A Retrospective Study of Implant-Retained Auricular Prostheses

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Purpose: *The purpose of this study was to retrospectively evaluate the clinical results of the implant-retained auricular prosthesis.* ***Materials and Methods:*** *Data were collected from 46 patients who were treated between 1992 and 2004 with implant-retained auricular prostheses. A total of 156 implants and 1 plate (Epitec System) were placed in 46 patients, including 23 EO System implants, and 133 Brånemark implants. The implant survival rate was 100%. Twenty patients with 53 implants were re-examined to evaluate the peri-implant soft tissue status. Two clinical peri-implant parameters were applied, skin probing depth and sulcus fluid flow rate.* ***Results:*** *No adverse skin reactions were observed in 22 implants. Skin pockets were found in all of the 53 reexamined implants, which indicates the need for greater skin reduction. The mean skin probing depth and sulcus fluid flow rate were 2.1 ± 0.9 mm and 1.8 ± 1.3 mm, respectively, and a significant positive correlation was found between these 2 parameters.* ***Conclusions:*** *From these results, it can be concluded that the implant-retained auricular prosthesis promises long-term stability for patients with severe defects or total loss of the ear. Furthermore, sulcus fluid flow rate is a valuable parameter for the evaluation of peri-implant soft tissue.* Int J Oral Maxillofac Implants 2008;23:539–543

Key words: *auricular prostheses, extraoral implants, osseointegration, peri-implantitis*

Partial ear deformities can be treated with reconstructive surgery, but major ear defects still present a challenging problem for the reconstructive surgeon. For patients with major ear defects, prosthetic rehabilitation appears to be a viable alternative therapy.[1] Although there have been improvements in reconstruction with prostheses,[2,3] the retentive method is always a particularly difficult problem. Traditional facial fixation tools, such as the aid of eyeglasses, adhesives, or skin tunnels have poor retention, and the results are often unsatisfactory.[4,5] The long-term use of osseointegration implants in the treatment of craniofacial defects has been well documented in the literature.[6–11] In 1979, Tjellström et al[9] first utilized osseointegrated implants for the retention of an auricular prosthesis. This method demonstrates much better stability and esthetic results and overcomes other disadvantages associated with conventional retentive methods.[4,5,10,11] Long-term success of implant-retained prostheses in the treatment of patients with complete and partial ear deformities has been reported by several authors.[10–14]

The purpose of this article was to retrospectively evaluate and re-examine the clinical results of patients treated with implant-retained auricular prostheses in the authors' clinic and to compare these results with other reports.

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MATERIALS AND METHODS

Patients

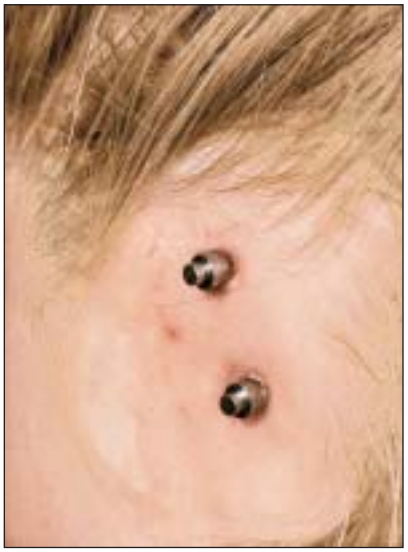
A total of 46 patients with ear deformities who were treated between 1992 and 2004 in the Department of Maxillofacial Surgery-Clinical Navigation and Robotics of Charité University Hospital in Berlin, Germany, were retrospectively evaluated. Patients were evaluated 3 months after the loading of their auricular prostheses. Patients who were lost to follow-up after the treatment were not included.

Table 1 Diagnoses of Included Patients

Diagnosis	No. of patients
Congenital defect	30
Goldenhar syndrome	8
Franceschetti syndrome	3
Thalidomide harm	1
Reason unknown	18
Tumor resection	12
Epithelioma	5
Malignant melanomas	1
Basaloma	4
Hemangioma	2
Inflammation	1
Chondrodermatitis	1
Trauma	2
Burn injury	1

Table 2 Distribution of Implants by Type

Implant type	No. of implants
Brånemark (Entific Medical System, Göteborg, Sweden)	133
EO system (Straumann, Basel, Switzerland)	23
Epitec system (Stryker-Leibinger, Freiburg, Germany)	1 plate



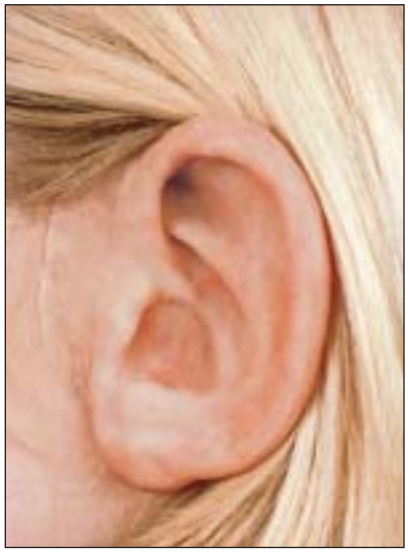


Fig 1 Two telescope magnets in place.

Fig 2 Auricular prosthesis anchored over a magnet supraconstruction.

The patient sample included were 18 female patients and 28 male patients. At the time of implant placement, the patients ranged from 5 to 96 years, with an average age of 38 years (SD 24.9). No radiotherapy was performed in any patient before insertion of implants or during the follow-up period. Congenital malformation (65.2%) was the most common indication for auricular prostheses. Other indications included resectioning because of tumor, inflammation, trauma, or burn injury (Table 1).

A 2-stage procedure was performed in 28 patients, with a healing period from 2.5 to 8 months (average 3.9 months). The other 18 patients were treated with 1-stage surgery and followed over an average interval of 3.2 months (range, 2.6 to 4.5 months) before loading of an auricular prosthesis. Thirty-one patients were treated with magnetic supraconstructions for prosthesis retention (Figs 1 and 2). Another 15 patients were provided with bar-and-clip supraconstructions. After 3 years, 4 of these patients were switched to magnet retention because of overgrowth of skin around the implants.

A total of 156 implants were placed in 45 patients. One hundred fifty-two were used; the others served as "sleeping" implants for future use in case of implant loss. One patient was treated with an 8-hole Epitec-system plate (Stryker-Leibinger, Freiburg, Germany) because insufficient bone volume in the mastoid region was found during the operation. No other intraoperative complications were reported during insertion of implants. The detailed distribution of implant types is shown in Table 2. No implant loss was observed during the follow-up period, which ranged from 6 months to 11 years. The survival rate of the implants was 100%.

Re-examination

All 46 patients were recalled for evaluation of the peri-implant soft tissue. Two clinical parameters, skin probing depth and sulcus fluid flow rate (SFFR), were examined.

Table 3 Peri-Implant Skin Reactions According to Holgers et al[16]

Grade	Description
0	No irritation
1	Slight redness
2	Reddish and slight moist tissue
3	Granulation tissue, revision surgery may be indicated
4	Removal of implant due to infection

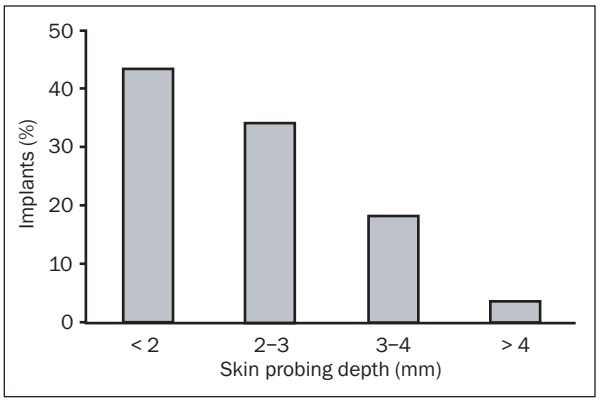


Fig 3 Distribution of skin probing depth in 53 implants.

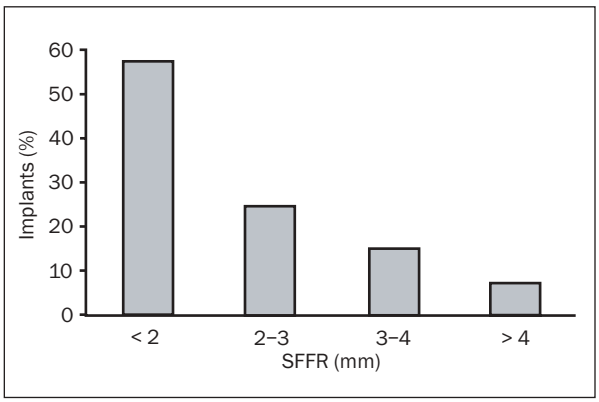


Fig 4 Distribution of SFFR in 53 implants.

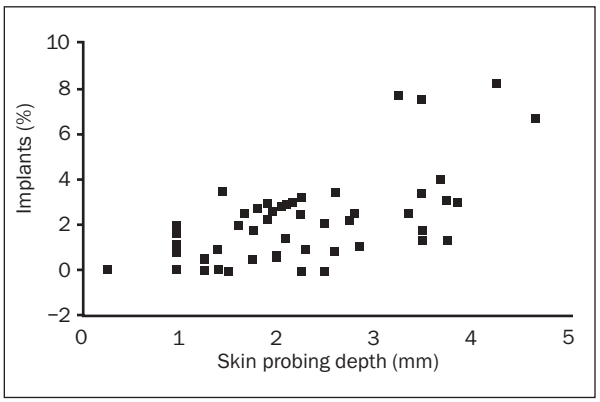


Fig 5 Scatter plot showing the correlation between skin probing depth and SFFR; $r = 0.64$.

A WHO periodontal probe was used to evaluate the peri-implant skin probing depth, which was measured clockwise (at the 12, 3, 6, and 9 o'clock positions). The mean of those 4 values was calculated.

SFFR is defined as the amount of sulcus fluid that could be accumulated with a standard filter paper within a fixed period. There is no or only a small amount of fluid in a healthy skin pocket. The more serious the peri-implantitis is, the greater the amount of the fluid that can be collected.[15] Without any previous local treatments, a small strip of filter paper (ISO 60, ORBIS Dental, Offenbach, Germany) was put into the sulcus, where the deepest probing depth was recorded. After 2 minutes the filter paper was colored by 1% Ninhydrin solution (in 70% ethanol). Three minutes later, the filter paper was measured with a ruler to record the length of the purple colored part. At the same time, peri-implant skin reactions were classified as grades 0 to 4 as reported by Holgers et al[16] (Table 3).

At each follow-up examination, the parameters were examined by 2 experienced, calibrated examiners. Recorded data were used for calculation of mean values, standard deviations, and percentage distributions. Spearman's correlation between skin probing depth and SFFR was calculated. Differences were considered statistically significant at $P < .05$.

RESULTS

Twenty patients (43.5%), 12 male and 8 female, with an average age of 47.7 years, were reexamined. Fifty-three implants were placed in these patients.

The mean skin probing depth was 2.1 ± 0.9 mm (range, 0.3 to 4.7 mm), while the mean SFFR was 1.8 ±1.3 mm (range, 0 to 8.2 mm). The detailed distribution of the 2 clinical parameters is shown in Figs 3 and 4. A significant positive correlation was found between skin probing depth and SFFR (Fig 5).

Table 4 Mean SFFR and Skin Probing Depth by Supraconstruction Type

	Magnet		Bar-and-clip	
Parameters	Mean	SD	Mean	SD
SFFR (mm)	1.8	1.4	2.1	1.5
Skin probing depth (mm)	2.0	0.9	2.6	1.5

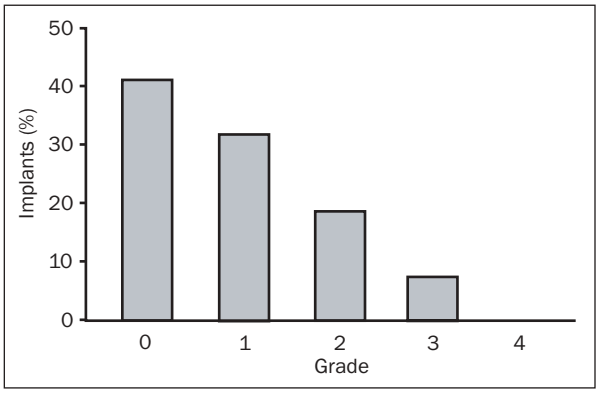


Fig 6 Distribution of grades of skin reaction in 53 implants.

The mean skin probing depth and SFFR were higher for implants (n = 8) with the bar-and-clip supraconstruction than for those with the magnet supraconstruction (n = 45). However, no significant difference was found between these 2 types of supraconstruction (Table 4).

No adverse skin reactions (grade 0) were found in 22 implants (41.5%). Slight redness (grade 1) or redness with moisture (grade 2) were found in 27 implants (51%). The patients with skin reaction grade 1 and 2 reported no complaints at all. Severe inflammation (grade 3) was observed in 4 implants (7.5%). Removal of implants due to infections was not necessary for any of the implants (Fig 6).

DISCUSSION

The use of titanium implants in the mastoid region is a well-established treatment concept. The authors' department has be utilizing this technology for more than 10 years. This study retrospectively evaluated 46 patients treated with implant-retained auricular prostheses; twenty of these patients were reexamined. No implant loss was observed in patients during the follow-up period; thus, the implant survival rate was 100%. A high implant survival rate in this region has also been reported by other authors.[10–14] The results in this and other studies support the conclusion that highest implant success rate is achieved in the mastoid region because of the dense cortical bone of the auricular region.[17,18] It has been generally thought that osseointegration requires a healing period of at least 3 months and that premature loading resulted in fibrous tissue encapsulation around the implants.[19,20] In this study, the average healing period in patients with either a 1- or 2-stage procedure was about 3 months.

Magnetic retention of a prosthesis is convenient for cleaning the peri-implant soft tissue and provides a natural mobility of prosthesis.[21,22] In contrast, with the conventional bar- and-clip method, it is difficult to maintain hygiene around the implants,[23] and metal clips may fracture over time, making revision and repair difficult.[24] In a study of auricular prostheses, Wazen et al reported that peri-implantitis in a patient was relieved after the changing from bar-and-clip to magnet supraconstruction.[25] In the reexamination conducted in the present study, higher skin probing depth and SFFR were observed with bar-and-clip supraconstruction; however, no statistically significant difference was found between the 2 types. The lack of significant difference may be related to the small number of implants under investigation.

Possible problems with the auricular prostheses include complications with irritation and inflammation of the skin around the implants. No adverse skin reaction or a minimal skin reaction (grades 0 to 2) were found for 92.5% of the implants, while granulation tissue (grade 3) was observed in 7.5% of the implants. This is consistent with other reports.[12,13,26] The majority of grade 1 or 2 skin reactions can be resolved with regular cleansing and application of mild ointments.[12,13,26] It is believed that the mechanical cleaning helps reduce extrinsic inflammatory factors.[27]

In the present study, skin pockets could be found in all of the examined implants, which indicated that a more restricted subcutaneous tissue reduction was necessary. As reported by other authors, peri-implant infection that persists even after intense local treatment can contribute to the thickness of the skin around the abutments, in which case skin reduction would be needed to normalize the soft tissue around the abutments.[11,26,28]

Although measurement of the SFFR was first developed to evaluate the gingival status around intraoral implants, Klein et al[29] found that SFFR is also a suitable parameter for the objective evaluation of peri-implant soft tissue in the craniofacial region. Knabe et al[15] reported that the SFFR is more useful than the skin probing depth in evaluating the peri-implant situation. Loe and his colleagues[30] found in a long-term study of gingivitis that the evaluation of the SFFR may indicate peri-implantitis before any clinical sign of inflammation. However, reports about the use of the 2 peri-implant parameters skin probing depth and SFFR in extraoral implants were not found in literature. Also,

there is still no standard definition of a healthy peri-implant skin pocket according to the skin probing depth and SFFR. The present study demonstrated in 53 implants that skin probing depth showed significant positive correlations with SFFR. In other words, a deep skin pocket is susceptible to an initial peri-implantitis. The results of this study demonstrate that SFFR may be a useful indicator of peri-implantitis. Measurement of SFFR should be considered as a routine clinical parameter in the assessment of peri-implant soft tissue; however, further study is needed to determine whether the SFFR can predict the early occurrence of inflammation. A standard score based on SFFR has not yet been reported. To find a correlation between SFFR and the grade of inflammation, a detailed histologic study of the skin pocket could be performed.

CONCLUSIONS

From the clinical results obtained in this study, it can be concluded that the implant-retained auricular prosthesis provides a high success rate in the mastoid region. A deep sulcus is usually a sign of peri-implantitis and indicates a need for surgical thinning of subcutaneous peri-implant soft tissue to relieve symptoms.

REFERENCES

1. Wilkes GH, Wolfaardt JF. Osseointegrated alloplastic versus autogenous ear reconstruction: Criteria for treatment selection. Plast Reconstr Surg 1994;93:967–979.
2. Postema N, van Wass MA, van Lokven J. Procedure for fabrication of an implant-supported auricular prosthesis. J Investig Surg 1994;7:305–320.
3. Butler DF, Gion GG, Rapini RP. Silicone auricular prostheis. J Am Acad Dermatol 2000;43:687–690.
4. Chang TL, Garrett N, Roumanas E, Beumer J III. Treatment satisfaction with facial prostheses. J Prosthet Dent 2005;94:275–280.
5. Markt JC, Lemon JC. Extraoral maxillofacial prosthetic rehabilitation at the M. D. Anderson Cancer Center: A survey of patient attitudes and opinion. J Prosthet Dent 2001;85:608–613.
6. Jacobsson M, Tjellström A, Fine L, Andersson H. A retrospective study of osseointegrated skin-penetrating titanium fixtures used for retaining facial prostheses. Int J Oral Maxillofac Implants 1992;7:523–528.
7. Wolfaardt JF, Wilkes GH, Parel SM, Tjellström A. Craniofacial osseointegration: The Canadian experience. Int J Oral Maxillofac Implants 1993;8:197–204.
8. Roumanas ED, Freymiller EG, Chang TL, Aghaloo T, Beumer J. Implant-retained prostheses for facial defects: An up to 14-year follow-up report on the survival rates of implants at UCLA. Int J Prosthodont 2002;15:325–332.
9. Tjellström A, Lindstrom J, Nylen O, et al. The bone-anchored auricular epithesis. Laryngoscope 1981;91:811–815.
10. Westin T, Tjellström A, Hammerlid E, Bergstrom K, Rangert B. Long-term study of quality and safety of osseointegration for the retention of auricular prostheses. Otolaryngol Head Neck Surg 1999;121:133–143.
11. Granström G, Bergtröm K, Tjellström A. The bone-anchored hearing aid and bone anchored epithesis for congenital ear malformations. Otolaryngol Head Neck Surg 1993;109:46–53.
12. Nishimura RD, Roumanas E, Sugai T, Moy PK. Auricular prostheses and osseointegrated implants: UCLA experience. J Prosthet Dent 1995;73:553–558.
13. Tolman DE, Taylor PF. Bone-anchored craniofacial prosthesis study: Irradiated patients. Int J Oral Maxillofac Implants 1996;11:612–619.
14. Watson RM, Coward TJ, Forman GH. Results of treatment of 20 patients with implant-retained auricular prostheses. Int J Oral Maxillofac Implants 1995;10:445–449.
15. Knabe C, Grosse-Siestrup C, Becker H, Pustelnik A, Gahl G. A new method to evaluate the CAPD-catheter-exit and other percutaneous devices. Int J Artif Organs 1991;14:83–86.
16. Holgers KM, Tjellström A, Bjursten LM., Erlandsson BE. Soft tissue reactions around percutaneous implants: A clinical study of soft tissue conditions around skin-penetrating titanium implants for bone-anchored hearing aids. Am J Otol 1988;9:56–59.
17. Klein M, Menneking H, Neumann K, Hell B, Bier J. Computed tomographic study of bone availability for facial prosthesis bearing endosteal implants. Int J Oral Maxillofac Surg 1997;26:268–271.
18. Tjellström A. Osseointegrated implants for replacement of absent or defective ears. Clin Plast Surg 1990;17:355–365.
19. Brunski JB, Moccia AF Jr, Pollack SR, Korostoff E, Trachtenberg DI. The influence of functional use of endosseous dental implants on the tissue-implant interface. I. Histological aspects. J Dent Res 1979;58:1953–1969.
20. Brånemark P. Osseointegration and its experimental background. J Prosthet Dent 1983;50:399–410.
21. Alvi R, McPhail J, Hancock K. Closed-field titanium magnets for the retention of complex craniofacial prostheses. Br J Plast Surg 2002;55:668–670.
22. Köhler S, Schmelzle R, Stemmann HJ. STECO titanium magnets. A new magnetic attachment [in German]. HNO 1994;42:173–176.
23. Menneking H, Klein M, Locke HG, Gonschior S. Postoperative management of bone-anchored facial epitheses [in German]. HNO 1998;46:579–582.
24. Payne AG, Solomons YF. Mandibular implant-supported overdentures: A prospective evaluation of the burden of prosthodontic maintenance with 3 different attachment systems. Int J Prosthodont 2000;13:246–253.
25. Wazen JJ, Wright R, Haftfield RB, Asher ES. Auricular rehabilitation anchored titanium implants. Laryngoscope 1999;109:523–527.
26. Portmann D, Boudard P, Herman D. Anatomical results with titanium implants in the mastoid region. Ear Nose Throat J 1997;76:231–236.
27. Bonding P, Ahlgren P, Dige-Petersen H. Permanent, skin penetrating, bone-anchored titanium implants. A clinical study of host-reaction in bone and soft tissue. Acta Otolaryngol 1992;112:455–461.
28. Niparko J, Langman A, Cutler D, Carroll WR. Tissue-integrated prostheses in the rehabilitation of auricular defects: Results with the percutaneous mastoid implants. Am J Otol 1994;14:343–348.
29. Klein M, Menneking H, Müller-Kauter U, Bier J. The application of objective parameter sulcus fluid flow rate (SFFR) for the evaluation of peri-implantitis in the craniofacial region. Progress of prosthetic surgery. In: Reitemeier G, Penkner K (eds). Kongressband 9. International Symposium of Prosthetic Surgery, Linz, Austria, 1997:43–48.
30. Loe H, Theilade E, Jensen SB. Experimental gingivitis in man. J Periodontol 1965;36:177–179.