Methods to Treat the Edentulous Posterior Maxilla: Implants With Sinus Grafting

Matteo Chiapasco, MD,* and Marco Zaniboni, DDS†

Prosthetic rehabilitation of the edentulous posterior maxilla with implant-supported prostheses frequently presents a challenge for the oral surgeon because of the lack of bone due to alveolar ridge resorption or maxillary sinus pneumatization. To overcome these problems, different solutions were proposed over the years, such as the use of short implants or tilted implants (including zygoma implants), with the aim of avoiding maxillary sinus floor elevation. Both of these techniques have advantages and disadvantages that should be evaluated carefully to choose the most appropriate treatment. Zygoma implants or short/tilted implants are not a panacea for the treatment of patients with inadequate posterior maxillary bone stock. Instead, treatment should be based on the characterization of resorption patterns of the posterior maxilla, and may include the need for sinus grafting or other grafting procedures to reestablish not only adequate bone volume for implant placement, but also a favorable intermaxillary relationship, to optimize the functional and esthetic outcome of the final prosthetic rehabilitation. The authors discuss the indications, advantages, and disadvantages of sinus-grafting procedures in association with or without other reconstructive procedures.

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Del Fabbro et al10 performed a systematic review of 39 selected studies (out of 252 screened as full text) in which 2,046 patients underwent sinus grafting and received 6,913 implants. After a follow-up period ranging from 12 to 75 months, an overall survival rate of 92.5% was reported (range, 61.2% to 100%). Results were also divided according to type of grafting materials. Overall, the survival rate of implants was 87.7% with autogenous bone, 94.9% when autogenous bone was mixed with other grafting materials, and 95.9% with nonautogenous grafting materials. Results were also reported according to type of implant surface. Overall, the survival rate was 85.6% for implants with smooth/machined surfaces, and 95.9% for implants with rough surfaces.

A review of the literature by Chiapasco et al11 selected 57 studies (out of 470 screened as full text) in which 3,163 patients were treated with 3,947 sinus-grafting procedures and 8,781 implants (3,760 immediate, 3,503 delayed, and 1,518 nonspecified). Criteria for selection comprised: 1) articles published in English; and 2) articles including a minimum of 5 patients followed for at least 6 months after the completion of prosthetic rehabilitation supported by implants placed in grafted sinuses. After a follow-up period from 6 to 134 months, an overall survival rate of 92.6% (range, 61.1% to 100%) was reported.
In a longitudinal follow-up study by Chiapasco et al., 692 patients underwent 952 sinus-grafting procedures (of whom 579 also received concomitant vertical and/or horizontal reconstruction with onlay grafts) and the placement of 2,037 implants. After a mean follow-up of 59 months (range, 12 to 144 months), an overall survival rate of 95.8% was reported.

Reports of high failure rates of short implants (8 mm or less) placed in the posterior maxilla led to recommendations that a minimum implant length of 10 mm, with a diameter of between 3 and 4 mm, was necessary to guarantee the long-term success of implants, particularly in the maxilla, where the bone quality is generally poorer than in the mandible. This often required sinus floor elevation and grafting. Recently, a tremendous improvement in implant quality has occurred, including new macrostructures and microstructures of implant surfaces, which has permitted the faster and stronger integration of implants in the residual bone, irrespective of the type of bone where the implants are inserted.15-17

Improved survival rates of shorter implants (lengths of between 6 and 8 mm25), and the success of zygoma implants or tilted implants placed anterior to the maxillary sinuses without sinus grafting,69 raised the question of whether sinus-grafting procedures13 are still necessary. Therefore, much controversy persists about “true” indications for sinus-grafting procedures.

In our opinion, this controversy is mainly related to the fact that the majority of publications do not report well-defined data concerning the initial clinical situation of the atrophic posterior maxilla to be rehabilitated with implant-supported prostheses. This aspect is deemed to be very important by the authors, because different amounts of residual bone and, in particular, the bone resorption pattern of the edentulous maxilla may greatly influence the treatment of choice (ie, short implants, tilted implants, zygoma implants, or sinus-grafting procedures). A recent review of the literature on this topic3 showed that the majority of publications recommended sinus-floor elevation procedures when the residual bone between the crest and the maxillary sinus floor was less than 8 to 10 mm, but it was not specified if an insufficient bone height was related to sinus pneumatization or to resorption of the alveolar ridge. It was shown that atrophy of the edentulous maxilla develops three-dimensionally, and may not only be related to sinus pneumatization.10 Therefore, insufficient bone height may also be attributable to vertical resorption of the alveolar ridge or a combination of both factors. Moreover, centripetal resorption of the edentulous ridge may lead to a horizontal discrepancy between the maxilla and mandible. These factors must be carefully assessed so that implants can be placed in the proper position, regardless of whether grafting procedures are involved. Placement of implants too far apically or palatally, regardless of type of implant, will be followed by a less than ideal prosthetic rehabilitation. For this reason, 2 patients with the same amount of residual alveolar bone may present with very different clinical situations. Thus, the atrophic posterior maxilla should be evaluated and classified not only with regard to the residual bone height and width, but also with regard to the vertical and horizontal intermaxillary relationships, to optimize implant placement and the final prosthetic results from functional and aesthetic perspectives.

According to these principles, Chiapasco et al13 presented a classification of bone defects of the edentulous posterior maxilla according to type of resorption pattern and amount of residual bone (sinus pneumatization alone, vertical and/or horizontal resorption of the alveolar ridge, and vertical and horizontal relationship between occlusal plane/opposing arch dentition and residual ridge of the posterior maxilla) to correlate the initial clinical situation with different treatment modalities. Defects of the lateral-posterior maxilla were divided into 9 categories. Patients characterized by significant vertical resorption or 3-dimensional maxillary atrophy are best treated with a combination of sinus grafting and implant restoration. The classification system and associated treatment recommendations include:

**Class A:** 1) Residual alveolar ridge height between 4 and 8 mm; 2) residual alveolar width ≥5 mm; and 3) absence of significant vertical resorption of the alveolar ridge.
**Class B:** 1) Residual alveolar ridge height between 4 and 8 mm; 2) residual alveolar ridge width <5 mm; and 3) absence of significant vertical resorption of the alveolar ridge.
**Class C:** 1) Residual alveolar ridge height <4 mm; 2) residual alveolar ridge width ≥5 mm; and 3) absence of significant vertical resorption of the alveolar ridge.
**Class D:** 1) Residual alveolar ridge height <4 mm; 2) residual alveolar ridge width <5 mm; and 3) absence of significant vertical resorption of the alveolar ridge.
**Classes E-H:** Same characteristics as in Classes A-D, but with significant vertical resorption of the alveolar ridge with an unfavorable vertical intermaxillary relationship.

**Class I:** Severe 3-dimensional atrophy of the edentulous maxilla with increased vertical crown implant space, horizontal resorption, and sagittal intermaxillary discrepancy with maxillary retrusion, because of a centripetal bone resorption pattern.

A residual height of 4 mm was arbitrarily chosen by the authors as the “cutoff” measurement between
different classes because this height, if associated with adequate bone width and adequate bone quality, can be considered sufficient to allow for primary stability of implants placed at the same time as the sinus-grafting procedure.

A residual bone width of 5 mm was arbitrarily chosen as the “cutoff” measurement between different classes because this width or higher values are sufficient to embed implants of adequate diameter, whereas lower values generally need reconstruction or regeneration of the deficient horizontal dimension. According to the initial clinical situation, several treatment modalities are proposed.

**Class A: Surgical Protocol**

Class A patients are characterized by sinus pneumatization, with enough residual bone volume and an adequate intermaxillary relationship. In case of moderate sinus pneumatization (6 to 8 mm residual alveolar ridge height), short implants without sinus-grafting procedures may be the first choice. In case of Class A defects, but with a residual alveolar ridge height of less than 6 mm, sinus-floor elevation, using either a transalveolar or a lateral approach, are suggested. There are no significant data concerning the use of extremely short implants (less than 6 mm) in the posterior maxilla.

**Class B: Surgical Protocol**

Because of horizontal resorption of the residual crest, short implants or sinus-floor elevation alone is not indicated, because implants should be placed more palatally, with less than ideal prosthetic outcomes. In this situation, ridge expansion, horizontal guided bone regeneration, or buccal onlay grafts are indicated, in association with or without sinus-grafting procedures.

**Class C: Surgical Protocol**

Class C is characterized by relevant sinus pneumatization, but maintenance of adequate bone width and a normal vertical interarch relationship. Sinus-floor elevation is the only procedure needed. There are no data concerning the use of extremely short implants (less than 4 mm) in the posterior maxilla.

**Class D: Surgical Protocol**

This class presents both relevant sinus pneumatization and reduction in alveolar-crest width. Sinus grafting should be associated with buccal onlay grafts or horizontal guided bone regeneration, to allow implant placement in a “prosthetically correct” buccal-palatal position.

**Class E**

These patients present bone volumes similar to those of Class A, but with an increased interarch distance, because of vertical resorption of the alveolar crest. These patients should be treated by means of sinus-floor elevation in association with vertical onlay grafts/vertical guided bone regeneration. The use of short implants only (although they were shown to support long suprastructures successfully) may represent a functional and esthetic compromise, particularly in patients with a “gummy smile.”

**Classes E-H**

These classes present bone volumes similar to those of Classes A-D, respectively, but an increased interarch distance is present because of vertical resorption of the alveolar crest. These patients should be treated by means of sinus-floor elevation in association with vertical onlay grafts or vertical guided bone regeneration (Classes E and G), or vertical plus horizontal bone grafts/guided bone regeneration (Classes F and H). The use of short implants only (although they were shown to support long suprastructures successfully) may represent a functional and esthetic compromise, in particular in patients with a “gummy smile.” Moreover, if horizontal resorption is not corrected, implants should be placed palatally, leading to a relevant esthetic and functional compromise.

**Class I: Surgical Protocol**

Extreme 3-dimensional atrophy of the maxilla is associated with unfavorable vertical, horizontal, and transverse interarch relationships. Sinus-grafting procedures in association with onlay grafts are unable to correct the initial clinical situation adequately. The surgical protocol suggested is represented by Le Fort I osteotomy with downward and forward repositioning of the maxilla, in association with interpositional iliac bone grafts.

The edentulous posterior maxilla may present an extremely wide variety of clinical situations, ranging from mild atrophy and sinus pneumatization to extreme 3-dimensional atrophy. The authors are convinced that every clinical case represents a “unicum,” not only as far as type of atrophy is concerned, but also in terms of other important factors, including postoperative morbidity, a patient’s expectations and compliance, number of surgical procedures needed, rehabilitation times, costs, and esthetic and functional outcome.
There is currently a tendency toward less invasive procedures, provided that the effectiveness of treatment is comparable to that obtained with well-consolidated (albeit more “aggressive”) procedures. The same principle can be applied to the rehabilitation of an edentulous posterior maxilla.

In selected clinical situations, the use of short implants or tilted implants may be indicated, particularly when: 1) the maxillary deficit is moderate and is mainly attributable to maxillary sinus pneumatization; 2) the relationship between the alveolar crest of the edentulous maxilla and the opposing arch is favorable; 3) the patient does not present a gummy smile; and 4) esthetic expectations are not very high. This approach simplifies the surgical procedure, reduces morbidity, and is supported by sufficient evidence.2-7

When sinus pneumatization is relevant (residual height of less than 4 mm), but when a favorable relationship exists between the maxillary ridge and the mandible (absence of relevant vertical/horizontal resorption of the maxillary bone), tilted implants6,7 or sinus-grafting procedures with either autogenous bone or allografts, xenografts, and alloplastic materials can be safely and predictably used.1,10,12,13,19-25 Conversely, when sinus pneumatization is associated with severe alveolar vertical or horizontal ridge resorption or with an unfavorable intermaxillary relationship, or the patient’s expectations are high, or the patient presents with a “gummy smile,” sinus-grafting procedures in association with reconstructive procedures of the deficient alveolar crest by means of autogenous bone grafts or guided bone regeneration still seem to be the treatment of choice.11,13,26-28 As far as this latter aspect is concerned, it is worth noting that although the use of allografts, xenografts, and alloplastic materials is well-documented for sinus-lifting procedures alone, there is a lack of support in the literature for the use of these materials in the concomitant vertical and horizontal reconstruction of the atrophic alveolar ridge.

Moreover, the use of zygoma implants, which are placed through the posterior part of the maxillary sinus toward the maxillary bone until they reach the zygomatic bone to obtain adequate primary stability, were advocated to avoid the necessity of major reconstructive procedures. However, although published data seem to demonstrate reliable long-term results,8,9 some disadvantages must be emphasized: 1) zygoma implants, because of their dimensions (range, 35 to 50 mm), need adequate mouth opening and quite frequently general anesthesia; 2) the procedure needs oral and maxillofacial expertise because of the potential risks of violating important anatomic structures such as the orbital cavity or infratemporal fossa (relevant postoperative complications such as sinusitis, oroantral fistula formation, periorbital or conjunctival hematomas or edema, lip laceration, pain, infraorbital nerve paresthesia, and orbital penetration and injury were reported); 3) very frequently the implant abutment is positioned palatally, leading to a more complicated prosthetic rehabilitation and patient discomfort because of the palatal bulkiness of the mesio/suprastructure; 4) the maintenance of oral hygiene may be more difficult; 5) zygoma implants may have some restrictions in indications, in particular when patients present with concave lateral walls of the maxilla; 6) an esthetic compromise of the final prosthetic rehabilitation must frequently be accepted; and 7) in cases of severe atrophy in totally edentulous patients, zygoma implants should be associated with standard implants placed in the anterior maxilla, for the proper support of a full-arch prosthetic rehabilitation: if atrophy is severe, the anterior maxilla needs to be grafted, exposing the patient to the same morbidity as in other grafting procedures.

The authors are well aware that reconstructive procedures are more invasive and carry higher morbidity, but they are also convinced that these procedures allow for the creation of more favorable conditions for ideal implant placement and related prosthetic rehabilitation.

References


