Extrasinus Zygomatic Implants: Three Year Experience from a New Surgical Approach for Patients with Pronounced Buccal Concavities in the Edentulous Maxilla

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ABSTRACT

Background: The surgical protocol for zygomatic fixtures prescribes an intrasinus approach ideally maintaining the sinus membrane intact and the implant body inside the sinus while gaining access to the zygomatic bone. In the presence of a pronounced buccal concavity, the implant head has to be placed far from the alveolar crest in a palatal direction, which results in a bulky bridge construction.

Purpose: The aim of this study was to report on the preliminary experiences with zygomatic implants placed with an extrasinus approach in order to have the implant head emerging at or near the top of the alveolar crest.

Materials and Methods: Twenty consecutive patients with pronounced buccal concavities in the edentulous posterior maxilla were treated with 104 regular and 36 zygomatic implants as support of fixed dental bridges. Sixteen patients were treated bilaterally and four patients were treated unilaterally. The zygomatic implants were inserted by using an extrasinus surgical approach with the implant body passing from the alveolar crest through the buccal concavity into the zygomatic bone. This enabled placement of the implant head at or close to the alveolar crest. The patients were followed from 36 to 48 months after occlusal loading with a mean follow-up of 41 months. The relation of the zygomatic implants to the crest was measured and compared with a control group of 20 patients treated with conventional placement of zygomatic implants.

Results: No implants were lost during the study period. No pain, discomfort, or complications related to the extrasinus path of the zygomatic implants were recorded after the initial healing period and up to the 36th-month checkup. The zygomatic implants emerged, on average, 3.8 mm (SD 2.6) palatal to the top of the crest compared with 11.2 mm (SD 5.3) to the conventional technique.

Conclusion: The present 3-year clinical study shows that an extrasinus approach can be utilized when placing zygomatic implants in patients with pronounced buccal concavities in the posterior maxilla. Moreover, the technique results in an emergence of the zygomatic fixture close to the top of the crest, which is beneficial from a cleaning and patient-comfort point of view.

KEY WORDS: edentulous maxilla, follow-up, maxillary sinus, surgical technique, zygomatic implants

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Prosthetic rehabilitation of the severely resorbed edentulous maxilla with implants constitutes a therapeutic challenge. The loss of bone following tooth extraction and use of dentures often results in bone volumes too small for placement and integration of dental implants as well as changes of the intermaxillary relation.[1] Many different approaches using bone grafts have been presented in the literature, and the choice of method is dictated by the severity of the resorption and

its effect on facial morphology. For instance, a retrognatic maxilla may require a Le Fort I osteotomy and bone grafting in order to increase bone volume for implants and correct facial morphology,[2] while onlay and/or inlay bone grafting may be sufficient in cases of a normal intermaxillary relation.[3] Moreover, implants have been placed simultaneously with the bone grafts or after some time of healing, the latter approach seemingly preferred today.[4] However, bone grafting procedures are resource demanding and require long treatment periods. There are risks for morbidity because of harvesting of bone grafts, and the failure rates are higher than in nongrafted situations.[5] Moreover, the procedures are made in general anesthesia, and the patient needs to be relatively healthy. One alternative to major bone grafting procedures is the use of zygomatic implants, which are placed through the maxillary sinus to be apically stabilized in the zygomatic arch.[6–9] This implant was originally used in reconstruction of maxillae of patients who underwent maxillectomy, and the indication has then been widened to involve also routine cases.[10,11] Several follow-up studies have reported high survival rates, although soft tissue problems related to the penetration of the intraoral mucosa and the maxillary sinus also have been discussed.[12–21] One drawback with the technique is the palatal emergence of the implant head, which often is the case, because of the desire to maintain the implant body within the boundaries of the maxillary sinus. This results often in a bulky dental bridge at the palatal aspect followed by patient discomfort and complaints.

The present study was conducted to evaluate a new surgical technique using an extrasinus approach when placing zygomatic implants to obtain implant head emergence at the center of the residual alveolar crest.

MATERIALS AND METHODS

Patients

The study group consisted of 20 consecutive patients (9 women/11 men, mean age 52 years, range 44–62 years) in need of prosthetic rehabilitation because of missing teeth in the maxilla and treated from October 2004 to October 2005. All patients were healthy. Of the patients, 12 were smokers; 10 patients smoked more than 10 cigarettes a day. Six patients received a diagnosis as being bruxers.

Inclusion criteria:

- The presence of residual alveolar crest with less than 4 mm in width and height, immediately distal to the canine pillar
- The possibility to place a minimum of three implants per quadrant
- The presence of buccal concavities in the maxillary sinus areas, which precluded intrasinus placement of zygomatic fixtures with the implant head emerging within a distance of 10 mm medial from the top of the alveolar crest

Exclusion criterion is the general and local health conditions that prevented the use of general anesthesia and/or intraoral surgery.

Surgical and Prosthetic Procedures

The presurgical radiographic examinations included computed tomography scans and orthopantomograms in all the patients (Figure 1A).

The patients were treated under general anesthesia and with local injections of lidocain/epinephrine. Patients were given antibiotics prior to surgery. Crestal and posterior vestibular releasing incisions were made, and mucoperiosteal flaps were raised to expose the alveolar crest, the lateral wall of the maxillary sinus, and the inferior rim of the zygomatic arch. A retractor was used to ensure good visibility of the zygomatic bone. The zygomatic implant site was planned by striving for placing the implant head at or near the top of the crest, usually in second premolar/first molar regions. Moreover, the implant body should preferably engage the lateral bone wall of the maxillary sinus while entering the zygomatic bone. The implant site was prepared, drilling from the palatal crest pointing the zygomatic arch without making a previous opening to the maxillary sinus nor taking into account the sinus membrane integrity, and followed the standard drilling steps for zygomatic implants as described.[20] As a result, the zygoma implant enters to the crestal bone or sinus cavity from the palate crest of the premolar/molar area, then comes out through the lateral maxillary sinus wall close to the sinus ground/maxillar basal bone. Then the implant goes in an extrasinus path and sometimes engages the lateral sinus wall. Finally, the implant head penetrates the zygoma arch and its head appears in the superior part of the zygomatic arch (see Figure 1, A–D). Additional conventional implants were placed in the

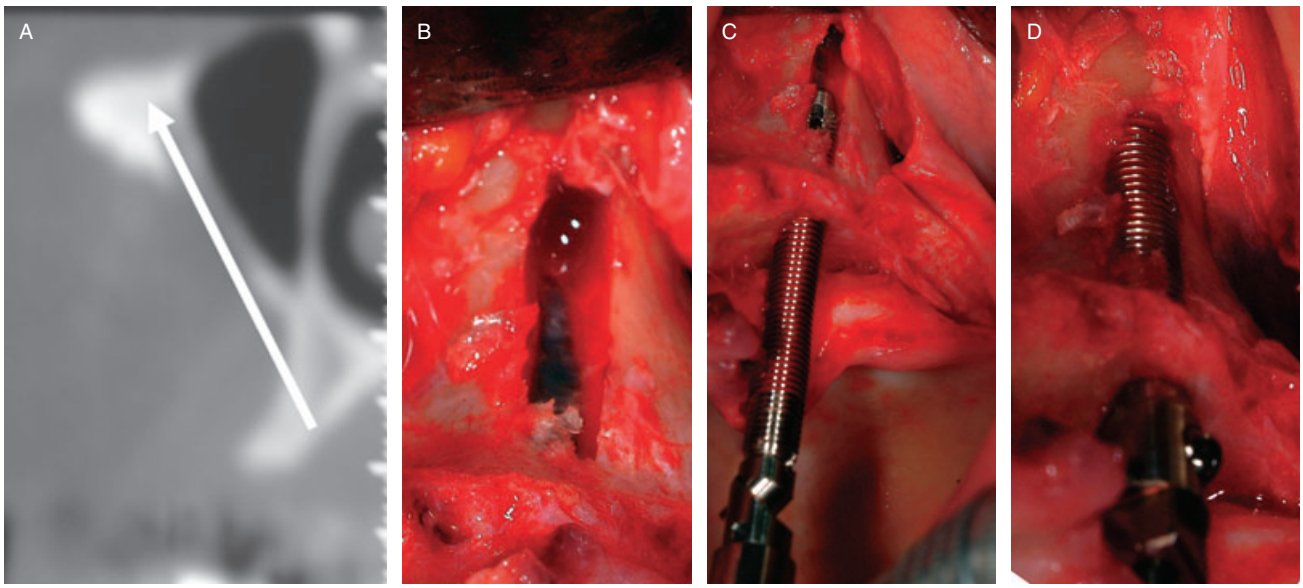

Figure 1 *A*, Tomographic section showing preoperative planning of an extrasinus zygomatic implant. *B*, Clinical view showing preparation of the lateral sinus wall. Note intact sinus membrane in the bottom of the preparation. *C*, Showing insertion of the zygomatic implant. *D*, Showing final seating of the implant.

anterior regions and, in some cases, posterior to the zygomatic implants (Figure 2A). In 19 patients, abutments were connected to the implants together with sterile impression copings (see Figure 2B). The wound was closed by suturing. Impressions of both jaws and bite registration were made immediately after surgery in order to manufacture a provisional fixed bridge to be connected within 24 hours (see Figure 2C). Submerged healing was used in one patient who received cover screws before closing the wound by suturing. The patients were prescribed postoperative antibiotics and analgetics. The two-stage patient was scheduled for abutment connection 6 months later for manufacturing of a provisional bridge.

A total of 36 zygomatic implants, machined titanium surface (Nobel Biocare AB, Göteborg, Sweden) in lengths from 35 mm to 52.5 mm were used (Table 1). Sixteen patients received zygomatic implants bilaterally, and four patients received zygomatic implants unilaterally. A total of 104 conventional implants with lengths from 7 to 18 mm and diameters of 3.75 and 4.0 mm (Nobel Biocare AB) were used (Table 2). The zygomatic implants had a turned surface, while the regular implants had an oxidized surface (TiUnite™, Nobel Biocare AB). Straight and angulated abutments (Multi-Unit Abutment, Nobel Biocare AB) were used in 15 patients who received screw-retained bridges. Individual abutments were used in 5 patients with cemented bridges. All the patients but one were provided with a provisional fixed implant-retained bridge within the next 24 hours to the implant placement.

Removal of sutures and checkup of occlusion were made 10 days after surgery. The provisional bridge was replaced by a permanent bridge 4 to 5 months after surgery (Figure 3). Radiographs were taken after 1 and 12 months of loading. Periotest (Periotest®, Siemens AG, Bensheim, Germany) measurements of implant stability were made when replacing the provisional bridge at the 4th to 5th month follow-up when the provisional constructions were replaced by a permanent ones and once a year afterward.

Follow-Up

The patients were scheduled for checkup examinations at the following time points:

- 10 days; suture removal, checking of occlusion
- 1 month; checking of occlusion, radiography
- 4 to 5 months; replacement of provisional bridge to a permanent one, periotest measurements
- 12 months; radiography and Periotest (Bensheim, Germany) measurements

The checkup examinations also included assessments of oral hygiene, soft tissue health, prosthesis stability, gold-screw loosening, and other mechanical complications. Standardized intraoral x-rays of the

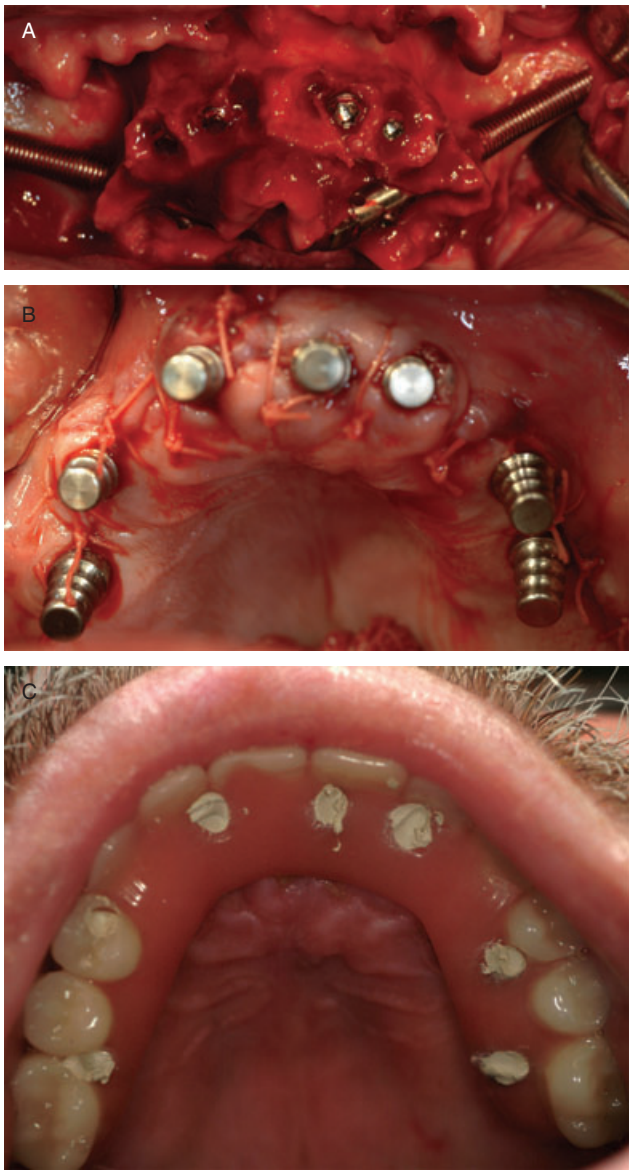

Figure 2 *A*, Clinical view after surgical placement of two extrasinus zygomatic and five additional implants. *B*, Impression copings on the implants after suturing. Note the emergence of the zygomatic implants that are close to the crest. *C*, A temporary, fixed prosthesis, which was delivered the day after surgery.

zygomatic implants could not be made and, consequently, these implants could not be evaluated with regard to marginal bone resorption. An implant removed for any reason was counted as a failure, and the implants still in function were counted as survivals. Implants in patients who did not come to checkup appointments were regarded as unaccounted for.

Assessment of Zygomatic Implant Placement

The distance from the hole of the central screw of the zygomatic implant head to the center of the residual ridge was measured with calipers to the nearest 0.1 mm. A control sample consisting of master models of 20 patients previously treated with the intrasinus approach was taken, and the same measurements were performed.

TABLE 1 Length and Number of Zygomatic Implants Used in the Study

Zygomatic implant length (mm)	Number of implants used
40	3
42, 5	7
45	13
47, 5	7
50	5
52, 5	1
Total	**36**

RESULTS

Clinical Findings

All patients attended the planned follow-up appointments. The healing period following implant surgery was normal in all patients with some postoperative pain and swelling that could be controlled with analgetics. There were no signs of infection neither within the oral cavity nor in the maxillary sinus area. Healthy mucosa covered the extrasinus part of the zygomatic implants, and there were no pain when palpating the area.

No implants were removed but remained stable during the follow-up.

Implant Stability Measurements

Periotest (Siemens AG, Bensheim, Germany) measurements of individual zygomatic implants showed a mean

TABLE 2 Length, Diameter, and Number of Routine Implants Used

Routine implant length/diameter (mm)	Number of implants used
11.5/3.75	4
11.5/4	3
13/3.75	27
13/4	10
15/3.3	3
15/3.75	20
15/4	23
18/3.75	1
18/4	13
Total	**104**

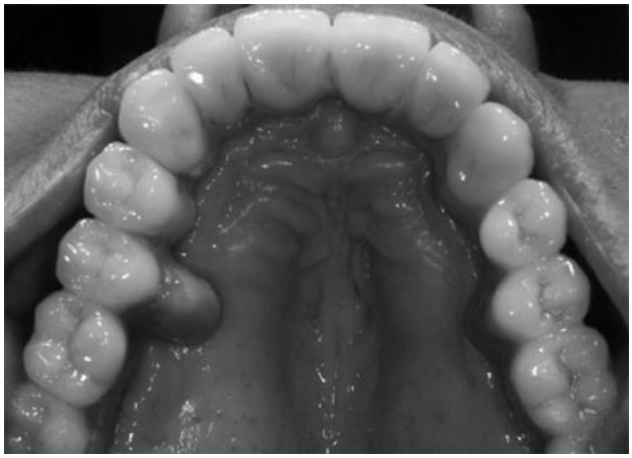

Figure 3 Occlusal view of a final fixed bridge in a patient treated with two extrasinus zygomatic implants. The right is emerging at the top of the crest and the left one slightly palatal.

Periotest (PT) value of –3.6 (range –5 to 3) 24 hours after implant insertion and –3.5 (range –5 to 3) after 4 to 5 months.

Prosthetic Findings

The mean distance from the zygomatic implant to the central part of the residual crest was 3.8 mm (SD 2.6). On the control group, the mean distance was 11.2 mm (SD 5.3).

DISCUSSION

The present study reports on the three year experiences with zygomatic implants placed with an extrasinus approach in 20 patients with extreme buccal concavities in the maxillary sinus areas. In addition, all patients but one received a fixed construction within 24 hours after surgery. After a mean follow-up of 41 months, no implants have been removed, and no patient has shown any unexpected tissue reactions to the zygomatic implants. Moreover, the extrasinus technique enabled placement of the implant head at or near the top of the residual crest, which resulted in a more normal extension of the bridge framework. Becktor and colleagues,[17] using an intrasinus approach, reported a mean distance of 11.2 mm from the hole of the gold screw to the nearest buccal cusp, which is the same distance as found in a control group of the present study. This is more than the 3.8 mm found for the extrasinus zygomatic implants in the present study. The fact that the extrasinus implants emerged close to the top of the crest allowed for less bulky constructions, which not only is beneficial from a cleaning point of view but also means a better comfort for the patients.

The good outcome with immediate loading of the zygomatic and conventional implants of the present study demonstrates the possibility of shortening the treatment period considerably. This is in line with the experiences of other authors when using zygomatic implants in immediate loading.[22–26] In a recent study from the present group, the outcome of immediate/early loading was reported for 25 patients treated with 46 zygomatic and 127 conventional implants and followed up for at least 1 year.[22] No implant losses but few other complications were experienced in this patient group. The Periotest (Siemens AG, Bensheim, Germany) measurements showed a similar degree of firm stability 24 hours after placement as after 4 to 5 months. The mean PT value after implant placement in the present study was lower (ie, higher stability) than in a previous study from the present group using zygomatic implants with a two-stage technique.[20] It may indicate that the extrasinus technique makes it possible to engage more bone, that is, at the alveolar crest and along the maxillary sinus. The PT values from the two studies were similar after 4 to 12 months, which indicates that healing results in increased implant stability.

The present research group has previously reported on the clinical outcome when using the conventional intrasinus approach with zygomatic implants. The results were very encouraging because no zygomatic implants and only 1% of conventional implants were lost during a follow-up period from 6 months up to 5 years. This is in line with the findings from other research groups and shows that the zygomatic implant is a reliable alternative to other reconstructive techniques in the posterior maxilla. For instance, Brånemark and colleagues followed 28 consecutive patients with 52 zygomatic implants for at least 5 years and reported a survival rate of 94.2%.[9] Moreover, Malevez and colleagues lost none of 103 consecutive implants placed in 55 patients during a follow-up period of 6 to 48 months.[15] However, other researchers have forwarded concerns regarding the soft-tissue health at the mucosal penetration of the zygomatic implants and in the maxillary sinus.[16,18] Becktor and colleagues encountered in their study severe sinusitis, which required removal of three zygomatic implants in three patients.[17] It was speculated that one reason may be the lack of osseointegration in the alveolar crest, which results in a oroantral

communication. Similar findings were reported by Al-Nawas and colleagues who examined the marginal soft-tissue conditions and peri-implant microbiotia at 20 zygomatic implants in 14 patients.[16] They found signs of soft-tissue problems in 9 of the 20 patients. It can be speculated that the extraoral approach as used in the present study may be beneficial from a soft-tissue health point because, in many cases, the maxillary sinus is not perforated at the level of the alveolar crest. Moreover, the use, from the beginning, of the definitive abutment probably benefits the desmosomal adhesion of the soft tissue to the titanium abutment surface. One concern with the technique may be the long-term effect of exposed threads toward the soft tissue at the lateral aspect of the zygomatic implants. However, Lekholm and colleagues could not observe any increased marginal bone loss or failure rate for machined implants with exposed threads at implant surgery as compared with fully submerged implants and followed up for 5 years.[27] Moreover, Petruson examined the maxillary sinuses of 14 patients with zygomatic implants using sinuscopy and found no signs of adverse reactions.[28] As discussed by Becktor and colleagues, it is more likely that problems with sinusitis are more related to oroantral communications rather than to exposed implant threads *per se*[17]. None of the patients of the present study have shown any adverse sensations or reactions from the region of the zygomatic implants. It should be stressed that the implants of the present study had a machined surface. Today, zygomatic implants with a roughened oxidized surface are commercially available. To the knowledge of the present authors, no clinical follow-up studies have been published with surface-modified zygomatic implants.

Success criteria for evaluated osseointegrated implants include parameters related to the marginal bone height during loading. With respect to zygomatic implants, intraoral periapical radiographs could not be used to assess marginal bone levels in a standardized manner. This was a result of the difficulty to place an intraoral film correctly because of the lack of palate curvature in these patients whose residual alveolar crest had literally disappeared and of the angulated design of the implant head. Moreover, because the stability of the zygomatic implants is mainly achieved by engagement of the zygomatic arch, the importance of integration in the residual alveolar bone is not known.

CONCLUSION

The present three year clinical study shows that an extrasinus approach can be utilized when placing zygomatic implants in patients with pronounced buccal concavities in the posterior maxilla. Moreover, the technique results in an emergence of the zygomatic fixture close to the top of the crest, which is beneficial from a cleaning and patient-comfort point of view.

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