Case Series

Sinus Floor Elevation Via the Maxillary Premolar Extraction Socket With Immediate Implant Placement: A Case Series

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Background: When immediate implant placement is considered for teeth with close proximity to the sinus floor, apical extension of the osteotomy is significantly limited, and often a staged approach is used. Implant placement into fresh extraction sockets and sinus floor manipulation using bone-added osteotome sinus floor elevation with implant placement are techniques most often used independently or sequentially. Very few reports have described the combined use of immediate implant placement in fresh sockets and the bone-added osteotome sinus floor elevation technique.

Methods: We present five cases in which a maxillary premolar was extracted and an implant placed into the extraction site with simultaneous abfracture of the sinus floor using osteotomes. All teeth were extracted atraumatically, and sockets carefully debrided and checked for integrity of the walls. After ideal osteotomy preparation, particulate bone graft was placed in the osteotomy and appropriately sized osteotomes were used for sinus floor elevation. After sufficient elevation, implant placement was completed and particulate bone was packed in the bone–implant gap when indicated.

Results: All implants were restored after a minimum healing period of 6 months. At the time of final restoration, bone was seen surrounding the implants from the apical portion to the most coronal thread. All five implants healed without complications and were in function for periods ranging from 6 to 12 months.

Conclusions: Immediate implant placement with simultaneous osteotome sinus floor elevation is an advantageous combination of two successfully used techniques. This combined approach can significantly reduce the treatment time for implant therapy in teeth with close sinus proximity and provide the operator with the ability to place implants of desired length. J Periodontol 2011;82:820-828.

KEY WORDS
Bone regeneration; dental implants, immediate; grafting, bone; maxillary sinus/surgery; osseointegration; osteotomy.

The traditional approach to implant placement, as described by Bråne- mark, recommended a 12-month healing period after tooth extraction.1 This, combined with the recommended 3- to 6-month period for implant healing, often results in prolonged treatment time. To reduce this treatment interval, Lazzara2 reported on implants placed into fresh extraction sites. Since then, implant placement in extraction sockets in combination with bone grafts and barriers has been well documented.3-6 During immediate implant placement, primary stability is achieved by preparing the osteotomy to engage the lateral walls and the native bone apical to the extraction socket. However, in many instances, apical extension of the osteotomy is limited because of the proximity of the maxillary sinus.

Sinus floor elevation (SFE) techniques facilitate placement of longer implants in the presence of reduced bone height. The Summers osteotome SFE7-9 technique was a modification of the traditional lateral approach for SFE, which offered the advantage of reduced morbidity,10 shorter clinical time,11 and reduced postoperative discomfort.12 The bone-added osteotome SFE (BAOSFE) technique is the addition of a bone graft into the...
osteotomy. The addition of the bone graft is thought to provide some cushioning during abfraction and membrane elevation, thereby reducing the risk for membrane perforation.9

When immediate implant placement is considered for teeth in close proximity to the sinus floor, a two-stage approach is often followed. In many instances, extraction followed by ridge preservation with or without SFE is the first step. Placement of an implant fixture is usually attempted after a suitable healing period. Simultaneous BAOSFE and immediate implant placement would greatly shorten the total treatment time while providing the operator the benefit of placing longer implants. In this article, we present a case series in which five implants have been placed in fresh extraction sockets with simultaneous SFE. We also present a decision tree (Fig. 1) aimed at helping practitioners determine the ideal sequence for using this treatment combination.

MATERIALS AND METHODS

Five consecutive patients (three male and two female), aged 46 to 58 years, presented for implant evaluation, from June 2007 to March 2009. Each patient required extraction of a maxillary premolar for varied reasons (Table 1; Figs. 2 through 6). The prognosis of the specific tooth (two first premolars and three second premolars) was discussed with the patient and the necessity for BAOSFE including risks of membrane perforation was thoroughly explained. Written informed consent was obtained for extraction of the tooth, BAOSFE, and implant placement from all five patients.

Careful presurgical evaluation was completed for all patients including a detailed health history questionnaire. All patients were current non-smokers, although two of the patients reported smoking in the past. Site-specific evaluation included periapical radiographs (Fig. 4A) taken using the paralleling axis technique or panoramic films. The distance between the root apex and sinus floor was measured using a ruler and standard periapical films (Table 2). Oral prophylaxis and scaling and root planing were completed and active carious lesions, if present, were treated. All patients were started on preoperative antibiotics 3 days before the procedure, and an over-the-counter nasal decongestant 1 week preceding the surgery.

All procedures were performed under profound local anesthesia. Sulcular incisions were made around

Figure 1.
Decision tree for determining ideal treatment sequence when using the combined techniques of immediate implant placement with simultaneous BAOSFE.
the tooth with a 15C blade and extended one tooth anteriorly and posteriorly when necessary (see supplementary video in online Journal of Periodontology). Periotomes were used to begin widening the periodontal ligament space. Straight elevators were then used to further luxate the tooth, which was removed using gentle rotational movement. The socket was carefully debrided and flushed with sterile saline multiple times before initiating implant placement. A periodontal probe was inserted into the depth of the socket and moved in a circular fashion to confirm the integrity of the socket walls using tactile sensation. The depth of the socket was used as the working length when <1 mm of native apical bone was present. When additional bone height was available, the osteotomy was prepared to 1 mm short of the sinus floor. Interradicular bone, when present, was preserved. Osteotomy preparation was started using a pointed twist drill engaging the palatal slope of the interradicular bone and enlarged using sequentially wider drills. In single-rooted premolars, ideal bucco-palatal positioning of the implant was maintained (Fig. 3B). When the osteotomy was enlarged to final dimension, a plug of bone graft (Table 2) was placed in the osteotomy. The sinus floor was carefully abfractured using appropriately sized osteotomes and gentle malletting. The Valsalva maneuver was performed on multiple occasions to detect any oroantral communication, and in all of our cases, no oroantral communication was noted. This procedure was repeated until sufficient elevation of the sinus membrane was achieved. Intraoperative radiographs were taken to confirm sinus floor abfracture, containment of the graft material (Fig. 4B), and adequacy of elevation after which the implant was placed (Figs. 2C, 3C, 4C, and 5B). Primary stability was confirmed with tactile sensation. The bone–implant gap was measured (Fig. 4D) and when found to be >1.5 mm, additional bone graft was placed on the buccal aspect of the implant. Buccal augmentation was required for all implants. The buccal and palatal flaps were then sutured with interrupted sutures. Healing abutments were placed at the time of implant placement for two patients or a second-stage procedure was completed 5 to 6 months later for the remaining three patients (Table 2). Detailed written and verbal postoperative instructions were given. All patients were prescribed an appropriate analgesic and antibacterial mouthrinse. Patients were instructed to refrain from vigorously blowing air from the nose or sneezing through the nose, and were seen for follow-up appointments at 2 weeks, 2 months, and 5 months.

Before final restoration, periapical radiographs showed increased radiopacity in the area immediately apical to the implant fixture. No crestal bone resorption was seen. Reformation of the sinus floor (Fig. 4E) with uniform increased radiodensity and absence of any radiolucent areas around and apical to the implants were seen. Bone gain ranging from 1 to 4 mm was obtained. All implants were restored by non-splinted single implant supported crowns (Figs. 2D, 2E, 3D, 3E, 5C, and 6C). All patients have been placed in a recall program that includes regular professional oral hygiene and dental screenings.
RESULTS

A total of five patients were treated with extraction of the first or second premolar, BAOSFE, and immediate implant placement. All implants were stable and functioning well during a follow-up period of 6 to 12 months, resulting in a survival rate of 100%. The various reasons for extraction, presence or absence of radiographic periapical pathology, or smoking habit (Table 1), had no impact on the successful outcome of the procedures. For all patients healing of the surgical site occurred without any complications.

Table 2 illustrates the different bone grafting materials that were used. Preoperative distance from root apices to the sinus floor ranged from <1 to 2 mm. Implant lengths ranged from 12 to 13 mm and four of the five implants were restored after a 6- to 9-month healing period. One implant (Case 1) was restored at 14 months because of financial limitations. Buccal bone augmentation after immediate implant placement was required for all implants because the bone–implant distance was >1.5 mm. In three of the five implants a second-stage procedure for placement of healing abutments was performed at 4 to 5 months and the other two implants were treated as single stage. Placement of a healing abutment at the time of implant placement did not seem to negatively impact successful integration.

The radiographs taken before restoration show no evidence of crestal bone loss around the implants with dense bone extending apical to all implants. The distance from the sinus floor to the apex of the teeth when measured on the periapical radiograph was 1 to 2 mm. At the time of final restoration, bone was seen surrounding the implant from the apical portion to the most coronal thread.

Primary stability (detected using tactile sensation) was achieved at placement for all implants. No mobility (detected using tactile sensation) was present when the final restorations were delivered at least 6 months after implant placement.

In this case series we present five cases that were treated using the BAOSFE and immediate implant placement techniques. In all cases, the walls were intact and we were able to obtain primary stability with concurrent sinus elevation successfully.

DISCUSSION

Many reports have attested to the long-term success of BAOSFE procedures, but the amount of bone gain obtained has varied significantly. Fugazzotto reported a mean bone gain of 3.5 mm with a range of 1 to 7 mm. A human cadaver study was conducted by Reiser et al. They used a 2-mm twist drill for osteotomy preparation, which terminated within 1 mm of the sinus floor. The authors report predictable SFE of 4 to 5 mm and sometimes elevation of 6 to 8 mm was observed. BAOSFE using endoscopy was conducted by Nkenke et al. The purpose of using an endoscope was for visualization of membrane perforations and they recommended only a 3-mm elevation for procedures done without the use of endoscopy. In our cases we have found SFE of 3 to 7 mm at the time of SFE, which eventually translated into bone gain of 1 to 4 mm at the time of restoration. It is widely accepted that periapical radiographs provide only two-dimensional representation of clinical anatomy and therefore use of three-dimensional radiography provides the most accurate measurement of vertical bone gain.

When SFE is attempted via extraction sites in the posterior maxilla, a two-step approach to SFE and implant placement has been recommended by many authors. Fugazzotto reported on 109 SFE procedures performed in 92 patients who needed either a first or second molar extracted. A calibrated trephine...
which was large enough to include the entire interradicular septum and 50% of the extraction socket, was used to prepare the site 1 to 2 mm short of the sinus floor. A suitable osteotome was used to implode the trephined core and the sinus membrane. The extraction socket was filled with a xenograft and covered with resorbable and non-resorbable barriers. After a sufficient healing period, 101 implants were placed at these sites. The author reported that the combination of SFE and guided bone regeneration performed at the time of extraction resulted in regeneration of an adequate amount of bone that would allow the placement of implants at least 10 mm long and 4.8 mm wide. In a follow-up to the previous study, Fugazzotto and De22 published results of 167 implants placed into sites where SFE was performed at the time of molar tooth extraction. Only two of the 167 implants failed to integrate resulting in a cumulative success rate of 98.2%.

Implant placement in fresh extraction sites is a recent advancement, but the success of this technique has been well documented. A key factor for achieving implant success is primary stability and immobility. Early mobility of implants significantly impacts clinical success.23 Becker et al.24 published reports on implant placement in conjunction with non-resorbable barrier membranes. After 5 years, a survival rate of 93.3% was reported. Many others have also reported on the predictability of this technique.5,6,25-28

The presence of chronic periapical and periodontal infection during immediate implant placement presents a concern about possible infection of the implant. However, a systematic review of human and animal studies pertaining to immediate implant placement into sites with periapical infection was conducted by Waasdorp et al.29 and the authors concluded that implant survival in infected sites was consistent with those placed in non-infected sites. Twelve publications (eight human and four animal studies) were examined. Implant survival in the infected sites of human studies ranged from 92% to 100%. Histologic evidence from the animal studies points to similar bone–implant contact in infected and non-infected sites. The use of antibiotics was reported in most studies included in this review. Some have reported starting antibiotics 1 hour before surgery and continuing it for 5 days30 postoperatively, whereas others have used antibiotics for periods ranging from 7 to 23 days.31 Implant placement in the presence of periodontal disease has been studied. In a report by Tözüm et al.,32 SFE was performed via the extraction socket in a periodontally involved molar tooth. The authors presented a case in which radiographic investigations revealed absence of native bone between...
the apical aspect of the tooth and the floor of the maxillary sinus with thickening of the Schneiderian membrane. SFE using bovine bone and synthetic hydroxyapatite was performed 4 weeks after extraction through the extraction site. After a 4-month healing period, two 12-mm implants were placed and restored 6 months later. In our case series, radiographic evidence of periapical radioluencies was evident in two cases. In both cases, thorough debridement of the socket was conducted, and the patients were prescribed antibiotics preoperatively and covered with antibiotics postoperatively for a period of 7 to 10 days. The findings of our case series are consistent with the systematic analyses, and we found that the patients with periapical pathoses had equally successful outcomes as those without periapical abnormalities.

Although both the techniques of BAOSFE and immediate implant placement are well established and documented, reports on the combined use of BAOSFE in fresh extraction sites with immediate implant placement are scarce. We found only two reports that have described immediate implant placement in conjunction with SFE.33,34 Artzi et al.33 described the placement of 12 wide-diameter implants in conjunction with internal sinus lift in molar extraction sites. The average preoperative residual bone height was 7.8 mm; after BAOSFE using bovine bone was performed at 10 of 12 sites, a bone gain of 4.3 mm was recorded. The authors reported microperforation at three sites; however, this did not influence implant healing. The prosthetic phase was completed 6 months after implant placement, and a 2-year follow-up of these patients revealed good stability and support of the implants and prosthesis. Another case series was presented by Barone et al.34 Twelve patients who each required extraction of a maxillary premolar and were scheduled for immediate implant placement were included. Preoperative bone height, as measured from the alveolar crest to the sinus floor, ranged from 6 to 10 mm. The length of implants ranged from 10 to 13 mm, and bone gain at the end of 18 months ranged from 3 to 5 mm. Of the 12 implants placed, one implant failed in the initial healing phase, but all other implants healed uneventfully and were functioning at the 18-month postoperative evaluation. The results from our case series compare favorably to the two other studies that have described the combined mode of treatment. We performed BAOSFE in all five patients, but did not experience any sinus...
membrane perforations. All implants had initial stability at the time of placement, and were functioning well for a follow-up period of 6 to 12 months after restoration.

There are many advantages to using a combined approach in patients requiring immediate implant placement in the presence of sinus proximity. The use of the BAOSFE technique allows for lateral and vertical expansion of the socket and facilitates placement of wider and longer implants. The reduced treatment time is another significant advantage. However, there are several clinical variables, such as integrity of the alveolar housing, sinus proximity, primary stability, and bone–implant distance, which impact the decision-making process. We developed a decision tree (Fig. 1) that was used for all cases presented in this series. Because this procedure is performed in one surgical visit, the operator’s chair time and patient visits are greatly reduced.

### Table 1.
**Patient Demographics, Smoking and Medical History, and Assessment of Implant Sites**

<table>
<thead>
<tr>
<th>Case</th>
<th>Age, Sex</th>
<th>Tooth</th>
<th>Reason for Extraction</th>
<th>Medications</th>
<th>Smoking History</th>
<th>Radiographic Periapical Pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 (Fig. 2)</td>
<td>49, M</td>
<td>#5</td>
<td>Severe fracture of lingual cusp</td>
<td>None</td>
<td>Former smoker (17 packs per year)</td>
<td>Absent</td>
</tr>
<tr>
<td>#2 (Fig. 3)</td>
<td>50, F</td>
<td>#4</td>
<td>Inadequate clinical tooth structure for crown retention</td>
<td>None</td>
<td>Negative</td>
<td>Present</td>
</tr>
<tr>
<td>#3 (Fig. 4)</td>
<td>54, F</td>
<td>#13</td>
<td>Inadequate clinical tooth structure for crown retention</td>
<td>None</td>
<td>Former smoker (30 packs per year)</td>
<td>Absent</td>
</tr>
<tr>
<td>#4 (Fig. 5)</td>
<td>46, M</td>
<td>#4</td>
<td>Severe recurrent decay extending subgingivally</td>
<td>Oxycodeone and acetaminophen for back pain</td>
<td>Negative</td>
<td>Absent</td>
</tr>
<tr>
<td>#5 (Fig. 6)</td>
<td>58, M</td>
<td>#13</td>
<td>Severe recurrent decay extending subgingivally</td>
<td>Lisinopril atenolol</td>
<td>Negative</td>
<td>Present</td>
</tr>
</tbody>
</table>

### Table 2.
**Root Apex to Sinus Floor Distance, Type of Bone Graft, Implant Dimension, Surgical and Restorative Time Line**

<table>
<thead>
<tr>
<th>Case</th>
<th>Bone Graft</th>
<th>Implant Dimensions (mm) and Date of Surgical Procedure</th>
<th>Preoperative Root Apex to Sinus Floor Distance (mm)</th>
<th>Healing Abutment Inserted at Implant Placement</th>
<th>Time Between Placement and Restoration (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 (Fig. 2)</td>
<td>Allograft*</td>
<td>3.7 × 13† May 2008</td>
<td>2</td>
<td>Second stage after 6 months</td>
<td>14</td>
</tr>
<tr>
<td>#2 (Fig. 3)</td>
<td>Allograft*</td>
<td>4.7 × 13‡ December 2008</td>
<td>2</td>
<td>Single stage</td>
<td>6</td>
</tr>
<tr>
<td>#3 (Fig. 4)</td>
<td>Allograft*</td>
<td>4 × 13‡ July 2008</td>
<td>&lt;1</td>
<td>Second stage after 6 months</td>
<td>8</td>
</tr>
<tr>
<td>#4 (Fig. 5)</td>
<td>Xenograft§</td>
<td>4.1 × 12‡ March 2009</td>
<td>&lt;1</td>
<td>Second stage after 5 months</td>
<td>9</td>
</tr>
<tr>
<td>#5 (Fig. 6)</td>
<td>Allograft¶</td>
<td>4.8 × 12¶ June 2007</td>
<td>2</td>
<td>Single stage</td>
<td>6</td>
</tr>
</tbody>
</table>

* Freeze dried bone allograft, Musculoskeletal Transplant Foundation, Edison, NJ.
† Zimmer, Carlsbad, CA.
‡ Prevail, BioMet, Palm Beach Gardens, FL.
§ Bio-Oss, Osteohealth, Wolhusen, Switzerland.
¶ Institute Straumann, Straumann Waldenburg, Switzerland.
¶ Dynablast, Keystone Dental, Burlington, MA.
CONCLUSIONS

In this series, we present cases in which BAOSFE was successfully performed with immediate implant placement in fresh extraction sites. Clinicians can follow the decision tree presented in Figure 1 to achieve successful outcomes using this combined technique. Benefits of using this combined technique include reduction in treatment time and the flexibility to place longer implants in the presence of sinus proximity. However, it is possible that when the ideal situation is not present, treatment modifications need to be made that may result in delayed implant placement.

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