Immediate rehabilitation of the posterior maxilla with extensive sinus pneumatization with one axial and one trans-sinus tilted implant: A 3-year clinical report and a classification

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ABSTRACT

Implant rehabilitation of the posterior maxilla can entail difficulties due to reduced bone quantity and poor bone quality, especially after long-term edentulism. In some patients, multiple surgeries are necessary, which may lead to higher patient morbidity and longer treatment times before a prosthetic rehabilitation can be achieved. This article presents an immediate fixed prosthesis in a posterior atrophic maxilla supported by 1 anterior axial implant and 1 posterior tilted fixture placed with an intrasinus insertion. Additionally, a classification scheme for immediate treatment for the posterior maxilla based on the available residual bone is provided. (J Prosthet Dent 2015;113:163-168)

THE CLINICAL REPORT

A 65-year-old woman was referred to a private clinic (Bollate) for the prosthetic treatment of a recently edentulous area in the maxillary right quadrant. Her treatment goals were to reestablish lost function and esthetics with a fixed prosthesis, to minimize the time period without teeth, and to avoid a removable alternative to grafting. Even if those techniques provide suitable posterior anchorage, they require considerable surgical expertise. Zygomatic implants in particular are associated with increased patient morbidity. Several clinical reports have reported encouraging results with a combination of tilted and axial implants for complete-arch restorations and lately also for immediate or delayed partial fixed prostheses.

In long-term edentulism and in patients with a fixed prosthesis replacing missing teeth, extensive sinus pneumatization can occur, thus reducing the residual maxilla. Different therapeutic options have been proposed. The use of a distal cantilever to avoid posterior implant placement can be a solution, but an extension longer than 15 mm is associated with reduced survival rates versus prostheses with a shorter cantilever, and long extensions have an increased risk for mechanical and biological complications. Sinus floor elevation with a crestal or lateral approach and bone grafting have been reported to provide good long-term success. However, if less than 4 mm of residual bone height is present, delayed implant placement and loading is recommended. One alternative to grafting is to insert implants with reduced length, commonly called short implants (according to current definitions, these are fixtures shorter than 8 mm), but their long-term prognosis is still controversial, and few studies with immediate function are available. Placing implants in specific anatomic areas such as the pterygoid region, the maxillary tuberosity, or the zygoma represents another alternative to grafting. Even if those techniques provide suitable posterior anchorage, they require considerable surgical expertise. Zygomatic implants in particular are associated with increased patient morbidity. Several clinical reports have reported encouraging results with a combination of tilted and axial implants for complete-arch restorations and lately also for immediate or delayed partial fixed prostheses.

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prosthesis. Clinical examination revealed the recent loss of the first premolar and first molar and preoperative radiography showed bone loss associated with the extracted teeth and extensive coronal pneumatization of the maxillary sinus in the area of the second premolar (Fig. 1). The patient was informed about possible treatment options: sinus floor elevation with delayed implant placement and prosthetic restoration and immediate fixed prosthesis supported by 1 axial implant and 1 posterior fixture with 30 degrees of mesial inclination and intrasinus insertion. The patient chose the second option and signed an informed consent form.

After local anesthesia had been administered, a mucoperiosteal flap was raised, exposing the facial bony wall of the right maxilla. A bony window was removed by using piezoelectric inserts at the level of the sinus cavity and was stored in sterile saline solution. The Schneiderian membrane was subsequently reflected and pushed posteriorly only in the anterior portion to provide adequate space for the implant drills. Starting from the area of the first molar, the implant site was prepared with a 30-degree mesial inclination passing through the sinus cavity and proceeding in the apical portion of the bone anterior to the sinus. An 18-mm NobelSpeedy Groovy implant (Nobel Biocare AB) was inserted, finding coronal stabilization in the crestal bone and apical fixation in the portion of bone mesial to the anterior wall (Fig. 2). One NobelSpeedy Groovy fixture was placed axially in the socket of the first premolar. Both fixtures had a 4 mm diameter and reached a final insertion torque of 40 Ncm (Fig. 3). Autogenous bone taken from the tuberosity and

Figure 1. Preoperative panoramic radiograph segment showing partial fixed prosthesis in right maxilla supported by first premolar and first molar, both with evident bone loss. Extensive sinus pneumatization noted in second premolar area.

Figure 2. Anterior part of Schneiderian membrane has been reflected to make space for drills. Trans-sinus tilted implant has its intermediate portion inside sinus cavity.

Figure 3. Segment of intraoperative panoramic radiograph made before abutment placement. Anterior implant was inserted in socket of first premolar, while posterior fixture was placed in residual crestal bone and in anterior sinus wall.

Figure 4. Occlusal view of definitive partial fixed dental prosthesis.
from the mandibular ramus buccal shelf was used to fill the anterior socket and sinus cavities and completely surrounded the implant surfaces. The Schneiderian membrane was adapted over the graft, and the bony window was repositioned with bone wax. Thirty-degree and straight Multi-unit Abutments (Nobel Biocare AB) were connected over the posterior and anterior implants respectively. Three hours later, a 3-unit acrylic resin interim prosthesis was inserted, keeping slight contacts in maximum intercuspation and avoiding any lateral excursions. After 6 months, a definitive prosthesis with titanium computer-aided designed/computer-aided manufacturing framework and acrylic resin teeth was delivered (Fig. 4).

**DISCUSSION**

Here the authors present a technique for the immediate fixed restoration of the posterior maxilla in patients with reduced bone height and sinus pneumatization. The innovation of this approach is in the placement of the posterior fixture as a trans-sinus tilted implant. Thanks to the inclination and direction, a longer fixture can be inserted, engaging 3 cortical layers: the alveolar crestal bone, floor of the sinus cavity, and anterior sinus wall with its body. Therefore, the coronal and apical parts of the implant are anchored in native bone, with the apex in the context of the canine pillar. The level of primary stability is theoretically higher than conventional implant insertion with simultaneous sinus elevation. Therefore, delivering an immediate restoration is possible, resulting in reduced total treatment time and the prompt reestablishment of function and esthetics for the patient. The advantages and limitations of the technique are summarized in Table 1.

The immediate rehabilitation of the posterior maxilla may be difficult if the bone quality is poor (influencing fixture stability) and/or the sinus cavity is near the alveolar crest, thus restricting implant positioning and dimensions in the case of a graftless approach. Often, bone is present between the anterior sinus wall and the canine root. According to Lekholm,21 given a minimum of 14 mm of bone between the distal fixture and canine and a bone height of 7 mm, 2 axial implants can be placed in this zone to support 2 or 3 dental elements. On the basis of clinical evidence and the high success rates of tilted implants,19 the authors have provided details of a new surgical approach. The full bone trapezoid is the space delimited by the canine root, and the sinus cavity (with its anterior wall and sinus floor), in which 2 implants can be placed to support a 3-unit fixed prosthesis without a sinus elevation. The minimum dimensions of this rectangular trapezoid are 21 mm of major base (parallel to the bone crest), 11 mm of anterior height (parallel and immediately distal to the canine root), and 10 mm of minor base (Fig. 5).

The 90-degree angles are located at the base of the canine root, while the inclined side is facing the anterior sinus wall, sometimes appearing as tangential to it. The authors suggest inserting a posterior 15 mm regular platform (4.0 mm in diameter) fixture (NobelSpeedyGroovy) with a 45-degree inclination running parallel to the inclined trapezoid side (and therefore parallel to the anterior sinus wall), and 1 anterior axial implant of 10 mm in length parallel to the canine root (Fig. 5). Alternatively the inclination of the posterior 15 mm implant can be reduced to 30 degrees, resulting in a trapezoid of 13 mm in height, with a minor base of the same dimension and a major base of 16 mm. In the case of low

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**Table 1. Advantages and disadvantages of trans-sinus tilted implants**

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<tr>
<th>Advantages</th>
<th>Disadvantages/Limitations</th>
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<tr>
<td>Insertion of longer fixtures engaging 3 cortical layers (alveolar crest, floor of sinus cavity, anterior sinus wall).</td>
<td>Advanced surgical procedure requiring experienced surgeon.</td>
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<td>Coronal and apical part of implant find anchorage in native bone with high level of primary stability.</td>
<td>Computed tomographic scan highly recommended for correct planning.</td>
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<td>Immediate loading with reduced total treatment time.</td>
<td>Experience with site underpreparation for immediate loading and good knowledge of implant characteristics and mechanical behavior.</td>
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<td>Wider anteroposterior spread resulting in shortened or no cantilever.</td>
<td>Minimum of 4 mm of crestal bone height and 4 mm of apical bone for trans-sinus implant stabilization.</td>
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bone density, and if sufficient residual bone is available apical to this trapezoid, using longer implants can increase primary stability (Figs. 6, 7). Priority regarding positioning and inclination is given to the posterior fixture because it bears higher mastication forces. A similar concept for rehabilitating an atrophied edentulous maxilla has been described by Krekmanov et al. with cumulative success rates of 98% for tilted implants and 93% for nontilted implants.

Sometimes extensive mesial sinus pneumatization can challenge the hypothetical trapezoid. This can result in 2 different scenarios: first, the anterior sinus wall can accommodate part of the body of the posterior fixture (Fig. 8); or second, the anterior sinus wall can accommodate the entire intermediate portion (Fig. 9). In both...
situations, the surgical technique described in this clinical report for inserting a trans-sinus tilted implant could be used. In the first scenario, the distal part of the tilted implant body will face the sinus cavity while the mesial portion will contact residual bone. In the second scenario, the entire implant body will be inside the sinus. The authors suggest a minimum of 4 mm of crestal bone height and 4 mm of apical bone anchorage to achieve sufficient stabilization for the trans-sinus implant. Furthermore, using a slightly tapered implant design or a fixture with a conical tip is preferred. The narrow tip of the implants used in these procedures facilitates insertion and stabilization in the most apical part of the surgical site by working as an osteotome and also prevents the spinning effect in dense bone areas.\(^22\) Usually 15 mm site by working as an osteotome and also prevents the stabilization in the most apical part of the surgical procedures facilitates insertion and stabilization in the most apical part of the surgical site by working as an osteotome and also prevents the spinning effect in dense bone areas.\(^22\) In situations with a minimum crestal bone height of 3 mm, or in the presence of only the cortical layer, the authors imply that a stable apical bone anchorage for the trans-sinus fixture and a connection with the anterior implant by means of a rigid prosthesis can be achieved, thus avoiding bending and macromovements.

Tilted posterior implants placed in either residual bone or across the sinus represent an alternative to axial implants placed in a grafted sinus cavity (Fig. 10). Compared to implant placement with an osteotome technique, the trans-sinus technique allows a longer fixture in the molar area where higher mastication forces occur. Additionally, in contrast with a graftless approach using short implants and prosthetic extensions, the trans-sinus implant requires limited or no cantilever (Fig. 11). Furthermore, trans-sinus implants can be used in the maxillary All-on-4 technique\(^3\) and are also an alternative to single zygomatic implants (Fig. 12). A classification scheme for the immediate treatment of the posterior maxilla based on the available residual bone is provided in Figure 13. However, adequate surgical experience and a significant learning curve are required before attempting these techniques.

**SUMMARY**

This article describes an immediate fixed prosthesis for a posterior maxilla with extensive sinus pneumatization, supported by 1 anterior axial implant and 1 posterior tilted fixture placed with an intrasinus insertion. Additionally, this study provides a new classification schematic for the immediate treatment of the posterior maxilla based on the available residual bone.

**REFERENCES**


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Noteworthy Abstracts of the Current Literature

Immediate occlusal loading of full-arch rehabilitations: Screw-retained versus cement-retained prosthesis. An 8-year clinical evaluation

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Purpose. The aim of this study was to evaluate the survival and success of screw-retained versus cement-retained implant restorations in immediately loaded implants at 8-year follow-up.

Materials and Methods. Patients who were scheduled for full-arch ceramic prosthetic restorations were divided into two groups by randomization: in one group, prosthetic frameworks were screwed onto implants (screw-retained group, SRG), and in the second group, the frameworks were cemented on abutments (cement-retained group, CRG). Dental implants were placed both in postextraction and in healed sites. A temporary full-arch prosthesis was placed immediately after implant placement. Intraoral digital radiographic examinations (evaluating marginal bone levels) were made at baseline, 6 months, and each year after implant placement.

Results. In 28 patients, 24 full arches and 192 implants were placed in the maxilla and 10 full arches and 80 implants in the mandible (17 rehabilitations in each group). After an 8-year follow-up period, a survival rate of 99.27% was reported for all implants. Within the first year after implant placement, bone loss was recorded as follows: the CRG showed mean bone levels of $-1.23 \pm 0.45$ mm, while the SRG showed mean bone levels of $-1.01 \pm 0.33$ mm. After a 3-year follow-up, a slight increase was found ($0.30 \pm 0.25$ mm in CRG and $0.45 \pm 0.29$ mm in SRG). After that point, marginal bone levels remained stable over time, up to the 8-year follow-up. No statistically significant differences were found between groups ($P > .05$).

Conclusions. Definitive cement- and screw-retained ceramic restorations are highly predictable, biocompatible, and esthetically pleasing, and the two groups presented no statistically significant differences in bone loss.

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