implant to have the polished collar in a position just superior to the crest of the bone. This collar position allows the soft tissue to attach in the region of the collar, while the enhanced, roughened implant surface at the first thread, or at its smooth transfer from the polished collar into the roughened surface, allows for bone attachment. The implant collar should be placed with the superior position of the polished collar equal to the line drawn from the facial height of contour (buccal bone height at the midfacial point) of the contralateral tooth to be replaced (ie, central/central, lateral/lateral, etc). Placing the implant in this fashion has been clinically observed to eliminate the "dieback" phenomenon and preserve the interdental bone and soft tissues.

GRAFTING MATERIAL

Autogenous bone is the best grafting material available. It is osteoconductive, osteoinductive, and osteogenic.18-21 However, a drawback of autogenous bone is the required second surgical site for harvesting the bone tissue. Many harvesting techniques require complicated surgical procurement and add significant surgical time and morbidity. Other options include the use of allogenic, alloplastic, and xenographic22,23 grafting materials, either with or without the use of various regenerative barriers. The use of these options has been well documented.24 If a nonautogenous grafting material is to be used, it should be biocompatible with the host tissue, osteoconductive,25-29 osteoinductive,30,31 and osteotrophic.32,33 Not all allogenic or alloplastic grafting materials have these important qualities. Some must rely on a vehicle to reconstitute their granular form. The author34-36 and others37-39 have observed that platelet-rich plasma (PRP) can enhance the osteoconductive—and possibly the osteoinductive—properties of various allogenic, alloplastic, and xenographic materials.

PLATELET-RICH PLASMA

An ideal autogenous vehicle to reconstitute an alloplastic or allogenic substrate is PRP.37-39 PRP (autologous platelet gel) is developed from autologous blood with a cell separator. The cell separator used in the author’s cases has a dual-spin cycle that completes the separation in 12 minutes (SmartPreP®, Harvest Technologies Corp, Plymouth, MA). Centrifugation of 55 mL of whole blood results in 10 mL of PRP that, when simultaneously mixed with thrombin
and calcium chloride, results in the degranulation of the platelets and subsequent release of growth factors, which stimulate both hard- and soft-tissue maturation and promote healing. For this reason, PRP is an ideal vehicle to reconstitute the substrate because it enhances the osteoconductive qualities, and perhaps osteoinductive properties, of the allogenic, alloplastic, or xenographic graft materials. In addition, PRP has been observed to accelerate soft-tissue maturation, which allows the gingival tissues to heal rapidly with minimal postsurgical contour alterations. Table 4 lists the substances released by the degranulated platelets.

However, controversy is present over the use of PRP in surgical dentistry. It is important to understand that not all PRP preparation systems are the same. PRP preparation systems range from simple centrifuges to sophisticated dual, one- to five-pin units with variable revolutions. Variations on percentages of platelet yield and coefficient of variability can alter greatly the effects of the platelets on healing.

**ABUTMENT SELECTION**

An abutment should be selected by using the carrier mechanism of the implant system, a dedicated provisional abutment, a contoured stock abutment (which can be used as a final abutment), or a stock zirconia abutment. Before use, many of these abutments require preparation. Incorporating the temporary/surgical guide system used by the author allows for this preparation to be accomplished in advance in the dental laboratory. Advanced abutment preparation eliminates the repeated removal of carrier mechanisms, intraoral preparation of the abutment (which can produce heat and micromovement via vibration), and the insertion of impression copings for implant indexing at the time of placement. It is important to remember that many times, with immediate tooth removal/immediate implant placement (especially in sinus elevations), the quality of bone is compromised; whatever the surgeon can do to minimize external forces to the fixture will be beneficial. In cases where the stock abutment provided does not allow for an appropriate path of insertion for the restoration because of the angle of implant placement, a stock angled abutment that can be easily prepared will suffice.

**TEMPORARY MATERIAL AND CONSTRUCTION**

As mentioned previously, the temporary, along with the surgical guide, is constructed in the laboratory after evaluation of the diagnostic wax-up. The TempStent II method uses the TempStent II surgical guide, which can be retrofitted into an esthetic provisional restoration that closely mimics that of the planned final restoration in regard to emergence-profile formation, interdental contours, contact points, and gingival contour at the facial marginal aspect.

Because TempStent II surgical guides are constructed to the exact parameters of the planned final restoration, the relationship to adjacent teeth and/or implants is brought to the surgical field, allowing for exact implant placement. After the implant has been placed, the surgical guide can be retrofitted onto the implant and the parameters for construction of the final restoration secured. Conventional surgical guides do not allow for this transfer or information, including contact-point relationships, emergence-profile formation, and parameters for the final esthetic restoration.

On final placement of the temporary, the patient's occlusion must be evaluated carefully. The author recommends that the provisional have no occlusal contact in the centric relation position, in addition to no lateral excursive or protrusive contacts. At 3 months, or 4 to 5 months in sinus-grafted cases, the prosthodontist or reconstructive dentist can proceed with the fabrication of the final implant-supported restoration. After the final impression appointment, the temporary restoration can be recemented with temporary cement and, again, confirmation of nonload obtained.
SUTURE MATERIAL
When suturing is indicated, a 5.0 monofilament (Monocryl®, Ethicon, Inc, Somerville, NJ) or 4.0 Vicryl Rapide® (Ethicon, Inc) suture is recommended by the author. In cases where advanced stabilization of the wound is necessary, 5.0 monofilament suture material is indicated because it is nonabsorbable and aids in stabilization of the wound.

TISSUE-SCULPTING ABUTMENT
At the 3-month postoperative appointment, the prosthodontist or reconstructive dentist should replace the initial provisional abutment/temporary complex with a tissue-sculpting abutment and provisional. In cases where the final abutment was seated at the initial surgical visit, a high-quality impression that registers the esthetic tissue contours will be required. In cases where a stock titanium, plastic provisional, or temporary abutment was placed and, where there was esthetic or prosthetic requirements, a custom or zirconia abutment will be required and a fixture level impression will be necessary. If necessary, an additional provisional restoration can be constructed and used for an extended period of time, especially in the esthetic zone, to create and form emergence profiles.
FINAL RESTORATION

Fabrication of the definitive prosthetic implant restoration (abutment/crown complex) and placement of the final restoration often is completed within 3 months (5 months in sinus-grafted cases). Contoured titanium or stock titanium abutments commonly are used as final abutments to support metal-based ceramic restorations. Depending on the esthetic requirements of the case, construction of an all-ceramic, gold with opaquing, or a contoured, preformed zirconia abutment can meet the esthetic needs of all-ceramic restorations. If the restoring dentist wishes to place a custom abutment, he or she should use a routine impression technique at fixture level with a transfer coping. After fabrication of the custom abutment, the abutment is seated and torqued at 30 Ncm. Then, the implant-supported restoration is completed as normal. Occlusal evaluation of the final restoration is imperative for long-term clinical success. A restoration that has the proper occlusal function in centric relation, and protrusive, right, and left lateral excursions, is necessary for the long-term clinical success of the implant complex.1-3

POSTOPERATIVE COURSE

As stated earlier, the prescribed healing phase is 3 months in immediate extraction or edentulous ridge cases, and 4 to 5 months in sinus-grafted cases. After the healing phase, if the restoring dentist plans to use the stock abutment seated at the initial visit, the abutment is torqued to 30 Ncm and the temporary is recemented. Routine restorative procedures are followed from that point.

Final digital periapical radiographs of the treated sites are taken to register the interproximal alveolar bone contours. Additionally, a panoramic or cone-beam image should be obtained to evaluate the peri-implant area and 360° contour of the alveolar bone surrounding the implant fixture and restoration.

The following case reports demonstrate the immediate implant placement and provisionalization procedure outlined in an edentulous site, an immediate extraction site, and a sinus-grafted site.

CASE 1

A 54-year-old, nonsmoking woman presented for treatment of an edentulous site that had been previously restored with a Maryland bridge (Figure 1). The tooth originally had been removed without a ridge preservation procedure, which resulted in loss of the buccal-palatal dimension of the edentulous ridge. The Maryland bridge had recurrent bonding failure to the abutment teeth, and the restorative dentist had recommended implant placement at the right central incisor site, with subsequent esthetic enhancement of the adjacent dentition. The preoperative periapical radiograph (Figure 2) showed adequate ridge height and an adequate intertooth space sufficient to create an esthetic emergence profile for the final implant-supported restoration.

After administration of an appropriate local anesthetic, a TempStent II surgical guide was inserted over the surgical area. Using a 2-mm twist drill, the planned implant site was marked, followed by removal of the surgical guide. Then, using a football shaped diamond, the esthetic emergence profile was created, following the balance and symmetry of the gingival emergence of teeth Nos. 7 and 9 (the contoured emergence profile can be seen in Figure 3). Using a Petrunagaro Elevator (Salvin® Dental Specialties, Inc, Charlotte, NC), a full thickness flap was elevated creating a "pouch" at the facial of the edentulous site No. 8. This "pouch" allowed for the elevation of the buccal contour of the edentulous site and a confined space for the allogenic graft to be placed. After widening of the surgical site to the adequate dimension, a 3.7 mm x 13 mm Tapered Screw-Vent® implant (Zimmer Dental, Carlsbad, CA) was placed (Figure 3). Then, the carrier mechanism was removed and a PRP-enhanced allogenic graft was placed. The graft complex, PRP and Puros® Allograft (Zimmer Dental) (1-mm to 2-mm sized cancellous particles) was reconstituted chairside several minutes before placement. The graft complex was placed by minimally invasive means into the "pouch" that was created earlier, and enough graft material inserted to slightly overbuild the facial contour of the right central incisor site (Figure 4). Then, the cover screw was removed, a contour abutment, 341S-type (Zimmer Dental), was inserted over the implant (Figure 5), and the screw was hand tightened. Following the manufacturer's instructions, the TempStent II surgical guide was retrofitted to create the final esthetic provisional restoration, which was cemented with strong temporary cement. The immediate postoperative digital periapical radiograph can be seen in Figure 6. The provisional restoration was nonfunctional in protrusive and centric relation movements.

After an uneventful 3-month healing phase, the patient was released to the restorative clinician for construction of the final implant restoration (Figure 7 and Figure 8).
CASE 2
A 51-year-old, nonsmoking woman presented for treatment of fractured teeth at the Nos. 9 and 11 sites (Figure 9). The teeth had a history of repeated root canal treatment, multiple bridge attempts and, with the most recent bridge failure, the teeth had become nonrestorable. The restoring dentist referred her for tooth removal and implant placement at sites Nos. 9 and 11, with ovoid pontic-site formation at tooth No. 10. The preoperative digital periapical radiograph can be seen in Figure 10. After creating maxillary and mandibular study models, taking a face-bow transfer, and mounting the casts on an articulator, the TempStent II surgical guide/provisionalization system was fabricated.

After administration of an appropriate local anesthetic by infiltration, teeth Nos. 9 and 11 were carefully removed by an atraumatic extraction technique, taking great care not to traumatize the gingival tissues. After removing the teeth, the extraction sites were debrided by mechanical techniques (curetting with a molt curette) and rotary instrumentation (round No. 8 diamond) with copious irrigation to remove
all remnants of the periodontal ligament space, any granulation tissue, and/or any remnants of residual tooth infection. Then, the TempStent II surgical guide was inserted and initial site coring accomplished in the extraction sockets (Figure 11). After appropriate site development and preparation, two 3.7 mm x 13 mm Tapered Screw-Vent implants were placed by minimally invasive techniques (Figure 12). Using the surgical guide, the edentulous site at

No. 10 was marked for creation of an ovoid pontic site. After removal of the implant carriers, a PRP and Puros Allograft complex was placed and heavily condensed into the peri-implant defects to the level of the implant collar (Figure 13). Additional deepening of pontic site also was accomplished at this time.

After retrofitting of the TempStent II guide into the provisional, the contours and emergence profiles of the provisional
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The implant collar should be placed with the superior position of the polished collar equal to the line drawn from the facial height of contour (buccal bone height at the midfacial point) of the contralateral tooth to be replaced (ie, central/central, lateral/lateral, etc).

restoration were corrected, including those of the ovoid pontic site. The restoration was cemented with strong temporary cement, and the occlusal parameters adjusted, making the provisional restoration nonfunctional in the centric relation, protrusive, and right and left lateral excursive movements.

After a 3-month healing and observation phase, the restorative dentist constructed a 3-unit implant-supported restoration (Figure 14). After case completion, a cone-beam radiographic image of the facial aspect of the implant at the central incisor site was taken (Figure 15).

CASE 3
A 63-year-old, nonsmoking man presented for rehabilitation of his failing dentition (Figure 16). After consultation with the restorative dentist and the patient, the decision was made to keep the patient in premolar occlusion (as he had been functioning for years), remove all failing and/or guarded/hopeless teeth immediately, and maintain his present vertical dimension.

The restorative dentist prepared all teeth that were to remain, gathered maxillary and mandibular study models and a face-bow transfer, and had the laboratory technician fabricate a TempStent II surgical guide and provisional restoration that would be used at the initial surgical visit. Additionally, the laboratory technician prepared the planned implant sites on the study models and placed implant analogues into the prepared sites with acrylic material in the study models, which held the analogues in place. After the acrylic material set, plastic provisional abutments (HLPT series, Zimmer Dental) were selected to match the implants to be used, placed over the analogues, and prepared for draw (Figure 17). Use of this technique simplified the delivery system of the provisional abutments and extensive provisional restoration.

Using techniques described previously in this article, the hopeless teeth were removed, sites debrided, and implants placed into the planned sites. The TempStent II then was seated over the area, and the implant placement confirmed (Figure 18). The peri-implant defects were corrected by the minimally invasive grafting technique described previously, using the PRP and Puros Dermis Allograft complex. After the peri-implant defects were corrected, the provisional abutments were removed from the study models and transferred to the implants, and the Temp-Stent II retrofitted following techniques described previously (Figure 19).

The patient underwent a 4-month healing and observation phase before the final restorative procedures. Ceramic custom abutments were placed on teeth Nos. 6 through 8, and final screw-retained implant-supported restorations were placed at site Nos. 5, 12, and 13 (Figure 20). Note the balance and symmetry of the facial of teeth Nos. 6 through 8 to that of the teeth Nos. 9 through 11.

At 1.5 years after surgery, the clinical appearance of the implant-supported restoration at the right central incisor site resembled the natural left central incisor (Figure 21). The digital panoramic radiograph can be seen in Figure 22.

CONCLUSION
Dental implants have become a common and acceptable part of treatment plans for those patients requiring replacement of single or multiple teeth. The conventional method of implant treatment requires a multistep process, often times with multiple surgical procedures.

In the past several years, new treatment options have been introduced, and the procedures have been documented clinically as highly successful. Immediate provisionalization of dental implants allows multiple procedures to be accomplished at the initial and sole surgical visit. Minimally invasive surgical procedures (bone grafting and implant placement) help clinicians to conserve gingival and alveolar tissues as well as papillary contours. Using a provisional abutment/crown complex allows clinicians to maintain the width of the root surface area at a constant dimension. This constancy
allows the clinician to reconstruct the lost buccal plate, while the implant fixture is integrating.

Patient benefits include shortened treatment times, reduced postoperative pain and swelling, and immediate use of an esthetic, nonremovable provisional. The author has observed an overall success rate of 98.9% over 8 years. Additional clinical studies are necessary to document and substantiate the long-term success of the immediate restoration procedure outlined in this article.

DISCLOSURE
The author is a consultant for Zimmer Dental and a shareholder in Harvest Technologies Corporation.

REFERENCES
17. Petrungaro PS. Using the TempSrent technique to simplify surgical stent and esthetic temporary fabrication in immediately restored implants in the aesthetic zone. Contemporary Esthetics and Restorative Practice. 2002;6(5):84-90.
Practical Applications


