Evaluation of 31 Zygomatic Implants and 74 Regular Dental Implants Used in 16 Patients for Prosthetic Reconstruction of the Atrophic Maxilla with Cross-Arch Fixed Bridges

Jonas P. Becktor, DDS;* Sten Isaksson, MD, DDS, PhD;† Peter Abrahamsson, DDS;‡ Lars Sennerby, DDS, PhD§

ABSTRACT

Background: The use of a specially designed implant to be anchored in the zygomatic body has been proposed as an alternative to bone grafting in the prosthetic rehabilitation of the severely resorbed maxilla. However, few studies have evaluated the long-term stability and soft tissue conditions of zygomatic implants.

Purpose: The aim of this retrospective study was to evaluate the clinical performance of zygomatic implants when used for prosthetic reconstruction of atrophic maxillae.

Materials and Methods: Sixteen patients consecutively treated with 31 zygomatic implants and 74 additional dental implants from 1998 to 2002 were retrospectively evaluated and prospectively followed using a standardized clinical and radiographic study design. Data were collected from the time of implant treatment until the last follow-up.

Results: The follow-up period ranged from 9 to 69 months from the day of implant treatment, with a mean of 46.4 months (3 years, 10 months). Three (9.7%) of the 31 zygomatic implants were surgically removed because of recurrent sinusitis. Three (4.1%) of the 71 additional dental implants failed to integrate. Poor oral hygiene and gingivitis were seen at most zygomatic implant sites (10/16). Local infections were observed in 9 of 16 patients. Sinusitis occurred in 6 patients. All patients (16/16) eventually received fixed bridges, which were stable throughout the observation period.

Conclusions: The results showed an acceptable outcome with regard to implant and prosthetic survival rates. However, postoperative complications not related to implant and prosthesis stability were frequent. Further investigations of the long-term performance of zygomatic implants and with a focus on soft tissue and maxillary sinus health are needed.

KEY WORDS: dental implants, edentulous maxillae, endosseous implants, maxillary sinus, zygoma implant, zygomatic implant

The use of endosseous implants is currently a routine treatment modality for prosthetic reconstruction of the edentulous maxilla. Rehabilitation of the masticatory function with dental implants can be achieved with predictable success in various clinical situations, and acceptable long-term results have been presented in patients with sufficient bone volume. However, the problem of insufficient height and width of the alveolar ridge at the implant site remains. Inadequate bone volume can be the result of resorption following extraction, trauma, infection, and pneumatization of the maxillary sinus.[1–3] The severely atrophied maxilla constitutes a challenging therapeutic problem because bone augmentation is required to enable placement of a sufficient number and length of implants. Several surgical procedures have been developed to

*Consultant, Division of Oral and Maxillofacial Surgery, Maxillofacial Unit, Länssjukhuset, Halmstad, Sweden; Department of Biomaterials, Institute for Surgical Sciences, University of Göteborg, Göteborg, Sweden; †head, Division of Oral and Maxillofacial Surgery, Maxillofacial Unit, Länssjukhuset, Halmstad, Sweden; ‡consultant, Division of Oral and Maxillofacial Surgery, Maxillofacial Unit, Länssjukhuset, Halmstad, Sweden; §professor, Department of Biomaterials, Institute for Surgical Sciences, University of Göteborg, Göteborg, Sweden

Reprint requests: Dr. Jonas Peter Becktor, Clinic, Strandvejen 116A, DK-2900 Hellerup, Denmark; e-mail: jonas@becktor.dk

TABLE 1 Other Studies on Zygomatic Implants

Study	Patients (*n*)	Follow-up (yr)	Zygomatic Implants		Additional Implants		Sinusitis	Soft Tissue Infection
			Placed	Failed	Placed	Failed		
Hirsch et al[14]	66	1	124	3 (2%)	?	?	8 (?)	8 (?)
Malevez et al[16]	55	0.5–4	103	0	194	16 (8%)	5	?
Brånemark et al[17]	28	5–10	52	3 (6%)	116	29 (27%)	4	2 (?)

increase the bone volume. Autogenous bone grafts, guided bone regeneration, allogeneic material, and combinations of these procedures are used to overcome insufficient bone volume.[4] A variety of bone augmentation procedures using autogenous bone have been described in the literature, that is, onlay bone grafting, grafting to the floor of the nose and the maxillary sinuses, and interpositional bone grafting in conjunction with a Le Fort I procedure. The donor sites are sometimes related to complications such as sensitivity disorders, hematomas, and postoperative pain.[5–7] Moreover, to obtain high success rates, a two-stage procedure with delayed implant placement is recommended.[8,9] The result is an increased number of operations, which reduce the patients' comfort. Increased failure rates have been experienced in situations with inadequate bone volume and/or low bone density in edentulous patients and especially in those when an overdenture has been the final prosthetic solution.[3,10,11] Therefore, the use of alternative implant sites and tilted implants has been advocated to reduce the necessity of bone grafting procedures. The placement of dental implants in the zygomatic bone is well known from preprosthetic surgery following ablative tumor surgery.[12,13] Zygomatic implants have been used in conjunction with regular implants in patients with severe resorption of the maxilla.[13–17] However, few studies include long-term evaluation of soft and bone tissue reactions to zygomatic implants. (Table 1). Recently, Brånemark and colleagues reported on 28 consecutive patients and 52 zygomatic implants followed for at least 5 years, with a survival rate of 94.2% (49/52).[17] Four patients had been treated for recurrent sinusitis. Malevez and colleagues reported on 103 consecutive implants placed in 55 patients followed for 6 to 48 months.[16] None of the zygomatic implants failed, and few other complications were observed. Al-Nawas and colleagues examined the marginal soft tissue conditions and periimplant microbiotia at 20 zygomatic implants in 14 patients.[18] They reported that 9 of the 20 implants showed signs of soft tissue problems, that is, bleeding on probing and probing depths > 5 mm. Petruson explored the maxillary sinuses with a sinuscope in 14 patients with zygomatic implants without any signs of infections.[19]

The objective of this investigation was to evaluate the clinical outcome of zygomatic implant treatment and consider if treatment with zygomatic implants could be an alternative to bone grafting and implant procedures in patients with edentulous maxillae.

MATERIALS AND METHODS

Subjects

The study included 16 patients, 6 males and 10 females, with a mean age of 61.1 years, with edentulous maxillae who were treated with endosseous implants and one or two zygomatic implants at the Division of Oral and Maxillofacial Surgery, Halmstad, Sweden, from 1998 to 2002 (Table 2). Because of advanced horizontal and vertical bone loss of the alveolar processes, as well as extensive pneumatization of the maxillary sinuses, the patients were considered to have insufficient bone volume for routine implant treatment. The goal of the treatment was to provide the patients with a fixed prosthesis. The patients were treated with zygomatic implants instead of a bone grafting procedure for several reasons: (1) patients who preferred a zygomatic

TABLE 2 Distribution of Patients with Regard to Gender, Age, and Follow-Up Period

N	Male/ Female	Mean Age (yr)	Age Range (yr)	Follow-Up Period, mo	Follow-Up Period Range, mo
16	6/10	61.1	29–77	46.4	9–69

implant treatment instead of a bone grafting procedure ($n = 11$), (2) for medical considerations ($n = 1$), or (3) patients who have had previous and unsuccessful treatment with implants and/or grafts ($n = 4$).

Radiologic Examinations

Preoperatively, panoramic images supplemented with intraoral radiographs were used to evaluate the bone volume of the maxilla. Computed tomograms were used to determine whether the anatomy would allow installation of zygomatic implants and to eliminate the risk of undiagnosed pathologic lesions. Preoperative classification according to Cawood and Howell[20] was done retrospectively with the help of panoramic radiographs. The posterior maxilla that was 5 mm or less of bone in height corresponded to class V and VI[20] in all 16 patients. Postoperatively, the radiographic examinations have not been consistently performed at the time of the abutment connection surgery and at the annual checkups.

Surgery

Surgery was performed under general anesthesia with nasal endotracheal intubation supplemented with infiltration of local anesthetic agents with a vasoconstrictor for hemostasis. Patients were given benzylpenicillin (3 g) and metronidazole (0.5 g) preoperatively routinely. A crestal incision was made extending from the second molar bilaterally. A vestibular releasing incision was made at the posterior extent of the incision in the maxillary second molar region. A mucoperiostal elevation revealed the nasal apertures and the piriform rim to the inferior aspect of the infraorbital foramina and laterally of the buttress and body of the zygoma bilaterally.

A round bur was then used to create a lateral window, 5 × 10 mm, in the lateral wall of the maxillary sinus. The sinus mucosa was then carefully reflected and protected through the preparation of the zygomatic implant site. A retractor was placed over the superior aspect of the zygomatictic arch to enable correct orientation of the implant site preparation. The zygomatic implant heads were placed palatally and as close as possible to the alveolar crest, in the region of the second premolar and first molar. After penetrating the maxillary bone into the maxillary sinus, the preparation was penetrating the cortical layer of the anterior-superior part of the zygomatic bone. The implant sites were then enlarged. Implant size was determined, and final placement of the implant was accomplished using the standard protocol. The zygomatic implant was placed using a low speed until the tip of the implant engaged the zygomatictic bone and was finalized manually until the implant was optimally seated. All 31 zygomatic implants had a stable and ridged primary stability at the installation and were dressed with a cover screw.

Patients obtained immediate placement of additional endosseous implants in the anterior region of the maxilla (see Table 3) (Brånemark System®, Nobel Biocare AB, Göteborg, Sweden, or Astra Tech Dental Implant System®, Astra Tech AB, Göteborg, Sweden).[20] The wound was closed with a continuous, absorbable 4-0 suture. Postoperatively, the patients were prescribed antibiotics for 1 week. Abutment connection surgery was performed after a healing time of 5 to 8 months (mean 6.4 months).[21]

Prosthodontics

The conventional dentures were relined after implant surgery and after abutment connection and were worn provisionally in the healing periods. Fabrication of gold-acrylic resin fixed prostheses followed the standard procedures for the implant treatment, as described elsewhere.[21] The fixed prosthesis was finally handed out 1 to 15 weeks (mean 3.9 weeks) after the abutment connection operation.

Examinations and Follow-Up

Data were collected from the time of implant treatment until the last follow-up and were retrospectively analyzed according to a research protocol. Sixteen patients received zygomatic implant treatment and were included in the study. All patients were contacted for a further prospective follow-up examination. Of 16 patients, 14 presented, 1 patient (No. 15) was deceased, and another patient (No. 11) was hospitalized in another city (Table 3). Subsequently, 14 patients underwent clinical and radiographic examination according to the prospective follow-up protocol. The follow-up period ranged from 9 to 69 months from the day of implant treatment, with a mean of 46.4 months (3 years, 10 months) (see Tables 2 and 3). From the patient records, the following parameters were recorded: age and gender, jawbone volume according to Cawood and Howell,[20] type and number of implants placed

TABLE 3 Distribution of Patients

Patient	Sex	Age (yr)	Zygomatic Implant Length, R/L (mm)	Follow-Up (mo)	Distance between Zygomatic Implants (mm)	Distance from Buccal Cusp to Zygomatic Implant, R/L (mm)	Dental Implant Type
1	M	71	45/45	65	13	10/10	BS
2	F	76	45/45	69	21	10/12	AS
3	F	62	45/40	62	-	-/10	BS
4	M	44	45/45	63	24	5/7	BS
5	F	68	40/30	57	18	15/9	BS
6	M	57	45/40	58	-	8/-	BS
7	M	77	45/45	45	24	12/10	BS
8	M	59	50/45	55	25	4/8	BS
9	F	63	40/40	48	24	10/8	AS
10	F	56	50/45	50	19	9/6	AS
11	M	76	40/40	38	-	-/-	BS
12	F	75	40/40	28	24	9/8	AS
13	F	49	40/40	34	29	9/7	AS + BS
14	F	29	40/40	28	-	6/-	BS
15	F	59	45/-	9	-	-/	BS
16	F	56	40/35	34	18	9/12	BS

and lost, implant position, postoperative complications, and prosthetic outcome.

RESULTS

Implant Stability

Sixteen patients were treated with 31 zygomatic implants (Brånemark System) with lengths from 30 to 50 mm. One patient was treated with a unilateral zygomatic implant, and 15 patients received a zygomatic implant bilaterally (see Table 3). Seventy-four additional dental implants (Brånemark System or Astra Tech Dental Implant System) were placed (see Table 3).

Three zygomatic implants, in three patients, were removed after the time of definitive prosthetic loading. Recurrent acute and chronic sinusitis occurred, and despite month-long treatment of local infection at the sites of the zygomatic implants, they had to be removed. Three (4.1%) of the 74 additional dental implants were lost between the abutment connection surgery and definitive prosthetic loading (see Table 3). After a mean follow-up period of 46.4 months (3 years, 10 months), the overall percentage of functioning implants, including the zygomatic implants, was 94.3% (99/105).

Implant Position and Implant Length

All 31 zygomatic implants were installed in the second premolar and first molar region. The palatal location of the zygomatic implants was measured with the distance from the nearest buccal cusp on the prosthesis to the center of the gold screw, with a mean distance of 11.2 mm (range 4–15 mm) (see Figure 1 and Table 3).

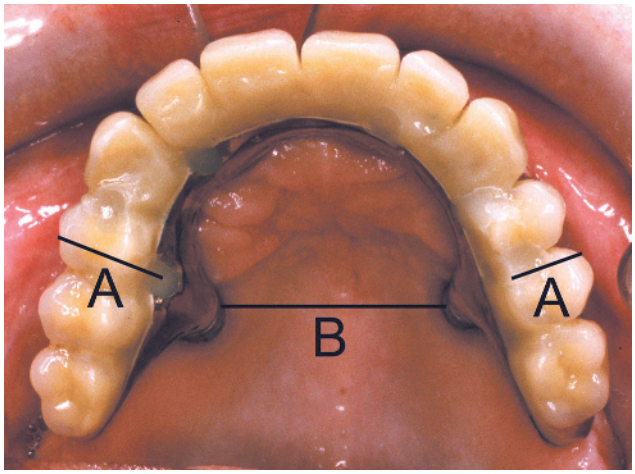

Figure 1 The mean distance from the nearest buccal cusp on the prosthesis to the center of the gold screw was 11.2 mm (A). The zygomatic interimplant distance was an average of 21.7 mm (B).

Dental Implant Placed/ Failed	Poor Oral Hygiene at Zygomatic Implant in Time Period (mo)	Local Infection at Zygomatic Implant in Time Period (mo)	Sinusitis Symptoms in Time Period (mo)	Periimplant Probe Palatal at Zygomatic Abutment with Antral Communication	Poor Oral Hygiene/ Local Infections/ Sinusitis Symptoms at Last Follow-Up	Zygomatic Implant Removed (*n*)
4/0	NO	YES 5-6	NO	YES / YES	NO / YES / NO	0
5/0	YES 0-1	YES 16-	NO	NO / NO	NO / YES / NO	0
4/1	YES 0-16	YES 2-14	YES	- / YES	NO / NO / NO	1 right side
4/0	YES 0-12	YES 3-19	NO	NO / NO	NO / NO / NO	0
5/1	YES 0-	NO	NO	NO / YES	YES / NO / NO	0
4/0	NO	NO	YES 33-37	YES / -	NO / NO / NO	1 left side
4/0	NO	NO	NO	YES / NO	YES / YES / NO	0
4/0	NO	NO	NO	NO / NO	NO / YES / NO	0
4/1	NO	NO	YES 1-6	YES / YES	YES / YES / NO	0
4/0	YES 0-	YES 4-10	NO	NO / NO	YES / YES / NO	0
4/0	YES 0-12	YES 1-12	NO	- / -	YES / YES / NO	0
6/0	YES 0-10	NO	NO	NO / NO	YES / YES / NO	0
5/0	YES 0-3	YES 1-4	YES 1-6	NO / NO	NO / NO / NO	0
4/0	YES 1-2	YES 1-2	YES 1-6	NO / -	NO / NO / NO	1 left side
6/0	YES 0-	YES 1-6	NO	- / -	YES / YES / NO	0
4/0	NO	NO	YES 18-	NO / NO	NO / YES / YES	0

The zygomatic interimplant distance was an average of 21.7 mm (range 13–29 mm) (see Figure 1 and Table 3). The length of the zygomatic implants varied between patients (see Table 3).

The additional 74 dental implants were all distributed in the anterior region of the maxilla. There was no need for additional bone graft or implant surgery.

Complications

There were no records of any complications during the implant surgery, in the implant healing phase, or at the abutment connection surgery.

After the abutment connection surgery, 10 of 16 patients had problems with oral hygiene at the zygomatic implant site (see Table 3). After professional help from a dental hygienist, seven patients improved their hygiene, and three patients are still in this phase. Gingivitis was seen in nine patients; five of these patients presented with fistulae and local infection around their zygomatic implant, and four of these five patients had fistulae bilaterally. Local infection was treated with antibiotics and, in some cases, excision of the fistulae. Sinusitis was a problem for six patients. Three patients had sinusitis bilaterally and another three unilaterally. This occurred both early and later in the period after the abutment connection surgery (see Table 3). They were treated by an otolaryngology specialist with antibiotics and sinus rinses. Three patients had one zygomatic implant removed owing to infection in the maxillary sinus. One patient was treated for sinusitis throughout the observation periods.

Prosthesis Stability

All patients wore a temporary complete denture during the implant healing phase (6–8 months). All 16 patients received a fixed prosthesis. Three patients were treated with an overdenture over a 7- to 15-month period before receiving the definitive fixed prosthesis. The majority, 13 patients, received a fixed prosthesis 1 to 3 months after the abutment connection surgery. During that period, a temporary complete denture was worn. All (16/16) of the fixed prostheses were stable throughout the observation periods.

DISCUSSION

The severely atrophied maxilla constitutes a challenging therapeutic problem, and bone augmentation is often required to enable placement and integration of dental implants. Predictable results can be achieved with bone

grafting and delayed implant placement.[8,9,22] However, the extended treatment time and risk of morbidity at the donor site are disadvantages for patients.[23] Becktor and colleagues reported on reconstruction of compromised maxillae using 64 patients with bone grafts and 437 Brånemark System implants, with a survival rate of 75.1% after a mean follow-up period of 68.9 months (5 years, 9 months) and a prosthetic survival rate of 100%.[22] Lekholm and colleagues reported from a 3-year retrospective multicenter study of bone grafting and implants, which had an overall implant survival rate of approximately 80%.[24] A literature review by Esposito and colleagues reported a pooled failure rate of 15% after 3 years of loading in edentulous and partial edentulous patients.[4] The efficiency of bone grafting with implant treatment still seems not good enough in comparison with conventional implant treatment.

The objective of this investigation was to evaluate the clinical outcome of zygomatic implant treatment in the severe atrophied maxilla as an alternative to bone grafting procedures in patients with edentulous maxillae. The zygomatic implant placement procedure did not require any adjunctive bone grafting procedures in our study. There were no adverse complications associated with this treatment modality because all patients had an uneventful healing period after the implant placement until the abutment connection surgery, similar to conventional implant surgery. After the abutment connection surgery, the complications were at an unacceptable level. After the abutment connection surgery, oral hygiene was a problem at the zygomatic abutment only. With help and instructions from a dental hygienist, most of the patients improved their oral hygiene. It seems that the posterior palatal localization of the zygomatic implant creates difficulties in upholding hygiene and the extra professional assistance is required. Even though effort was made to place the zygomatic implant as close as possible to the alveolar crest, this was not possible to accomplish in this material due to the anatomy and degree of atrophy. The distance from the nearest buccal cusp on the prosthesis to the zygomatic implant was measured with a mean distance of 11.2 mm (range 4–15 mm) (see Figure 1 and Table 3). The zygomatic interimplant distance had an average of 21.7 mm (range 13–29 mm) (see Figure 1 and Table 3). An optimal dental implant placement is often considered to result in a screw hole in the center of the prosthetic crown, which would mean 2 to 4 mm from the cusp.[21] Considering the localization of the zygomatic implant occurring in this study, one can understand the difficulties of managing an optimal oral hygiene.

All of the zygomatic implants osseointegrated, and a survival rate of 100% would have been the case if three zygomatic implants in three patients did not have to be removed because of recurrent sinusitis, with good results. Nine of 16 patients had problems with local infections at the periimplant site of zygomatic implants with gingivitis and/or fistulae, which is in line with the findings of other researchers.[18]

The reason for the sinusitis observed in this study can be attributed to several factors. The internal threaded abutment screw chamber of the zygomatic implant seems to create a communication from the oral cavity into the antrum, which may result in sinusitis. Another causative factor may be the lack of osseointegration, bone-to-implant contact, at the marginal level in the palatal area and the functional loading, resulting in transversal mobility of the long coronal part of the zygomatic implant. This could implicate a higher risk of communication between the antrum and the oral cavity and thereby introduce sinusitis. The prosthetic survival rate of 100% in this clinical report is encouraging for the treatment of this patient population. Treatment with the zygomatic implant in extensive maxillary defects looks very promising and could, in some cases, be the only treatment solution.[12,25,26] However, the risk of soft tissue problems and sinusitis should not be underestimated, especially if other treatment options are at hand. Further prospective long-term clinical studies are required focusing on the health of the maxillary sinus.

CONCLUSION

The zygomatic implant, when placed in conjunction with premaxillary implants, can facilitate surgical rehabilitation of patients presenting with severe maxillary resorption. The ability to immediately use existing dentures can result in higher treatment acceptance in this group of patients. A prosthesis survival rate of 100% was observed, with a mean follow-up period of 46.4 months. Three of 31 zygomatic implants were removed owing to sinusitis. Zygomatic implant treatment is promising and has several advantages over bone grafting procedures. However, the frequent soft

tissue complications at the abutment level and the development of sinusitis call for more studies.

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