

# Rehabilitation of Severely Atrophic Maxillae with Fixed Implant-Supported Protheses Using Zygomatic Implants Placed Using the Sinus Slot Technique: Clinical Report on a Series of 21 Patients

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**Purpose:** The purpose of this article is to describe the management of patients with extreme maxillary atrophy. Their treatment consisted of maxillary fixed protheses supported by conventional implants placed in residual anatomic structures in conjunction with zygomatic implants positioned using the sinus slot technique of Stella and Warner. **Materials and Methods:** A retrospective chart review was conducted of all patients who received zygomatic implants between January 2000 and January 2005. The preoperative evaluations included panoramic digital radiographs and computed tomographic scan to identify the anatomic structures and detect the presence of pathology. All intra- and postoperative complications were recorded. Screw-fixed restorations were placed 4 to 6 months after implant placement. After prosthetic restoration, all patients received a minimum of 12 months' follow-up. **Results:** Twenty-one patients (11 women and 10 men) with severe maxillary atrophy underwent treatment with zygomatic implants placed using the sinus slot technique. Mean patient age was 54.1 years (range, 31 to 75 years). One patient presented with ectodermal dysplasia. A total of 89 conventional implants and 40 zygomatic implants were placed. During surgery, the sinus membrane was perforated in all cases; however, there were no significant postoperative complications. One patient presented with an ecchymosis. Two conventional implants failed; none of the 40 zygomatic implants failed. Mean follow-up after placement of the implants was 29 months, during which time the protheses and implants remained stable and functional. **Conclusion:** Zygomatic implants, when positioned in conjunction with premaxillary implants, can facilitate the surgical rehabilitation of patients presenting with severe maxillary resorption, as an alternative to bone grafting. (Case Series) INT J ORAL MAXILLOFAC IMPLANTS 2007;22:645-650

**Key words:** atrophic maxilla, dental implants, sinus slot technique, zygomatic implants

The zygomatic dental implant, which was designed by Nobel Biocare for the Brånemark System, was developed for use primarily for the severely resorbed maxilla. Since the initial description of the technique, zygomatic implants have been the subject of a number of studies designed to improve on the procedure.<sup>1-9</sup> The recommendations for zygomatic implant placement were to create a sinus window to

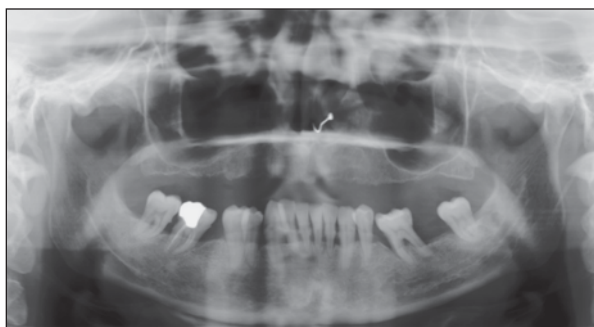
help visualize the angulation and eventual positioning. In fact, in an already resorbed maxilla, a sinus window could further compromise the precarious bone support of the remaining dental alveolus. Furthermore, the final position of the zygomatic implant with a palatal placement can affect the configuration of the prosthesis.<sup>2</sup> In 2000, Stella and Warner<sup>2</sup> presented zygomatic implant placement based on the sinus slot technique. In this technique, the dissection is narrower than the original Brånemark protocol, and the palatal mucosa is reflected only to expose the crest of the ridge. This technique minimizes dissection, and recovery time is reduced because of the reduction of postoperative symptoms. The sinus slot technique improves upon a number of aspects of the original procedure, such as implant orientation and elimination of the sinus window. A slot is formed, which results in a smaller anastomy and serves to orient the twist drills for implant placement under

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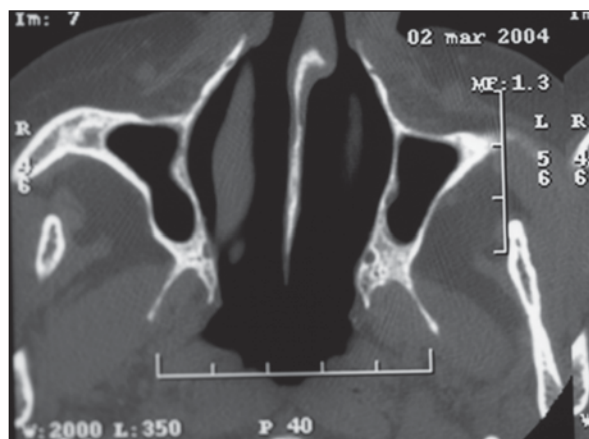
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**Fig 1** Case 6: Completely maxillary edentulous patient. Extraoral panoramic radiographic image prior to surgery.

**Fig 2 (right)** Case 14: CT image showing significant resorption of the maxillary bone.



direct visualization. The implant abutment is placed in the first molar region.

The particular interest of this study resides in the placement of zygomatic implants using the sinus slot technique, together with the use of residual anatomic structures such as the canine eminence and pterygoid area to rehabilitate patients with fixed implant-supported prostheses. A clinical series of 21 patients with severe atrophy of the maxilla was rehabilitated with conventional implants at the canine eminence and pterygoid area and zygomatic implants.

## MATERIALS AND METHODS

### Inclusion Criteria and Presurgical Evaluation

Twenty-three patients with severely atrophied maxillae rehabilitated with zygomatic implants placed using the sinus slot technique<sup>2</sup> between January 2000 and January 2005 were consecutively included in a retrospective chart review. All the patients had insufficient bone volume for routine placement of implants in the posterior maxilla. Before surgery, a digital extraoral panoramic radiograph (Fig 1) and computed tomographic scan (Fig 2) of the maxilla were studied to discount any sinus pathology such as acute or chronic sinusitis with mucosal hypertrophy and to evaluate the possibility of placing zygomatic implants. The inclusion criteria were (1) lack of medical pathology, (2) nonsmoker or smoker of less than 10 cigarettes per day, (3) restoration with zygomatic implants placed using the sinus slot technique, (4) restoration with fixed prostheses, and (5) a minimum follow-up period of 12 months from the time of prosthesis placement. One patient was excluded from the study for not regularly attending the follow-up examinations and another for not having a fixed prosthesis.

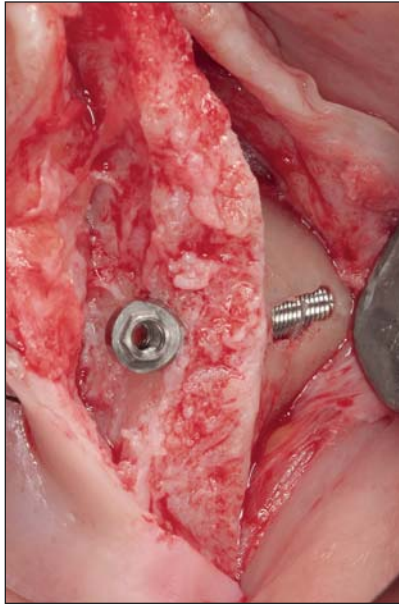
The following data were extracted from the dental records of all patients: age, sex, general history, smoking status, the number of zygomatic implants placed, the length of the implants, the number of additional implants placed, the type of prosthesis placed, the type of antagonist, the follow-up (in months), and general observations. All intra- and postoperative complications were recorded.

### Surgical and Prosthodontic Technique

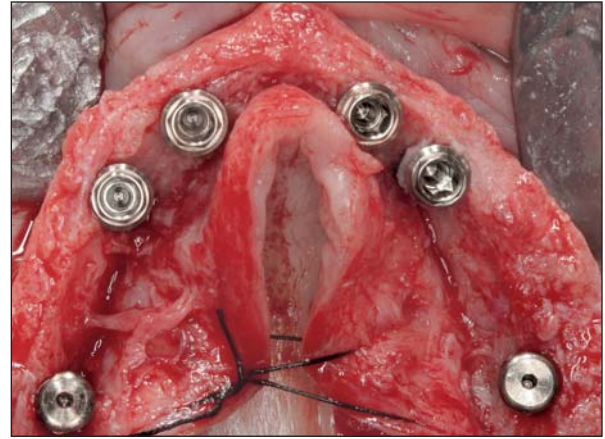
Surgery was performed by 1 surgeon (MP) using local anesthesia (4% articaine with 1:100,000 adrenalin; Articaina, Laboratorios Inibsa, Barcelona, Spain) and sedation with 1% propofol solution (Diprivan, Astra Zeneca Farmacéutica Spain, Madrid, Spain).

The zygomatic implants (Nobel Biocare, Göteborg, Sweden) were placed in the malar zygoma using the procedure described by Stella and Warner (Fig 3).<sup>2</sup> The conventional implants used were Defcon TSA implants with Avantblast surfacing (Impladent, Sentmenat, Barcelona, Spain; Figs 4 and 5) and ITI threaded implants (Straumann, Basel, Switzerland). In cases with a narrow bone crest, the implants were angulated into the palatine area,<sup>10</sup> facilitating placement of implants of an optimal length (Fig 4). All the implants remained submerged, and the second surgery was performed 2 months after implant placement.

All patients received postsurgical administration of amoxicillin (Clamoxyl, GlaxoSmithKline, Madrid, Spain) 500 mg/8 hours for 7 days; ibuprofen (Bexistar; Laboratorio Bacino, Barcelona, Spain) 600 mg/8 hours for 4 days; 0.12% chlorhexidine rinses (GUM, John O. Butler/Sunstar, Chicago, IL) 3 times a day for 7 days; and magnesium metamizol (Nolotil; Boehringer Ingelheim España, Barcelona, Spain) 575 mg upon demand in the event of intense pain. No allergies to these drugs were observed.

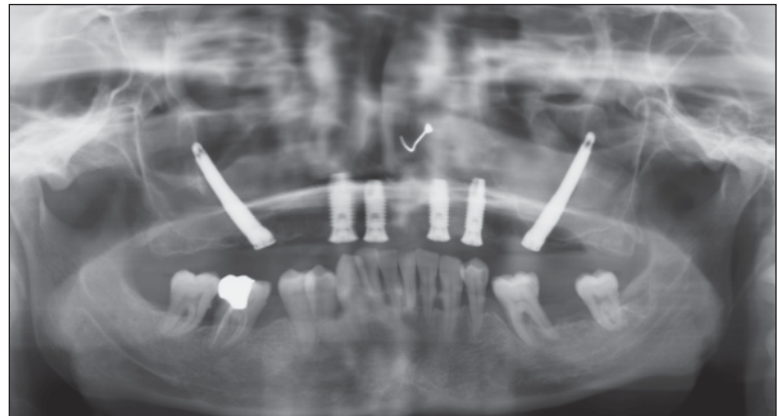


**Fig 5** Case 2: Extraoral panoramic radiographic image following the placing of 4 conventional and 2 zygomatic implants.



**Fig 3 (left)** Case 6: Placement of the anterior and zygomatic implants.

**Fig 4** Case 6: Image obtained following placement of the anterior implants.



Edentulous patients used their pre-existing complete dentures as provisional prostheses during implant healing or, for partially edentulous patients, provisional prostheses were fabricated. Patients were instructed not to use provisional prostheses for 1 week following implant placement. The definitive screw-retained prostheses were placed between 2 and 4 months after surgery (Figs 6 to 8). All patients were reviewed 1 month after implant placement and at 6 and 12 months after delivery of the definitive prostheses.

#### Success and Failure Criteria

Implants were considered successful if there was no mobility, infection, or pain from the implants when used to support a dental restoration. Each individual zygomatic implant was evaluated for stability following removal of the fixed prosthesis at annual follow-ups.

## RESULTS

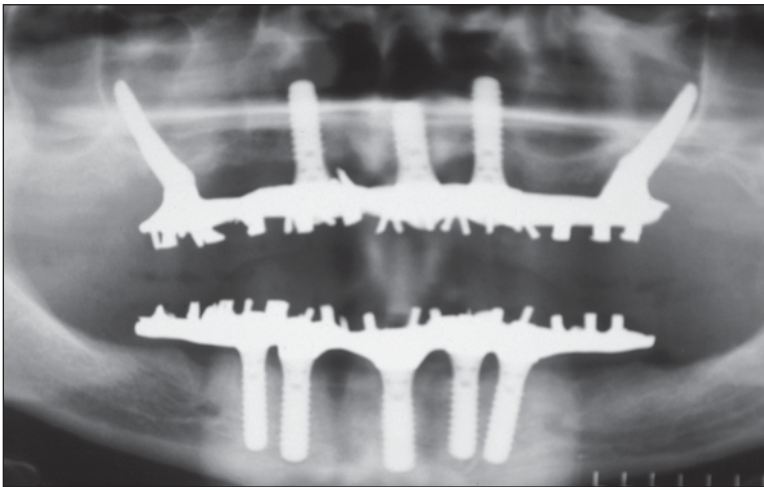
Twenty-one patients with severe maxillary atrophy underwent treatment with zygomatic implants placed using the sinus slot technique.<sup>2</sup> The implants were then restored with fixed prostheses. The clinical cases are summarized in Table 1. The mean follow-up was 29 months (range, 12 to 45 months). The mean patient age was 54.1 years (range, 31 to 75 years). Of the 21 patients, 11 were female and 10 male. With regard to previous history, 1 patient had ectodermic dysplasia, and 3 were smokers of less than 10 cigarettes per day. A total of 40 zygomatic implants were placed (bilaterally in 19 patients and unilaterally in 2 patients). The length of the zygomatic implants varied between 30 and 42.5 mm. Eighty-nine conventional implants were placed: 47 Defcon TSA implants and 42 ITI threaded implants. Seventy-eight implants



**Fig 6** Case 6: Soft tissue healing.



**Fig 7** Case 2: Intraoral clinical image following the placement of a screw-retained prosthesis.



**Fig 8** Case 2: Extraoral panoramic radiographic image following prosthesis placement.

were placed in the anterior area, seeking residual bone of the canine eminence, and 11 implants were placed in the pterygomaxillary area. The number of zygomatic and conventional implants located in each patient is shown in Table 1. The sinus membrane was perforated in all cases. Maxillary sinusitis occurred in 2 cases. In one case this resolved following the administration of antibiotics, and in the other case following the removal of a conventional implant. A total of 20 complete fixed screw-retained prostheses and 1 partial fixed screw-retained prosthesis were placed. The occlusion of the antagonist arcade is shown in Table 1. Two implants failed: 1 anterior implant was lost 1 month after surgery due to periapical peri-implantitis, and the other (a pterygoid implant) failed at 2 months as a result of trauma with the complete prosthesis. In the 2 patients in which implants failed, the definitive fixed screw-retained prostheses were supported by the remaining implants. Success was achieved in 98.7% of the premaxillary implants and in 90.9% of the pterygoid implants.

## DISCUSSION

In cases of maxillary atrophy, 2 types of treatment can be performed: bone grafts (onlay, sinus lift, or sinus inlay grafts)<sup>11-14</sup> or implant placement in residual anatomic structures (zygomatic implants, implants in the canine eminence and/or in the pterygomaxillary region).<sup>2-8,15</sup>

In published studies on the placement of implants in patients with bone atrophy,<sup>14,16,17</sup> the success rate is greater for implants placed in mature residual bone than for those placed with bone grafts. Widmark et al<sup>14</sup> found a failure rate of 13% against 25% after 2 years of follow-up. Additionally, the use of zygomatic implants reduces treatment time and eliminates the donor site morbidity associated with bone grafting. In recent studies, the success rate with zygomatic implants has ranged from 94.2% to 100%.<sup>18-20</sup> In the present study, the complications were minimal (ecchymosis in 1 case), and none of the 40 zygomatic implants had failed after a follow-up of 12 months.

**Table 1** Summary of Treatment and Complications

Case	Age	Sex	History	N° ZI	Length ZI	Anterior implants	Pterygoid implants	Type of antagonist	Follow-up (mo)	Complications
1	48	F	Hysterectomy Appendectomy	2	35/30	4		OD	39	
2	52	F	–	2	30/30	3		FP-I	35	
3	57	M	–	2	42.5/40	4	2	ND	21	
4	31	M	Ectodermic dysplasia	2	35/40	3		OD	33	
5	58	M	–	2	40/40	4		ND with FP	33	
6	47	F	–	2	40/35	4		ND	27	
7	48	M	Smoker	2	40/35	4		ND with FP	33	
8	50	M	–	2	35/40	4		ND with FP	45	
9	62	F	–	2	30/30	4	2	OD	36	
10	46	M	–	2	35/35	4		OD	22	
11	52	M	–	2	40/35	4		ND and FP-I	12	
12	54	F	Smoker	2	30/30	4	1	OD	41	
13	48	F	Smoker	2	35/30	6		ND	21	
14	75	F	–	2	35/35		2	OD	22	
15	54	M		1	42.5	2	1	OD	24	Sinusitis and anterior implant failure
16	63	M	–	2	40/42.5	4		ND and FP-I	33	
17	75	F	High blood pressure	2	35/30	2	2	OD	41	Ecchymosis
18	55	F		2	35/35	4		OD	29	Sinusitis
19	49	F	–	2	35/35	4		FP-I	21	
20	56	F		2	40/35	3	1	ND and skeletal	22	Pterygoid implant failure
21	56	M	–	1	35	7		FP-I	21	

ZI = zygomatic implant, OD = overlay denture, ND = natural dentition, FP = fixed prosthesis, FP-I = fixed implant-supported prosthesis

In this study, zygomatic implants were placed in an effort to provide a graft-free procedure for patients with atrophic maxillae and severe bone resorption in the anterior maxilla. The sinus slot technique, described by Stella and Warner<sup>2</sup> in 2000, was used to (1) better visualize the implant as it is seated into position; (2) reduce sinus complications by eliminating the need for the sinus window; (3) reduce postoperative symptoms; and (4) position the zygomatic implant more buccally, thus bringing the head of the implant into better alignment with the resultant prosthesis. The sinus slot technique allows a more vertical zygomatic implant angle and thus permits an improved design for the prosthesis. In this study, the zygomatic implants were bilateral in 19 cases and unilateral in 2 cases. In addition, residual anatomic structures, such as the canine eminence<sup>19</sup> and pterygoid area,<sup>20–22</sup> were used to restore all the patients with fixed, screw-retained prostheses.

## CONCLUSION

A high implant survival rate was observed following the placement of zygomatic implants in 21 patients using the sinus slot technique.

## REFERENCES

1. Brånemark P-I, Svensson B, van Steenberghe D. Ten-year survival rates of fixed prostheses on four or six implants ad modum Brånemark in full edentulism. *Clin Oral Implants Res* 1995;6:227–231.
2. Stella JP, Warner M. Sinus slot technique for simplification and improved orientation of zygomatic dental implants: A technical note. *Int J Oral Maxillofac Implants* 2000;15:889–893.
3. Bedrossian E, Stumpel L, Beckerly M, Indersano T. The zygomatic implant: Preliminary data on treatment of severely resorbed maxillae. A clinical report. *Int J Oral Maxillofac Implants* 2002;17:861–865.
4. Bothur S, Jonsson G, Sandahl L. Modified technique using multiple zygomatic implants in reconstruction of the atrophic maxilla: A technical note. *Int J Oral Maxillofac Implants* 2003;18:902–904.

5. Boyes-Varley JG, Howes DG, Lownie JF, Blackbeard GA. Surgical modifications to the Brånemark zygomatic protocol in the treatment of the severely resorbed maxilla: A clinical report. *Int J Oral Maxillofac Implants* 2003;18:232–237.
6. Schmidt B, Pogrel MA, Young C, Sharma A. Reconstruction of extensive maxillary defects using zygomatic implants. *J Oral Maxillofac Surg* 2004;62:82–89.
7. Peñarrocha-Diago M, Uribe-Origone R, Guarinos-Carbó J. Implant-supported rehabilitation of the severely atrophic maxilla: A clinical report. *J Prosthodont* 2004;13:1–5.
8. Peñarrocha M, Uribe R, García B, Martí E. Zygomatic implants using the sinus slot technique: Clinical report of a patients series. *Int J Oral Maxillofac Implants* 2005;20:788–792.
9. Hirsch JM, Öhrnell LO, Henry PJ, et al. Clinical evaluation of the zygoma fixture: One year of follow-up at 16 clinics. *J Oral Maxillofac Surg* 2004;62:22–29.
10. Mattsson T, Kondell PA, Gynther GW, Fredholm U, Bolin A. Implant treatment without bone grafting in severely resorbed edentulous maxillae. *J Oral Maxillofac Surg* 1999;57:281–287.
11. Isaksson S, Alberius P. Maxillary alveolar ridge augmentation with onlay bone-grafts and immediate endosseous implants. *J Craniomaxillofac Surg* 1999;20:2–7.
12. Rasmusson L, Meredith N, Cho IH, Sennerby L. The influence of simultaneous versus delayed placement on the stability of titanium implants in onlay bone grafts. A histologic and biomechanic study in the rabbit. *Int J Oral Maxillofac Surg* 1999;28:224–231.
13. Waite PD, Sastravaha P, Lemons JE. Biologic mechanical advantages of three different cranial bone grafting techniques for implant reconstruction of atrophic maxilla. *J Oral Maxillofac Surg* 2005;63:63–67.
14. Widmark G, Andersson B, Carlsson GE, Lindvall AM, Ivanoff CJ. Rehabilitation of patients with severely resorbed maxillae by means of implants with or without bone grafts: A 3- to 5-year follow-up clinical report. *Int J Oral Maxillofac Implants* 2001;16:73–79.
15. Balshi TJ, Wolfinger GJ. Analysis of 356 pterygomaxillary implants in edentulous arches for fixed prosthesis anchorage. *Int J Oral Maxillofac Implants* 1999;14:398–406.
16. Keller EE, Tolman DE, Eckert SE. Maxillary antral-nasal inlay autogenous bone graft reconstruction of compromised maxillae: A 12-year retrospective study. *Int J Oral Maxillofac Implants* 1999;14:707–721.
17. Lekholm U, Wannfors K, Isaksson S, Adielsson B. Oral implants in combination with bone grafts. A 3-year retrospective multi-center study using the Brånemark implant system. *Int J Oral Maxillofac Surg* 1999;28:181–187.
18. Brånemark P-I, Gröndahl K, Öhrnell LO, et al. Zygoma fixture in the management of advanced atrophy of the maxilla: Technique and long-term results. *Scand J Plast Reconstr Surg Hand Surg* 2004;38:70.
19. Ahlgren F, Storksén K, Tornes K. A study of 25 zygomatic dental implants with 11 to 49 months' follow-up after loading. *Int J Oral Maxillofac Implants* 2006;21:421–425.
20. Farzad P, Andersson L, Gunnarsson S, Johansson B. Rehabilitation of severely resorbed maxillae with zygomatic implants: An evaluation of implant stability, tissue conditions, and patients' opinion before and after treatment. *Int J Oral Maxillofac Implants* 2006;21:399–404.
21. Mattsson T, Köndell PA, Gynther GW, Fredholm U, Bolin A. Implant treatment without bone grafting in severely resorbed edentulous maxillae. *Int J Oral Maxillofac Implants* 2000;15:722–730.
22. Pi Urgell J. Implantes en la región pterigomaxilar: Estudio retrospectivo con un seguimiento de 1 a 10 años. *RCOE* 1988;3:339–348.
23. Balshi TJ, Wolfinger GJ. Treatment of congenital ectodermal dysplasia with zygomatic implants: A case report. *Int J Oral Maxillofac Implants* 2001;17:277–281.