Success and Failure Rates of 1,344 6- to 9-mm-Length Rough-Surface Implants Placed at the Time of Transalveolar Sinus Elevations, Restored with Single Crowns, and Followed for 60 to 229 Months in Function

Paul A. Fugazzotto, DDS

Purpose: To assess the success and stability of 6-, 7-, 8-, and 9-mm-long, 6.5-mm-wide-neck tissue-level implants placed at the time of transalveolar sinus augmentation therapy, utilizing a trephine and osteotome approach, which were restored with single crowns. Materials and Methods: In total, 1,344 implants were placed by the author, varying in length from 6 to 9 mm, with parallel-wall 4.8-mm-diameter implant bodies and 6.5-mm-diameter implant necks. The implants were restored with single abutments and crowns by a variety of practitioners. They were followed for 60 to 229 months in function, with a mean time of 121.1 months in function. Implant success was evaluated by the author utilizing a combination of the Albrektsson et al criteria, and buccal and palatal/lingual bone sounding under anesthesia. Results: The overall cumulative success rate was 98.8%. One hundred ninety 6-mm-long implants demonstrated a cumulative success rate of 97.5% at a mean time of 109.2 months in function. Eleven 7-mm-long implants demonstrated a cumulative success rate of 100% at a mean time of 218.5 months in function. One thousand ninety-four 8-mm-long implants demonstrated a cumulative success rate of 98.9% at a mean time of 112.3 months in function. Forty-nine 9-mm-long implants demonstrated a cumulative success rate of 100% at a mean time of 212.1 months in function. Conclusion: Implants of 6 to 9 mm in length, placed at the time of trephine and osteotome transalveolar sinus elevation procedures and restored with abutments and single crowns, demonstrate a high level of long-term clinical success, assuming specific comprehensive treatment criteria are met. Int J Oral Maxillofac Implants 2017;32:1359–1363. doi: 10.11607/jomi.6204

Keywords: implant success, osteotomes, shorter implants, sinus augmentation, trephines
longer-term success and failure rates for implants placed utilizing a trephine and osteotome transalveolar augmentation technique potentially offers valuable information to the clinician.

**MATERIALS AND METHODS**

Following a thorough review of medical histories, patients were deemed unsuitable to receive transalveolar sinus augmentation and implant therapy based upon the following exclusion criteria:

- Uncontrolled diabetes, autoimmune diseases, a history of intravenous bisphosphonate therapy, or other contraindicating systemic conditions
- Radiation therapy to the head and neck region in the 12 months prior to proposed therapy
- Chemotherapy in the 12 months prior to proposed therapy
- Patient unwillingness to undergo comprehensive, multidisciplinary, dental therapy, including management of parafunction
- Uncontrolled periodontal disease
- History of persistent sinus infections, or an active sinus infection
- A smoking habit of greater than 10 cigarettes per day
- Unwillingness to commit to the prescribed long-term post-active therapy maintenance program

Periapical radiographs were obtained for patients treated before 2002. Cone beam computed tomography (CBCT) scans were obtained for patients treated from January 2002 to the completion of the retrospective study. Diagnostic casts, face bow mountings, diagnostic wax-ups, and surgical templates were employed as necessary. A thorough examination of oral hard and soft tissues and head and neck musculature was carried out for each patient. An overall treatment plan was formulated in conjunction with all other treating dentists.

A total of 1,344 sites were treated in 1,305 patients. Of these patients, 725 were women (56%), and 580 were men (44%). All surgical therapy was performed by the author, as were preoperative and postoperative measurements and assessment of implant success or failure.

The surgical technique of trephine and osteotome transalveolar sinus augmentation, with simultaneous implant placement, as well as postoperative management and healing time have been previously described. All treated sites presented with between 4 and 6 mm of residual bone crestal to the floor of the sinus. The size of the implant that was placed was in all instances no greater than 2x–2, with x being the amount of bone crestal to the floor of the sinus prior to osteotomy preparation and implant placement. Only rough-surface implants were placed.

All implants were restored with individual abutments and crowns.

The definition of implant success utilized was a combination of the Albrektsson et al criteria, and bone sounding on the midbuccal and palatal/lingual aspects of the implants, to ensure that peri-implant bone levels had remained stable.

Progressive bone loss on any aspect of the implant greater than 0.2 mm annually after the first year of implant placement rendered classification of the implant as a failure, despite the presence or absence of implant mobility.

**RESULTS**

A total of 1,344 implants were placed in 1,305 patients, following transalveolar apical positioning of the sinus membrane through a combined trephine and osteotome technique. Implants were followed for 60 to 229 months in function. The followed implants included 97 of the 116 implants reported upon in a previous publication. The remaining patients previously reported upon were deceased or could not be brought back for assessment of implant success due to relocation or other factors. The two implants that were mobile at the time of uncovering and reported upon previously were not included. No implants placed since January 2002 were mobile at the time of uncovering.

The overall implant cumulative success rate at 60 to 229 months in function, with a mean time of 121.1 months in function, was 97.2%. One hundred ninety-six mm-long implants reported a cumulative success rate of 97.5% at a mean time of 109.2 months in function. Eleven 7-mm-long implants demonstrated a cumulative success rate of 100% at a mean time of 218.5 months in function. One thousand ninety-four 8-mm-long implants demonstrated a cumulative success rate of 98.9% at a mean time of 112.3 months in function. Forty-nine 9-mm-long implants demonstrated a cumulative success rate of 98.9% at a mean time of 112.3 months in function.

**Table 1 Implant Distribution and Time in Function**

<table>
<thead>
<tr>
<th>Implant length (mm)</th>
<th>60–71</th>
<th>72–83</th>
<th>84–95</th>
<th>96–107</th>
<th>108–119</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>10 (1)</td>
<td>17</td>
<td>17</td>
<td>10</td>
<td>18 (1)</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>136 (1)</td>
<td>140</td>
<td>130 (1)</td>
<td>139 (3)</td>
<td>117</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>146 (2)</td>
<td>157</td>
<td>147 (1)</td>
<td>149 (3)</td>
<td>135 (1)</td>
</tr>
</tbody>
</table>

© 2017 BY QUINTESSENCE PUBLISHING CO, INC. PRINTING OF THIS DOCUMENT IS RESTRICTED TO PERSONAL USE ONLY. NO PART MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM WITHOUT WRITTEN PERMISSION FROM THE PUBLISHER.
The cumulative success rate of 100% at a mean time of 212.1 months in function (Tables 1 to 4).

**DISCUSSION**

The challenges facing clinicians anticipating reconstruction of the edentulous posterior maxilla have been well documented.6–9 These challenges include ridge atrophy and resorption in a buccal-palatal dimension, sinus pneumatization, and often a poorer quality of bone than is encountered in other areas of the mouth. It is well accepted that the utilization of rough-surface implants significantly enhances bone-to-implant contact following attainment of osseointegration.

In addition, if shorter implants may be utilized without sacrificing long-term implant success rates and...
patient function, the need for lateral wall sinus augmentation therapies will be lessened, allowing the clinician to either utilize a transalveolar augmentation approach or place shorter implants that obviate the need for sinus augmentation therapy of any type.

Numerous authors, including Lai et al,\textsuperscript{10} have demonstrated, through finite element analysis, that force application to implants results in the greatest force concentration being present at the peri-implant crestal bone.\textsuperscript{\textit{11-15}} Holmgren et al,\textsuperscript{12} Himmlová et al,\textsuperscript{13} Pierrisnard et al,\textsuperscript{14} and Lee et al\textsuperscript{15} found that the stress to the peri-implant crestal bone was independent of implant length.

A number of clinical studies have documented successful utilization of shorter implants, and a lack of correlation between implant length and implant survival.\textsuperscript{\textit{16-22}} The results of this retrospective analysis further confirm the efficacy of the use of short implants in the maxillary posterior region, specifically following transalveolar augmentation, reporting a success rate of 97.2\% for 1,344 shorter implants in function for a mean time of 121.1 months.

It is important to note that all therapy was carried out within specific parameters, as follows. Appropriate record taking, and comprehensive, interdisciplinary diagnosis and treatment planning were always performed. In patients treated after 2006, and any patients who remained on a regular maintenance schedule with the author’s office regardless of their treatment date, therapy included the determination of the presence or lack of parafunctional habits. These parafunctional habits were treated through a combination of occlusal equilibration, bite appliance therapy, restoration of lost tooth structure, and/or Botox injections, depending upon the time at which therapy was performed. In addition, if parafunctional habits were noted during maintenance visits or upon the return of the patient following a protracted period of having not been examined, the presence or absence of a parafunctional habit was once again assessed and treated as necessary. Lum and Osier,\textsuperscript{23,24} Lobbezoo et al,\textsuperscript{25,26} and Komiyama et al\textsuperscript{27} found in their finite element analysis studies that parafunctional forces resulted in greater force application to the peri-implant crestal bone. Miyata et al\textsuperscript{28-30} reported similar results in monkeys.

Patients had to agree to the comprehensive care proscribed by the treating clinicians. Such therapy included resolution of periodontal, endodontic, and other dental diseases, utilization of orthodontic therapy as necessary, and treatment of parafunction.

Transalveolar sinus augmentation was not employed when buccal alveolar bone augmentation was necessary. The determination of the need for such augmentation was made as follows. The ideal implant position was determined through appropriate record taking and diagnostic wax-ups. An implant of the ideal diameter for replacement of a given tooth was visualized. An additional 2 mm of buccal bone at the alveolar crest was deemed necessary to help ensure long-term peri-implant crestal bone stability. If the patient’s alveolar bone was insufficient to meet all the aforementioned requirements, buccal ridge augmentation therapy was carried out as previously described.\textsuperscript{31} In such situations, transalveolar sinus augmentation was not deemed an appropriate therapy.

All molar replacement was carried out utilizing a 4.8-mm-wide bodied implant with a 6.5-mm-wide neck diameter. Lum\textsuperscript{11} and Himmlová et al\textsuperscript{13} posited that the use of wider implants, thus increasing the bone-to-implant contact at the site of the peri-implant crestal bone, would decrease stresses applied to the peri-implant crestal bone under a given magnitude of load.

Anitua et al\textsuperscript{32} has stated that wider implants decrease stress to peri-implant crestal bone.

Only rough-surface implants were utilized in the present study. Feldman et al,\textsuperscript{33} reporting upon 5-year survival rates of 2,294 rough-surface implants and 2,259 machine-surface implants, found that the difference in cumulative survival rates between shorter and longer implants was not statistically significant, but that the difference in cumulative survival rates between smooth-surface and rough-surface implants was statistically significant.

When appropriate, transalveolar sinus augmentation utilizing a trephine and osteotome approach offers a number of advantages in the context of such reconstructive therapy, including a shorter course of therapy, simplification of therapy, a decrease in patient morbidity, and less financial burden for the patient.

The present report of 97.2\% success of 1,344 shorter implants in function for a mean time of 12.1 months demonstrates the predictability of this treatment approach. Implant success was reported upon rather than implant survival. This was accomplished by combining the Albrektsson et al criteria,\textsuperscript{9} and bone sounding of each implant on its buccal and palatal/lingual aspects, thus ensuring the long-term stability of the peri-implant crestal bone. Such assessment offers a number of advantages to both the patient and the clinician over the more traditional implant survival.

Of the 19 implants deemed failures, three were still immobile, but demonstrated approximately 50\% bone loss. In all three instances, the patients had not had dental care, including prophylaxis, for more than 5 years, and demonstrated poor homecare and extensive plaque accumulation around their natural teeth and implants. Three implants were present in one patient who had not sought any professional dental care for more than 36
months and demonstrated severe parafunctional habits and extensive wear on the natural teeth and implant restorations. Seven other implant failures in this group all occurred in patients with severe parafunctional habits. Five of the failures had been placed in patients with less than 2 mm of buccal alveolar bone at the osseous crest, prior to such augmentation being considered a prerequisite for implant placement in the molar region. Each of these implants demonstrated significant buccal dehiscences and mobility. One implant failed for no discernable reason in the 84 to 95 months in function.

CONCLUSIONS

Placement of implants following transalveolar sinus restoration utilizing a trephine osteotome approach, and subsequent restoration, is a predictable procedure that yields a high level of implant success under function. Attainment of such success is dependent upon a number of therapeutic factors.

ACKNOWLEDGMENTS

The authors reported no conflicts of interest related to this study.

REFERENCES