Interim Endodontic Therapy for Alveolar Socket Bone Regeneration of Infected Hopeless Teeth Prior to Implant Therapy

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The immediate placement of implants in the fresh extraction sockets of infected teeth with periradicular and periapical lesions is contraindicated because of both the infection and the loss of architecture required for proper implant placement. There are 4 approaches for implant replacement of a hopeless tooth with lesions: (1) extraction and delayed implant placement; (2) extraction, debridement, guided bone regeneration (GBR), guided tissue regeneration (GTR), and delayed implant placement; (3) extraction, intrasocket debridement, and immediate implant placement; or (4) extraction, debridement, GBR, GTR, and simultaneous implant placement. The extraction of such hopeless teeth often results in large bone and soft tissue defects that are difficult to repair. This article introduces an alternative approach: interim endodontic implant site preparation, defined as a transitional, surgical, or nonsurgical endodontic treatment to regenerate the hopeless tooth bone defects and prepare the site for proper implant placement. This article describes 3 distinct interim endodontic protocols used to manage 5 patients, all of whom had severely infected hopeless teeth with large lesions and were treatment planned for implant replacement: the first, interim nonsurgical endodontic treatment to restore the normal anatomy of the infected hopeless tooth; the second, interim surgical endodontics on the hopeless tooth with preexisting endodontic treatment to regenerate apical bone for primary implant stability, thus avoiding the involvement of the maxillary sinus and other critical anatomic structures; and the third, interim surgical endodontics on the hopeless tooth with preexisting endodontic treatment to confine the size of the osseous defect and simplify the GBR and GTR procedures. The outcome of interim endodontic treatment on these 5 patients demonstrated that tooth extraction would have been a less predictable approach. The interim treatment changed the overall direction of the patients’ dental care. When treated, these hopeless teeth served many preventive, biologic, and esthetic functions. The infections of the alveolar sockets were eliminated, the alveolar bone defects were repaired through normal bone regeneration, and sockets anatomies were maintained or restored. Furthermore, the patients were spared maxillary sinus surgery and the possible complications resulting from major GBR and GTR procedures. In summary, the interim treatment facilitated tooth extraction and immediate implant placement.

Key Words: interim endodontic therapy, alveolar bone regeneration, infected hopeless teeth, implant site preparation

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INTRODUCTION

Immediate placement of an implant in the fresh extraction socket of a hopeless tooth is a common procedure in implant dentistry. This procedure is generally indicated for patients with infection-free, anatomically intact extraction sockets. This approach, however, is contraindicated for patients presenting infected teeth with periradicular and periapical lesions that destroy the dental socket bone necessary for the primary stability and proper osteointegration of the implant.

The extraction procedure for such teeth and debridement of the diseased socket often lead to larger anatomic and esthetic defects that are extremely difficult to repair.

Currently, 4 treatment approaches are employed for replacement of an infected hopeless tooth with osseous defects. The first method involves extraction followed by a provisional restoration and delayed implant placement. The second is a multi-step approach that features localized ridge augmentation, guided bone regeneration (GBR), and guided tissue regeneration (GTR) followed by implant placement 9 months later. The third approach is flapless surgery extraction, which involves intrasocket debridement followed by immediate placement of the implant. The fourth approach is a complex surgical protocol that includes flap elevation, defect debridement, and simultaneous implant placement with GBR using an autogenous graft from the patient’s ramus or chin (or artificial augmentation) and GTR using barrier membranes followed by primary surgical closure.

GBR, GTR, and other secondary surgery procedures associated with implant therapy require advanced surgical skills, and they are technically sensitive and time consuming, and carry the risk of complications. Furthermore, it is not clear whether they are appropriate for ensuring histologic osteointegration when the implant is placed in an immature grafting site.

This article introduces an alternative treatment approach, “interim endodontic implant site preparation,” which is defined as a transitional surgical and nonsurgical endodontic treatment protocol to regenerate the alveolar bone defects of hopeless teeth planned for extraction and immediate replacement with implants.

Three different variations of the interim endodontic protocol will be presented:

1. Interim nonsurgical endodontics to eliminate hopeless tooth infection and regenerate periapical and periradicular osseous defects and to restore the socket anatomy to avoid damage to the inferior alveolar mandibular neurovascular bundle (Case no. 3).

2. Interim surgical endodontics to eliminate hopeless tooth infections, increase apical bone height for implant primary stability and maximum bone-implant contact, and to avoid involvement of adjacent critical anatomic structures such as the maxillary sinus (Case nos. 1 and 2), the incisive canal foramen, the nasal cavity floor (Case no. 5) or the inferior mandibular neurovascular bundle (Case no. 3).

3. Interim surgical endodontics to eliminate hopeless tooth infection and confine the periradicular osseous defect size to enhance tissue regeneration or simplify GBR and GTR procedures (Case nos. 1 and 4).

Case No. 1

Interim surgical endodontic implant site preparation to eliminate infection and to confine the size of the osseous defect to avoid maxillary sinus surgery and to regenerate apical and periradicular bone (tooth no. 14)

Patient Report

A 28-year-old female patient (ASA I) was undergoing dental care at the Prince Abdul-Rahman Advanced Dental Institute (PAADI). The patient's medical, social, and familial histories were all within normal limits. The
FIGURES 1–6. **FIGURE 1.** Preoperative radiograph of hopeless tooth no. 14 as presented by the patient with post cavity preparation and pulp chamber floor perforation. **FIGURE 2.** Clinical view of hopeless tooth no. 14 with pulp chamber floor bur perforation. The tooth was previously endodontically treated and was being prepared for cast post restoration when the perforation occurred. **FIGURE 3.** A full-thickness buccal and palatal mucoperiosteal intrasulcular flap revealed a defect that involved the furcation and the entire palatal bone of tooth no. 14. **FIGURE 4.** For esthetic reasons, a provisional fixed partial denture (FPD) was constructed from the buccal roots of tooth nos. 12–14. Observe the radiolucency of the defect that became visible after the removal of the palatal root and defect debridement. **FIGURE 5.** After 1 year of interim surgical endodontic treatment, the provisional FPD was sectioned at the bicuspid level, the buccal roots were extracted. Observe the complete regeneration of the furcal and palatal bone. **FIGURE 6.** (A) An implant was placed in the furcal and palatal regenerated bone. A second implant was placed in the edentulous area of tooth no. 13. (B) The implants placed in tooth nos. 13 and 14. Observe the opacity of the regenerated area on tooth no. 14 in comparison to the radiographic radiolucency in Figure 4.
patient was cooperative, highly motivated to undergo comprehensive and esthetic dental care and reported an extensive history of restorative dentistry.

Specifically, the patient complained of pain and repeated swelling on the palatal side of tooth no. 14. Endodontic treatment of tooth nos. 14 and 12 had been performed 3 months earlier (February 2007).

Radiographic Report
Tooth nos. 12 and 14 revealed radiographically acceptable endodontic therapy (Figure 1). No radiolucency or osseous defects were visible on tooth no. 14.

Response Testing and Restorative Report
Removal of the provisional restoration on tooth no. 14 revealed major loss of tooth structure and a damaged pulp chamber floor. The treated canal orifices were clearly visible and adequately sealed with gutta-percha. A large perforation in communication with the furcation in the pulp chamber floor near the palatal canal orifice was observed (Figure 2). A review of the patient’s dental treatment record indicated that the perforation occurred accidentally during removal of a provisional cement restoration placed in the pulp chamber following endodontic therapy. The perforation was sealed immediately and a postcavity preparation was performed on the palatal root. A cast post and core restoration was fabricated. Several weeks later, the patient returned with pain and swelling. The distal and palatal tissues of tooth no. 14 were severely inflamed and hemorrhagic. Clinical probing revealed an isolated 12-mm defect on the palatal root. The mesial, buccal, and distal periodontal probe depths were 1–3 mm. Due to the tooth structure loss and pulp chamber floor perforation, the tooth was considered restoratively and structurally hopeless, with a periradicular and periapical osseous defect.

Patient Case Presentation
The patient was informed of the hopeless condition of the tooth and the treatment options for hopeless tooth management, as listed in the introduction of this article, including interim surgical endodontic treatment. The patient was concerned about the negative esthetic consequences of losing tooth nos. 13 and 14. Discussion of the treatment plan, consisting of hemisection of tooth no. 14 and fabrication of a provisional fixed partial denture (FPD) from tooth nos. 12–14, calmed the patient, who consented to the interim endodontic treatment protocol.

Interim Surgical Endodontics
One week prior to surgery, the patient received oral prophylaxis. A combination of greater palatine foramen block injection and buccal and lingual infiltration injections were administered to anesthetize the buccal and palatal tissue of the maxillary left quadrant (Xylocaine, 20 mg/mL in 1.8 mL; Dentsply by Astra, Italy, 12.5 mg/mL). An intracoronal composite build-up with retentive pulp chamber features was performed on the buccal roots of tooth no. 14. The composite build-up involved only the buccal half of the tooth. The perforation and palatal root orifice were left visible as a reference where the mesiodistal hemisection cut will be made.

The objectives of the surgery were to: (1) relieve the patient’s symptoms; (2) debride the palatal defect; (3) remove the palatal root of tooth no. 14 to confine the size of the defect to the damaged site, thus preventing the enlargement of the defect and the possible oroantral complications that would occur if the tooth were extracted; (4) regenerate bone for implant placement; and (5) perform crown lengthening and osseous contouring on tooth no. 12. Periodontal sounding confirmed the existence of a 12-mm palatal defect. Using BP15C (Hu-Friedy, Chicago, Ill) for the incision, a microsurgical curette (MAR #3, Hu-Friedy)
for the free-gingival elevation, and a periosteal elevator (Allen P9A, Hu-Friedy) for periosteal elevation, a full-thickness buccal and palatal mucoperiosteal intrasulcular flap was elevated on tooth nos. 12–14. The flap elevation on the palatal side revealed a large defect involving palatal tissue from the mesial line angle to the distal surface of tooth no. 14 and extending palatally deep into the hard palate. Once the palatal defect was debrided, the palatal root was clearly visible and denuded from the bone. Interestingly, in spite of the size of the defect, it did not appear on the periapical radiograph of tooth no. 14 (Figure 1). The palatal root was easily sectioned mesiodistally. Once the root was removed, the palatal defect and furcation defect became connected and created a larger defect. This new defect extended from the alveolar ridge to the periapical level of the palatal root of the hard palate, reaching 15 mm in length and 15 mm in width (Figure 3). The defect was meticulously debrided to remove all granulation tissue, which was sent for biopsy. The apical surface of the defect was gently probed, revealing a small maxillary sinus exposure. The remaining buccal roots were examined, and the tooth furcation area was refinished to remove any undercuts or furcal spurs. No crack lines were observed on the remaining buccal roots. Osseous contouring was performed on the buccal roots of tooth no. 14, as well as tooth no. 12 for proper flap primary surgical closure. Suturing was completed with 4-0 Vicryl (polyglactin 910, Johnson & Johnson, Belgium). Antibiotics (500 mg of amoxicillin bid for 5 days) and a mild painkiller (600 mg of ibuprofen qid for 5 days) were prescribed. Six months later, the implants were restored.

**Case no. 2**

*Interim surgical endodontic implant site preparation to eliminate site infection and regenerate and increase apical bone height to avoid maxillary sinus surgery (tooth no. 5)*

**Patient Report**

A 39-year-old female patient was seen on April 6, 2006. The patient’s medical, dental
and oral hygiene, social, and personal histories were within normal limits. The patient reported a history of bronchial asthma treated with a Ventolin inhaler as needed and thalassemia minor treated with a daily dose of ferrous sulfate. The patient specifically reported pain in tooth no. 5 and had a history of endodontic treatment 3 years earlier (April 2003).

Radiographic Report

Tooth no. 5 revealed a midroot periradicular defect and no periapical defect. The existing endodontic treatment left a 2-mm endodontic overfilling that extended to the surface of the maxillary sinus floor (Figure 7). The root apex of tooth no. 5 was within 2–3 mm of the sinus floor radiographic image.

Response Testing and Restorative Report

Periodontal probing revealed an isolated 6-mm defect located at the midbuccal surface of tooth no. 5. Periodontal probing depths of the buccal, mesial, distal, and palatal surfaces were 1–3 mm. A palpation test confirmed the presence of a hard swelling on the buccal surface of tooth no. 5. The clinical crown was restored with composite restoration. To evaluate the quality of the endodontic treatment, the composite restoration was removed, and the pulp chamber was debrided of the gutta-percha filling. The pulp chamber was free from any staining, leakage, defects, or crack lines. To evaluate the quality of the gutta-percha endodontic condensation, the gutta-percha was removed to the midroot level and was checked for proper sealing with nos. 20 or 25 spreader (M-series ISO spreaders, Dentsply Maillefer). The root canal filling condensation was found to be acceptable, and the canal was refilled with gutta-percha. No fractures or crack lines were detected on the root canal walls or in the clinical crown. The tooth was restored via a composite intracoronal build-up.

The patient was advised of the risks and benefits of the following treatment options: (1) extraction and delayed implant placement, (2) extraction and immediate implant placement with the possibility of sinus floor bone grafting, (3) FPD, (4) exploratory surgery to determine the underlying problem and decide on a course of action accordingly, and (5) interim endodontic implant site preparation. The patient was anxious about losing the tooth or undergoing invasive surgeries and agreed only to the exploratory procedure.

Exploratory Surgery Clinical Procedure

The objectives of the surgery were strictly diagnostic (to identify the cause of the tooth buccal surface defect by surgical exploration). The patient’s maxillary right quadrant was anesthetized with a combination of greater palatine block and buccal and lingual infiltration injections for tooth nos. 3–6 (Xylocaine, 20 mg/mL in 1.8 mL; Dentsply, Italy, 12.5 μg/mL). Periodontal sounding revealed a deep (10-mm) isolated defect on the buccal aspect of tooth no. 5. The periodontal probing depths of the adjacent teeth were within normal limits. The periodontal probe depth on the palatal side was 1–3 mm, and no osseous defect was found. A full-thickness buccal mucoperiosteal intrasulcular envelope flap was elevated on tooth nos. 4–6 using BP15C (Hu-Friedy) for the incision, a microsurgical curette (MAR #3, Hu-Friedy) for the free-gingival elevation, and a periosteal elevator (Allen P9A, Hu-Friedy) for periosteal elevation. Due to the exploratory nature of the surgery, no vertical incision was needed. The envelope flap elevation revealed a buccal osseous defect of 8 mm (height) × 10 mm (width) at the midroot level. The defect was outlined with BP15C and debrided with Gracey standard curettes (Hu-Friedy), a microsurgical straight apical curette (MAR-SC2, Hu-Friedy), and a microsurgical long-shanked excavator (MAR-C2,
Hu-Friedy). Surgical field hemorrhage was controlled with Nu Gauze (Crosstex International, Hauppauge, NY) soaked with Astrigedent (Ultradent, South Jordan, Utah). Methylene blue (Mayne Pharma, Melbourne, NY) was applied to the tooth structure and the area was rinsed and dried. Transillumination of the area with a fiber-optic light revealed a buccal crack line that started at the midroot level and extended apically; the buccal cervical third of the root was intact. The area was cleansed and the flap was repositioned, coaptated, and sutured with interrupted sutures of 4-0 Vicryl (polyglactin 910; Johnson & Johnson). The occlusion on tooth no. 4 was adjusted to release the tooth.

**Figures 7–12.** Figure 7. Preoperative radiograph of tooth no. 5 with root mid-third defect. The tooth also had 2–3 mm endodontic overfill. Observe the proximity to the maxillary sinus floor. Figure 8. Postoperative radiograph of tooth no. 5 following interim surgical endodontics via deep apicoectomy and apical gutta-percha cold burnishing. Note: No osteoconductive material was placed in the apical defect in order to monitor the bone regeneration. The defect was filled with radiolucent collagen wound dressing and covered with barrier membrane. Figure 9. Tooth no. 5, 1 year following interim surgical endodontics. Observe apical socket bone regeneration. Figure 10. The fresh extraction socket of tooth no. 5. Observe the thickness of the regenerated apical bone separating the socket from the maxillary sinus and providing native bone for implant primary stability. Figure 11. Immediate implant replacement of tooth no. 5 with a SIS 12-mm Straumann Standard Plus implant. Figure 12. The implant restoration 9 months after immediate placement.
from occlusal contacts. Standard postoperative care procedures were prescribed. Amoxicillin (500 mg bid for 5 days) and ibuprofen (600 mg qid for 5 days) were also prescribed. Based on the exploratory finding of a vertical apical fracture, the tooth was considered structurally hopeless, with a periradicular osseous defect. Immediately following exploratory surgery, the patient was informed of the findings and the poor long-range prognosis of the tooth. The sutures were removed 7 days later.

Patient Recall

The patient was seen 2 and 3 months later. The surgical site healed properly, except for the remaining defect on tooth no. 5. Four months later, the patient returned complaining of pain and swelling recurrence. The buccal defect was still present at the same location. All other surfaces were within the range of normal periodontal conditions.

The patient was advised of all treatment options described in the introduction of this article, as well as FPD. The interim surgical endodontic implant site preparation protocol was recommended, and the patient consented to its use.

Interim Surgical Endodontic Site Preparation Procedures

The patient was scheduled in July 2006. One week prior to her surgery appointment, the patient received full mouth dental prophylaxis. The objectives of the surgery were to: (1) relieve the patient symptoms; (2) remove the fractured root segment to midroot level, leaving the cervical third of the root to assure surgical flap reattachment; (3) remove the infected tissue; (4) place a buccal barrier membrane to cover and protect the debrided defect; and (5) promote bone regeneration, to increase the height and thickness of the apical bone separating the socket from the maxillary sinus floor. The area was anesthetized as described above, and a full-thickness buccal and palatal mucoperiosteal intrasulcular flap was elevated from tooth nos. 3–5 using BP15C (Hu-Friedy), microsurgical curettes (MAR-EX3, Hu-Friedy), and a periosteal elevator (Allen P9A, Hu-Friedy). To maintain atraumatic flap elevation, access, and visibility at the root end of tooth no. 5, a distal vertical releasing incision was made in the attached gingiva on the buccal surface of tooth no. 3. The buccal flap was elevated 3–5 mm apical to the root end of tooth no. 5, thus completely exposing the buccal cortical plate defect on tooth no. 5. The palatal flap was constructed in an enveloped design involving tooth nos. 4–6 in order to visualize the palatal cervical surface of tooth no. 5 and determine whether the root fracture had extended to the palatal surface of the root, as well as to debride the area in case such a complication had occurred. The buccal osseous defect was outlined with a BP15C (Hu-Friedy), debrided with a microsurgical long-shanked excavator (MAR-C2, Hu-Friedy), and was sent for biopsy. The root structure of the apex was completely exposed and visible. Hemorrhage control was achieved by scrubbing the area with 1 × 1 cm Nu Gauze (Crosstex International) soaked with Astringedent (Ultradent). Methylene blue (Mayne Pharma) applied to the root surface revealed that the vertical crack line had extended from midroot to the apex of tooth no. 5. The structure of the cervical third of the tooth was intact, although it was partially denuded from the bone. Using a fissured surgical-length bur, and starting at the apex, the root was sectioned at a 90° angle to the long axis of the root. The sectioning involved the total root surface (buccolingually and mesiodistally). The completeness of the root sectioning and the quality of the gutta-percha root filling was evaluated with methylene blue dye (Mayne Pharma) and transillumination. The root was sectioned to solid tooth level,
leaving a minimum of 6 mm of the cervical third for flap repositioning and reattachment. The surgical site was also evaluated for additional curettage and osseous contouring at the cervical zone of the adjacent teeth to assure proper support of the soft tissue in the entire quadrant. Prior to surgical closure, a periapical radiograph was obtained to assure that the root end procedures had been carried out properly and that the apical site had been completely debrided from root fragments or filling materials. The radiograph also served as a reference for monitoring the healing progress and regeneration of the site (Figure 8).

The debrided surgical defect was packed with a collagen wound dressing (Colla Cote, Sulzer Medica, Integra Life Science Corp for Zimmer Dental). This was used to stabilize and protect the blood clot and to prevent collapse of the barrier membrane into the surgical osseous defect. A BioGide resorbable bilayer membrane (25 × 25 mm, Geistlich Pharma AG, Switzerland) was then trimmed to encompass 2 mm beyond the defect borders, and thus was kept away from the incision edges of the flap. The flap was then repositioned with the assurance that the membrane was completely stable and covered with the flap. Sutures (4-0 Vicryl [polyglactin 910], Johnson & Johnson) were placed, assuring primary surgical closure. The tooth occlusion was adjusted out of contact with the opposite dentition. Postoperative surgical care instructions were given. Amoxicillin (500 mg bid for 5 days) and ibuprofen...
FIGURES 17–22. Figure 17. Preoperative radiograph of hopeless tooth no. 30 with vertical root fracture and periradicular and periapical defect involving the entire mesial root. Figure 18. A full-thickness mucoperiosteal intrasulcular buccal and lingual flap revealed a buccolingual mesial root vertical fracture. Observe the loss of the mesiobuccal cortical plate and mesial interproximal bone. Figure 19. Once the mesial defect was debrided for hemorrhage control and visibility, the mesial root was sectioned buccolingually. Figure 20. The mesial root is completely sectioned and ready for removal. The coronal restoration was also modified to satisfy the requirements of proper restorative principles and oral hygiene care. Figure 21. The removal of the fractured root allowed access to debride the entire mesial socket. Care was exercised in debriding the apical side of the defect to avoid the inferior mandibular neurovascular bundle. Figure 22. The furcation area was modified and refinished to remove any dentinal spurs or rough surfaces and to allow proper oral hygiene care throughout the interim therapy period. The interproximal contacts were maintained and the restoration was removed out of occlusion.
(600 mg qid for 5 days) were prescribed. Sutures were removed 7 days later.

The patient reported several symptoms commonly encountered following oral surgical procedures. Tooth no. 5 demonstrated increased mobility (second degree). The tooth was examined again to ensure that no occlusal contacts were made with the opposite dentition. The patient was seen again 3 and 6 months after surgery, at which time the patient was asymptomatic and satisfied with the procedure, and tooth mobility had improved significantly. Twelve months later, the patient was recalled for implant placement (Figure 9). Periodontal probing revealed normal clinical attachment of 1–3 mm. However, periodontal sounding showed a defect at midbuccal cervical area. The tooth was extracted easily and atraumatically (Figure 10), and an implant (Straumann Standard Plus implant SIA 12 mm, Institut Straumann) was placed (Figure 11). The final restoration was placed 9 months later (Figure 12).

**Case no. 3**

**Interim nonsurgical endodontic implant site preparation to eliminate site infection, regenerate lost apical bone, and protect the inferior alveolar mandibular neurovascular bundle (tooth no. 19)**

**Patient Report**

The patient was a 25-year-old male with medical, social, personal, and family histories within normal limits. A dental history revealed multiple defective and carious restorations. The patient specifically complained of pain in the left quadrant of the mandible and in tooth no. 19. The patient was receiving dental care at PAADI. An emergency pulp extirpation of tooth no. 19 had been performed 3 months earlier (September 2007).

**Radiographic Report**

Radiographic evaluation revealed multiple provisional restorations and caries on tooth nos. 18–21. The provisional restoration of tooth no. 19 extended deep into the pulp chamber and the furcation zone. The radiograph revealed a disrupted lamina dura and periodontal space continuity in tooth no. 19, as well as large periradicular, furcal, and periapical radiolucencies (Figure 13).

**Response Testing and Restorative Report**

Tooth no. 19 was nonresponsive to CO	extsubscript{2} ice pulp testing. Periodontal probing revealed an isolated osseous defect on the buccal furcation, with readings of 3-12-3 mm, and lingual surface readings of 3-4-3 mm. A palpation test revealed hard swelling on the buccal surface of tooth no. 19. Percussion and mobility testing results were within normal limits.

With the rubber dam isolation in place, the provisional restoration on tooth no. 19 was removed. Massive tooth structure loss, extending well into the lingual furcation area, was evident. The lingual gingival tissue was severely inflamed and had grown into the tooth lingual furcation area. The pulp chamber floor was transparent and the furcal tissue could be seen underneath; however, no perforation was evident (Figure 14). The lingual furcation was also exposed. The tooth was considered restoratively hopeless, with large periapical and periodontal osseous defects. A decision was made to provide the patient with emergency care to alleviate his symptoms. The gingival tissue hemorrhage was controlled by Nu Gauze (Crosstex International) soaked with Astrigedent (Ultradent). Standard endodontic debridement, canal preparation, and disinfection (with 5% sodium hypochlorite) were performed. All canals were enlarged to size 40 using a combination of hand and automated methods (Profile .04, Dentsply, Switzerland). The canals were flushed with anesthetic solution (Xylocaine, Dentsply, Italy) to float the debris and dried with size 40 paper points. The tooth was then...
provisionally closed. The rubber dam was removed, and the occlusal surface of the tooth was reduced to avoid occlusal contacts with the opposite dentition.

Patient Case Presentation

The patient was advised of the hopeless condition of the tooth and the risks and benefits of the treatment options listed in the introduction of this article. The interim endodontic approach was recommended, and the patient accepted and consented to this treatment.

Interim Nonsurgical Endodontic Site Preparation Procedures

Two weeks after the emergency treatment visit, the patient was scheduled for completion of endodontic treatment. The patient reported total resolution of all symptoms.

An inferior mandibular block anesthesia with Xylocaine (20 mg/mL in 1.8 mL; Dentsply, Italy, 12.5 μg/mL) was administered. The tooth was isolated with a rubber dam, and the provisional restoration was removed. The canals were irrigated, flushed, and disinfected with 5.5% sodium hypochlorite, and the canal walls were refinished with size 40 files (Profile .04, Dentsply, Switzerland) using automation for the cervical and midroot third preparations and hand instrumentation for the apical third. The apical canal preparations were completed to size 40. The canals were flushed with anesthetic solution using a 25-gauge needle adjusted to the canal length to the float filing shavings and debris. The canals were then dried and filled with gutta-percha points (Meta Dental Co Ltd, Korea) (Figure 15) and AH26 silver-free cement (Dentsply, Germany). The cervical gutta-percha was trimmed to the canal orifice, and the intracoronal composite restoration was placed with proper interproximal contacts and with no occlusal contacts with the opposite dentition. The patient has since reported no problems at site no. 19. A recall radiograph was obtained on April 12, 2009 (Figure 16). The patient is now awaiting immediate implant placement.

Case no. 4

Interim surgical endodontic implant site preparation to eliminate site infection, confine osseous defect size, and regenerate apical and periradicular bone to protect the inferior mandibular canal (tooth no. 30)

Patient Report

A 49-year-old man was seen at PAADI clinics. The medical history (ASA II) revealed multiple significant medical problems: diabetes mellitus controlled with Glucophage (metformin, 500 mg tid), high blood pressure controlled with Zestril (lisinopril, 250 mg qid), hypercholesterolemia controlled with Zocor (simvastatin, 200 mg qid), and asthma controlled with a Ventolin inhaler as needed. The patient’s social, familial, and personal histories were all within normal limits. The patient was cooperative and had excellent oral hygiene. Specifically, the patient complained of repeated chronic swelling (1 year in duration) and exudate from tooth no. 30. The tooth had been endodontically treated 18 years earlier (1990). For prosthodontic reasons, a cast post and a new crown had been fabricated in 1999.

Radiographic Report

Radiographic examination revealed large periapical and periradicular radiolucent osseous defects on the mesial root of tooth no. 30. The defect involved the entire mesial root (Figure 17).

Response Testing and Restorative Report

The tooth had acceptable quality porcelain bonded to a metal restoration. Periodontal probing indicated a localized mesiobuccal defect of 7 mm, a mesiolingual depth of 5 mm, and a Grade I furcation defect. A fistula was traced to the mesial defect. The gingival tissue of the tooth was anesthetized
via local infiltration. Gentle deflection of the free gingiva at the mesiobuccal line angle revealed a vertical fracture. The mesiobuccal site was rubbed with Nu Gauze (Crosstex International) and soaked in Astringedent (Ultradent) to obtain a clear view of the vertical fracture line.

**Patient Case Presentation**

The tooth was considered structurally hopeless due to the presence of a vertical fracture.

The patient was advised of all possible treatment options, as listed in the introduction of this article, and the interim surgical endodontic approach was recommended.

**Interim Surgical Endodontic Site Preparation Procedures**

One week prior to surgery, the patient received dental oral prophylaxis and was given antibiotics in consultation with the patient’s physician. The objectives of the
The surgery was performed in March 2008. An inferior mandibular block injection was administered (Xylocaine, 20 mg/mL in 1.8 mL; Dentsply, Italy, 12.5 μg/mL). Periodontal sounding confirmed the presence of 12-mm localized defects on the mesial root via root amputation procedure, (4) confine the size of the defect to the mesial side of the tooth via transitionally keeping the distal root and its sound bone until the mesial defect has healed, (5) augment the mesial defect socket, and (6) modify the restoration of tooth no. 30 to maintain contacts with adjacent teeth and prevent occlusal contacts with the opposite dentition.

The surgery was to: (1) relieve the patient symptoms, (2) eliminate the site infection, (3) remove the structurally hopeless mesial root via root amputation procedure, (4) confine the size of the defect to the mesial side of the tooth via transitionally keeping the distal root and its sound bone until the mesial defect has healed, (5) augment the mesial defect socket, and (6) modify the restoration of tooth no. 30 to maintain contacts with adjacent teeth and prevent occlusal contacts with the opposite dentition.

The decision to elevate a buccal and lingual flap was based on the presence of 2 defects, indicating buccolingual spread of the infection. Flap elevation revealed a large defect involving the mesial half of tooth no. 30 (Figure 18). The surgery area hemorrhage was controlled with Nu Gauze (Crosstex International) and moistened with Astringent (Ultradent). The defect was debrided of purulent contents with Gracey standard curettes (Hu-Friedy), a microsurgical straight apical curette (MAR-SC2, Hu-Friedy), and a microsurgical long-shanked excavator (MAR-C2, Hu-Friedy). No tissue was available for biopsy. Methylene blue (Mayne Pharma) was applied to the tooth structure, and the area was rinsed thoroughly and dried to reveal a vertical fracture (Figure 18) on the mesial and complete loss of the buccal and lingual cortical plate on the mesial half of the tooth. The furcal and distal bones were intact. The mesial root was sectioned buccolingually with a long surgical fissured bur starting at...
the buccal and lingual furcation area (Figure 19). The mesial root was removed in pieces (Figure 20), and the mesial socket was meticulously debrided (Figure 21). The furcation side of the restoration was examined and finished to remove any spurs or rough surfaces (Figure 22). Once the site was completely debrided, it showed clearly the extent of the defect (Figure 23). Despite the use of a rubber dam and proper isolation to prevent metal and gold shavings from accumulating in the defect, some gold shaving did accumulate. A radiograph was obtained to verify the quality of the root amputation and the site debridement prior to augmentation and surgical suturing (Figure 24). The defect was filled with the natural bone substitute, BioOss (Geistlich Pharma AG), and covered with a BioGide resorbable bilayer membrane (25 × 25 mm, Geistlich Pharma AG) for blood clot and graft protection. The socket bone was adjusted to assure primary flap closure, and the flap was repositioned with confidence that the membrane was completely covered. Sutures (4-0 Vicryl [polyglactin 910], Johnson & Johnson) were placed, assuring primary closure. The tooth occlusion was adjusted to prevent contact with the opposite dentition. Postoperative surgical care instructions were given; amoxicillin (500 mg bid for 5 days) and ibuprofen (600 mg qid for 5 days) were prescribed. Sutures were removed 7 days later.

In July 2008, 5 months after the interim endodontic implant site preparation, the patient showed rapid healing. A decision was made to proceed to immediate implant placement by extracting the distal root of tooth no. 30 and placing an implant (Figure 25). A recall radiograph was obtained 8 months after implant placement and 1 year after interim surgical endodontics (February 2009) (Figure 26). The final implant restoration was placed in July 2009 (Figures 27 and 28).

**Case no. 5**

**Interim surgical endodontic implant site preparation to eliminate infection and regenerate and increase apical bone height to avoid incisal canal foramen and nasal cavity floor (tooth nos. 8 and 9)**

**Patient Report**

A 40-year-old male patient was referred for the management of endodontic treatment failure on tooth nos. 8 and 9. The patient was previously informed of the hopeless condition of the 2 teeth and decided to seek alternative treatment. The patient was a practicing attorney with an excellent medical and dental condition and normal social and personal history. The patient’s chief complaint was chronic pain and swelling on these teeth. The patient reported a lengthy history of trauma, restorative, nonsurgical, and surgical endodontic treatment for 15 years.

**Radiographic Report**

The periapical radiograph of tooth nos. 8 and 9 (Figure 27) showed 2 porcelain-fused-to-metal restorations with short post and failing endodontic treatment. The root end of the teeth had substandard retro-fillings. Two large periapical and periradicular lesions were evident and seemed to interconnect. The periradicular defect on tooth no. 9 appears to have destroyed the midline interproximal bone.

**Response Testing and Restorative Report**

Periodontal probing of tooth nos. 8 and 9 showed an 11-mm isolated defect limited to the midbuccal and the midline area of both teeth. The palatal periodontal probing was a normal 2–3 mm. The palpation test on the periapical area of tooth no. 9 elicited severe painful response and the area felt tender to touch. The palatal palpation test was normal. The PFM restoration margins were visible due to gingival recession, and the restoration looked unesthetic. To evaluate the quality of the underlying tooth structure
and the endodontic treatment of tooth nos. 8 and 9, the area was anesthetized and the restorations were removed. The exploratory evaluation showed a well-anchored cast post on tooth no. 9 and composite build-up on tooth no. 8. The examination also revealed an inseparable crack line located at the mid-buccal surface of root no. 9. The composite build-up on tooth no. 8 was removed to evaluate the endodontic treatment, which was found acceptable. A new composite build-up was fabricated on tooth no. 8, and 2 esthetic resin full coverage restorations were made for the teeth. The occlusion of the provisional restorations was kept out of contact with the lower anterior teeth.

Patient Case Presentation

As stated earlier, the patient was previously informed by other dentists of the different treatment options for his dental condition. However, the patient decided to seek additional opinions and alternative treatment options. The patient was informed of the interim surgical endodontic approach to which he consented.

Interim Surgical Endodontic Site Preparation Procedures

The standard presurgical procedures of dental prophylaxis and antibiotic premedication were administered. The objectives of the surgery were to: (1) relieve the patient symptoms, (2) remove the infected periapical tissue and debride the defect, (3) remove the substandard retro-fillings of tooth nos. 8 and 9, and (4) modify the roots of tooth nos. 8 and 9 by performing deep apicoectomy to mid root level to make room for apical bone regeneration for implant placement away from the incisive canal foramen and the nasal cavity floor. The area was anesthetized on the buccal and palatal tissue. Presurgical probing and sounding confirmed 10- to 12-mm deep defects on the buccal of tooth no. 9 and the midline area between tooth nos. 8 and 9. Using a BP15C (Hu-Friedy) for incision, microsurgical curettes (MAR-EX3, Hu-Friedy) for gingival elevation, and a periosteal elevator (Allen P9A, Hu-Friedy) for periosteal elevation, a full mucoperiosteal intrasulcular flap was elevated on the labial of the 6 maxillary anterior teeth without the need for a vertical releasing incision. The elevation revealed a large defect on both central incisors measuring about 18 mm in width and 10 mm in height. The corresponding buccal cortical bone plate was totally eroded. The defect was outlined, curetted, and submitted for biopsy. The roots for both teeth were visible and accessible. The defect extended apically towards the nasal cavity floor about an additional 10 mm. The defect depth measurement that extended palatally was 15–18 mm from the labial cortical plate. The midline septal bone was completely absent (Figure 27). The deep apicoectomy was performed with a 701 long surgical fissure bur. The exposed root end gutta-percha was evaluated for the sealing quality with methylene blue dye and transillumination examination. The seal was found acceptable and the gutta-percha was burnished into place under a stream of cold water. A radiograph was obtained before suture placement (Figure 28). It is important to note here that even after the surgical debridement, the size of the defect showing on all radiographs was smaller than it was in reality. The defect was packed with collagen wound dressing (Colla Cote, Sulzer Medica, Integra Life Science Corp for Zimmer Dental), and a resorbable membrane (BioGide resorbable bilayer membrane, 25 × 25 mm, Geistlich Pharma AG) was applied over the defect. The membrane encompassed 2 mm beyond the defect borders and thus kept away from the incision edges. The flap was repositioned and sutured in place assuring primary surgical closure using (4-0 Vicryl [polyglactin 910], Johnson & Johnson). Postoperative surgical care instructions were given;
amoxicillin (500 mg bid for 5 days) and ibuprofen (600 mg qid for 5 days) were prescribed. Sutures were removed 7 days later.

**Patient Follow-up**

The patient returned for follow up 4, 8, and 12 weeks later and reported no symptoms. The area exhibited excellent signs of healing. The patient was recalled 6 months later and showed excellent soft tissue healing. Slight mobility and persistence of the defect was limited to the labial of tooth no. 9, indicating an excellent resolution of the midline zone. The recall radiograph showed an excellent regeneration of the apical bone (Figure 29). The recall findings were explained to the patient, and the patient was referred back for implant placement. However, the patient preferred to wait a few additional months because he was in the process of moving to another city where he would have the treatment completed.

**DISCUSSION**

This section will review 3 points in question. First, the universal trend of immediate implant placement in intact extraction sockets and the controversy of such placement in infected extraction sockets will be addressed. The review will focus on the criteria for, indications of, advantages of, and disadvantages of this procedure. Second, the approach to interim endodontic implant site preparation will be analyzed, outlining the indications and specific details of the interim nonsurgical and surgical treatment protocols. Third, the innovative concept of the “valuable hopeless tooth” and its role in simplifying single tooth implant replacement will be reviewed.

**I – Immediate implant placement in an intact and infected extraction socket**

The implant dentistry literature indicates that immediate placement of implants in fresh extraction sockets requires an infection-free, intact alveolar socket with sufficient bone to secure the primary stability of the implant and maximal bone-implant contact. Immediate placement of implants in infected extraction sockets with defects is contraindicated and controversial. As indicated earlier, there are currently 4 treatment approaches for the management of hopeless teeth with periradicular and periapical pathology and osseous defects. Tooth extraction followed by provisional restoration and delayed implant placement frequently leads to alveolar socket collapse, crestal bone resorption, and unesthetic soft tissue loss. Flapless extraction and immediate placement of the implant in the infected site is not recommended due to 2 reasons: first, is the approach violation of the surgical principles of access, visibility, and hemorrhage control; and second, is the diagnostic limitation of the periapical radiograph in depicting the actual hopeless tooth alveolar pathology. In 4 of the 5 cases reported herein, periapical radiographs failed to reveal the nature, size, extent, or contents of the defects found surgically. Only flap elevation enabled us to identify the problem and visualize and assess the defect (Case nos. 1, 2, 4, and 5). The tissue specimens removed from the defects in Case nos. 1, 2, and 5 were biopsied as a matter of surgical protocol. Case no. 4 presented defects that were principally purulent, and therefore no biopsy was obtained. Surgical biopsy results classified all 3 defects as periapical granuloma. Clinically, however, the defect contents varied from granulomatous tissue to dense fibrous tissue to purulent content intermixed with liquefied debris. The poor relationship between alveolar bone histopathology and radiographic appearance is well documented in the literature. Only intact anatomic landmarks can be accurately depicted radiographically. The integrity of the socket lamina dura and periodontal
space outline are good indicators of intact socket bone. However, once endodontic or periodontal infection has advanced into the alveolar medullary spaces, the diagnostic accuracy of the radiograph is significantly reduced. The actual sizes of osseous defects are typically larger in reality than they appear on the radiograph. Furthermore, radiographs show only where the buccal or lingual cortical bone is perforated, where 12.5% of the bone mass is lost, or where there is a 7.1% reduction in the mineral content of the alveolar bone. Complete loss of the cancellous bone is not visible by radiography. Consequently, the periapical radiograph is not a valid method to determine defect histopathology, size, extent, and depth (Case nos. 1, 4, and 5). Due to the above limitations of the radiography, intrasocket debridement or flapless immediate implant placement in infected socket sites is risky, especially in the context of defects close to the maxillary sinus or other critical anatomic structures. Implants can be unknowingly placed in cancellous infected tissue that is masked by an intact cortex.

The third and fourth approaches are strict surgical protocols of flap elevation, defect debridement, GBR and GTR, and delayed immediate implant placement. The third is a multi-stage approach that features localized ridge augmentation and delayed implant placement. Nine months is required for the bone to heal prior to implant placement in order for the graft to mature, thereby increasing the rate of implant survival and osseointegration. The fourth approach is a surgical protocol that includes flap elevation, defect debridement, and augmentation with demineralized bovine bone. An alternative procedure features an autogenous corticocancellous graft that is harvested from the chin or retromolar trigone and covered with a barrier membrane. Both approaches are surgically sound in principle and have demonstrated clinically successful outcomes; however, their success is largely dependent on the success of the bone grafting and tissue regeneration procedures. GBR and GTR require advanced surgical skills to be performed only by experienced surgeons. The procedures also carry the risks of many complications such as maxillary sinus infection, chin paresthesia, or infection spreading to the adjacent tissue causing graft and implant rejection. In some instances, the bone loss and soft tissue dehiscence caused by GBR and GTR complications are more difficult to manage than the original problem defect. Clinical observation indicates that the larger the osseous defects, the less predictable are the outcomes of bone grafting. Nine to 12 months are needed for the bone graft to mature and the treatment outcomes to be clinically visible and stable. As demonstrated in Case nos. 1 and 2, the patients were spared maxillary sinus floor grafting. In Case no. 5 the patient was spared major autogenous chin bone grafting surgeries and free-gingival grafts, and the problem of provisionalization. Such treatments are difficult to justify to a patient who experiences no pain and still uses his or her damaged tooth. In treatment situations in which lateral augmentation was indicated (Case no. 4), the interim endodontic protocol confined the defect to the mesial segment of tooth no. 30 and reduced the extent and complexity of bone augmentation.

II – Interim endodontic concept

In this article, we propose interim endodontic implant site preparation as another alternative approach to consider in addition to the currently indicated procedures addressed above. The concept of interim endodontics is based on 3 premises. The first premise is that the majority of dentoalveolar pathologies are of pulpal and periapical etiologies, and therefore endodontic treatment is the most effective and most
logical treatment for this pathology. Endodontic treatment skills are basic dental skills that general practitioners are trained to master. Thus, interim surgical endodontics is a safe and straightforward procedure compared to autogenous bone or gingival grafting surgeries. The second premise is that the bone regenerated following endodontic treatment is normal bone, similar to the patient’s native bone, and is perhaps more suitable for implant osteointegration than the artificial materials used in grafting procedures. The third premise is that not all hopeless teeth are useless. The majority of hopeless teeth can be treated and transitionally maintained to serve preventive, therapeutic, or esthetic purposes and can be extracted once the purpose is served.

The interim endodontic implant site preparation protocol can be nonsurgical (Case no. 3) or can involve surgical endodontics (Case nos. 1, 2, 4, and 5). The patient case presentation is a very important part of the interim endodontic protocol and focuses on the following points: (1) the specific problem that made the patient’s tooth hopeless, (2) the risks and benefits of each treatment approach discussed in this article, (3) the transitional and exploratory nature of the interim endodontic nonsurgical or surgical treatment, (4) the possibility of aborting the operation or extraction of the tooth, and (5) the full explanation of procedure details and documentation of the patient’s consent to treatment.

III – Interim nonsurgical endodontics

In Case no. 3, in spite of the “restoratively hopeless” condition of tooth no. 19, the patient’s symptoms subsided within days following endodontic treatment. The buccal defect showed significant resolution within 4–6 weeks, and disappeared clinically within 3 months following the interim endodontic treatment. In the absence of such signs of improvement, nonendodontic etiology should be investigated, and interim surgical endodontic therapy should be undertaken to identify and eliminate the problem by root amputation, or tooth hemisection, as in Case no. 4 (tooth no. 30).

IV – Interim surgical endodontics

Hopeless teeth with radiographically acceptable quality endodontic therapy, endodontic post, and coronal restoration (eg, Case nos. 1, 2, 4, and 5) represent the most common and favorable indications for interim surgical endodontics, especially if the hopeless tooth is in the esthetic zone or in close proximity to the maxillary sinuses (Case nos. 1 and 2), incisive canal foramen, nasal cavity floor (Case no. 5), or the mandibular inferior alveolar nerve (Case no. 4). The labial cortical plate is thin and in close proximity to the infected root apex. The labial plate therefore is usually the anatomy that is most affected by pulpal and periapical pathology. The full buccal intrasulcular mucoperiosteal flap elevation was the most effective flap design to assure surgical access and expose defects in the labial or buccal cortical plates. This flap design also provided access to adjacent teeth and permitted evaluation of the esthetic need for osseous contouring of the involved quadrant. The vertical incision was made distal to the tooth to keep the operative site clear from hemorrhage and to assure containment of the barrier membrane away from the edges of the flap and oral environment contamination.

When a barrier membrane is used to cover a periapical defect, the placement of
opaque osteoconductive material into the apical osseous defect is not advised. This is to allow the normal regeneration of native bone necessary for histologic osteointegration and to allow radiographic monitoring of the bone regeneration progress (as in Case nos. 1, 2, and 5). However, augmentation materials and barrier membrane are recommended for multiple-wall defects (as in Case no. 4). Primary surgical closure was most essential for successful and complication-free postsurgical healing. Most postsurgical complications are caused by faulty surgical suturing methods. Patients were recalled after 3 months for clinical assessment and fabrication of new provisional restorations (Case no. 1). These provisional restorations ensured excellent marginal integrity, good retention, good interproximal contacts, proper contours, and soft tissue support. Recall radiographs should be obtained at 6, 9, and 12 months after interim endodontics, and the site should be evaluated for suitability for extraction and immediate implant placement.

**V - The hopeless tooth question**

The successful outcomes of interim endodontic treatment on the 6 hopeless teeth reported in this article raise questions about the common practice of random extraction of hopeless teeth and the associated GBR and GTR procedures that are currently so prevalent in implant therapy. Hopeless teeth planned for implant replacement rarely undergo detailed clinical examination. Their evaluation is usually brief, visual, or radiographic, and is focused on factors that support tooth extraction due to the treatment complexity, cost, and long-range prognosis. Little consideration is given to the consequences of the tooth extraction procedure, which often results in larger osseous defects. The clinical results of these cases indicate a need to review hopeless tooth definition and management in implant dentistry. Tooth restorability, periodontal support, and the long-range treatment prognosis are the traditional clinical guidelines used to describe a tooth as hopeless. Hopeless teeth are classified as restoratively hopeless, endodontically hopeless, periodontally hopeless, or structurally hopeless. Unfortunately, this tooth-oriented classification is of little value to the clinician planning hopeless tooth extraction and implant replacement because the implant placement procedure is dependent on the condition of the hopeless tooth socket and not to the condition of the tooth itself.

An implant therapy-oriented and hopeless tooth socket-based classification is therefore suggested as follows:

- Class I: Hopeless tooth with intact socket.
- Class II: Hopeless tooth with periapical socket defects.
- Class III: Hopeless tooth with periradicular socket defects.
- Class IV: Hopeless tooth with periapical and periradicular socket defects.

As indicated earlier there is universal agreement that hopeless teeth with intact alveolar socket Class I can be managed by extraction and immediate implant placement. However, Class II, III, and IV hopeless teeth should not be routinely extracted. Rather, such teeth should be evaluated to determine whether the hopeless tooth problem can be treated and controlled by interim therapy or the tooth should be extracted to stop the damage it is causing to the alveolar ridge bone. Such evaluation is essential prior to any hopeless tooth extraction.

**VI - Hopeless tooth assessment**

This article used the 4R operational diagnosis protocol used at PAADI. The protocol features 4 areas for diagnostic data collection: (1) report of the patient, which focuses on the patient’s chief complaint, and medical, dental, social, and personal histories; (2)
radiographic report, which focuses on the tooth structure, the socket lamina dura, periodontal space, periradicular and periapical bone, and the size and opacity of the osseous defect; (3) response testing, which focuses on the dental pulp responses, periodontal responses, and periapical responses to the application of different stimuli such as thermal, physical, probing, percussion, palpation stimulation, or testing measures; and (4) restorative report, which focuses on the tooth restorative condition and its structural integrity such as large cavities, dentinal cracks, fractures, and anomalies. Once the dental pulp response test is completed, it is advisable to anesthetize the tooth to carry on the periodontal probing, periodontal sounding, and other exploratory operative procedures, such as restoration removal, caries removal, and pulp chamber debridement.

The hopeless teeth periradicular and periapical osseous defects are mainly caused by endodontic disease, periodontic disease, or root structure damage. The osseous defects caused by endodontic etiology are usually isolated, deep and narrow, and limited to one root surface, keeping the tooth firmly attached to the unaffected socket walls and without any pathologic mobility. These defects respond rapidly to interim endodontic treatment, the patient symptoms resolve within days of endodontic treatment initiation, and the defect regenerates within 3 to 6 months following the endodontic treatment (Case no. 3). The osseous defects caused by periodontic disease etiology are usually generalized, deep and wide, and involve more than one root surface, thus, causing pathologic tooth mobility. These defects do not respond to interim endodontic therapy and should be evaluated for orthodontic extrusion or extraction, GBR, GTR, and delayed implant placement. The osseous defects caused by tooth or root structure damage or fractures are usually isolated, deep, and narrow when the root crack or the fracture is partial, incomplete, or limited to 1 root surface (Case nos. 1, 2, and 5). However, when the fracture is a complete vertical fracture, the defect then will be multi-surface involving all the socket walls surrounding the fractured root. The buccolingual fracture causes the damage and eventual loss of the buccal and lingual cortical plate (Case no. 4), and the mesiodistal fracture causes the damage and eventual loss of the interproximal septal bone. In multi-rooted teeth, these defects respond rapidly to surgical removal of the damaged structure, the furcation perforation (Case no. 1), and the fractured root segments (Case no. 2) or root amputation and defect debridement (Case nos. 1 and 4). In single rooted teeth, the complete vertical root fractures are best evaluated for extraction GBR, GTR, and delayed implant placement.

VII - The role of the hopeless tooth

In 1988, Hall defined hopeless teeth as teeth that cannot be treated with a reasonable chance of elimination or even control of a dental problem: “Such teeth are not always extracted, and in some situations may be retained for periods as long as several years.”

The concept of maintaining hopeless teeth for therapeutic or functional purposes has existed in periodontal therapy for years to treat periodontal defects, improve mobility, and maintain compromised dentition. Another valuable use of hopeless teeth occurs during orthodontic extrusion, as reported by Salama, to “manipulate ‘hopeless teeth’ to modify their local defect environment, thereby, enhancing the predictability of subsequent implant placement differential at these sites.”

While all 6 teeth reported in this article were restoratively, endodontically, and structurally considered hopeless, the interim endodontic treatment outcomes proved
otherwise. These hopeless teeth played a role in changing the overall direction of the patient’s dental care and served valuable biologic, preventive, and esthetic functions. The infections of all 6 dental socket sites were eliminated, and alveolar defects were regenerated with the patient’s own bone. This enabled placement of the implant without involvement of the maxillary sinus (Case nos. 1 and 2) or the inferior mandibular canal (Case no. 4). The augmentation and or the barrier membrane procedures used in (Case nos. 2, 4, and 5) were minimized because the defect was kept small. By keeping the clinical crown in the socket during the regeneration period, the dental space and crestal bone were protected from the bone collapse and atrophy that usually follow extraction and delayed implant placement. Finally, and most importantly, the implant placement procedures were significantly facilitated by atraumatic extraction (of the remaining segment of tooth no. 5 in Case no. 2, the buccal roots of tooth no. 14 in Case no. 1, and the distal root of tooth no. 30 in Case no. 4), which enabled proper, safe, and restoratively-oriented positioning of the implant (Case nos. 1, 2, and 4) away from the maxillary sinus and inferior alveolar mandibular canal or the incisive canal foramen and nasal cavity floor (Case no. 5).

The clinical implications of this case report reemphasize the value of alveolar bone preservation in dental patient care. A bone thickness of 1–2 mm in the anterior zone often makes the difference between esthetic and unesthetic implant placement and restoration. The same bone thickness in the posterior zone will frequently make the difference between safe and unsafe implant placement. Bone loss is preventable by early treatment of endodontic and periodontal pathologies. Another implication is that hopeless teeth should not be extracted without comprehensive assessment of the problem that rendered the tooth hopeless. The possibility of controlling or treating this problem and reversing its consequences should always be considered. The clinical results and the unexpected complications of hopeless tooth extraction should always be anticipated and accounted for in advance. Based on the above premise, the clinician must always evaluate each treatment option in terms of risks and benefits, and select the treatment approach that minimizes risks of complications and failures, and maximizes treatment success.

**Conclusions**

The reported cases have clinically demonstrated that interim endodontic implant site preparation, when performed properly on infected hopeless teeth with periapical and periradicular osseous defects of endodontic or root fracture etiology, will (1) eliminate the hopeless tooth infection, (2) regenerate the bone of the osseous defects, (3) provide an esthetic and natural provisional restoration, (4) preserve the socket and the dental space while the osseous defects are healing, (5) prepare the treated or modified hopeless tooth for atraumatic extraction, (6) reduce the need and simplify the GBR and GTR procedures, and (7) facilitate safe and proper immediate implant placement.

**Abbreviations**

GBR: guided bone regeneration
GTR: guided tissue regeneration
PAADI: Price AbdulRahman Advanced Dental Institute
FPD: fixed partial denture

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