Implant-Retained Prostheses for Facial Defects: An Up to 14-Year Follow-up Report on the Survival Rates of Implants at UCLA

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Purpose: An analysis of retrospective data was conducted to establish the survival rates of osseointegrated implants used to retain orbital, nasal, and auricular prostheses over a 14-year period and to recommend guidelines in the restorative treatment of such facial defects. **Materials and Methods:** Included in this study were all patients who received implant-retained prostheses for auricular, nasal, or orbital defects from 1987 to 2001 in the Maxillofacial Clinics at the UCLA and City of Hope Medical Centers. Data were obtained from patient charts. Two methods were used to determine survival rates: *(1)* the percentage of the total exposed implants that survived was determined, and *(2)* lifetable analysis was used to calculate cumulative survival rates at different time intervals. **Results:** A total of 207 implants were placed in 72 patients, and 182 implants had been uncovered. During the study period, 35 implants failed to integrate, and the survival rate for all exposed implants was 80%. Auricular implants showed the highest survival rate (95%), and orbital implants showed the lowest survival rate (53%). The lifetable analysis demonstrated a cumulative 6-year survival rate of 92% for auricular implants and 87% for piriform/nasal implants. In contrast, the survival rate for orbital implants showed a steady downward trend and reached 59% at 66 months. **Conclusion:** It is possible to achieve high survival rates of implants in the auricular and piriform/nasal sites through careful presurgical and radiographic planning. The less favorable long-term survival of implants in the orbital rim, especially at irradiated sites, requires further study. *Int J Prosthodont 2002;15:325–332.*

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Osseointegrated implants have had a dramatic impact on patient acceptance of facial prostheses. Patients like the security, comfort, and convenience of implant-retained prostheses, benefits that are not attainable with earlier methods of retention.[1–4] Surgeons have come to appreciate the reduced need for numerous complex surgical reconstructive procedures in many of these patients. For large defects, a multidisciplinary approach is recommended, combining flap reconstruction and implant-retained prosthetic rehabilitation to achieve optimal results.[5–7] Earlier reports have shown that osseointegrated implants are not uniformly successful, and the failure rates in some patients/sites are quite high.[8–11] The failures and complications appear to be site specific and radiation and time dependent.[12–16]

In the 14 years since UCLA began placing implants in the craniofacial region, the institution's treatment approach has evolved through a better understanding of factors involved in the long-term maintenance of osseointegration and careful presurgical

Table 1 Patient and Implant Data

Implant site	Age range (y)	Mean age (y)	Sex	Defect etiology	Total implants placed	Implant lengths	Mean healing time (mo)	Overall survival rate (%)
Auricular	15–73	36.8	M: 32 F: 5	Tumor: 13 Congenital: 13 Trauma: 11	117	Brånemark 3 mm: 63 4 mm: 30 BUD (BUD Industries) 3.5 mm: 24	4.9	95
Nasal	48–80	64.5	M: 11 F: 9	Tumor: 20	43 (35 piriform, 8 glabella)	Brånemark 3 mm: 14 4 mm: 8 ≥ 7 mm: 20 BUD 5 mm: 1	6.2	81 piriform, 25 glabella
Orbital	14–79	48.8	M: 8 F: 7	Tumor: 13 Trauma: 2	47	Brånemark 3 mm: 26 4 mm: 13 BUD 3.5 mm: 6 4.5 mm: 2	5.2	53

planning. This is an updated report providing the survival rates of implants used for the purposes of retaining auricular, nasal, and orbital prostheses and briefly describing the current treatment protocols for these three types of facial defects.

Materials and Methods

A total of 72 patients treated with osseointegrated implant-retained auricular, nasal, and orbital prostheses were included in this study. They represent all patients treated from 1987 to 2001 for these three types of defects in the Maxillofacial Clinics at the UCLA and City of Hope Medical Centers. Patient charts were reviewed for demographic data, defect types, etiology, surgical dates, radiation status, implant sites, implant lengths, dates of implant placement, and completion of prosthetic rehabilitation (Table 1). Follow-up appointment entries were checked for reports of complications, implant failures, and other pertinent information.

Of the 207 implants placed in these patients, 25 had not yet undergone stage-two surgery. Two patients with five implants in the auricular group wore their prostheses for a short period and then requested to have their implants buried. These five implants were counted as buried. Three additional implants were buried in the auricular congenital group as a result of persistent soft tissue infections. Four other patients, two with auricular and two with nasal defects, lost some or all of their initial implants (seven total). Subsequently, seven additional implants were placed in these patients. Because these patients were treated at two separate times they were counted twice, and both initial and replacement implants were included in the final sample of 182 exposed implants. Within the auricular congenital anomalies group, three patients required bilateral prostheses plus a bone-anchored hearing aid (Brånemark system, Nobel Biocare).[17] The three implants used to retain the hearing aids were also included in the final sample.

Implant Placement Protocol

The following is a brief description of the implant placement protocol observed in our clinic. Stage-one surgeries are performed as described by Adell et al[18] and Tjellström.[19] Templates with markers are routinely used during radiographic evaluation as well as during surgery to ensure optimal implant placement with adequate spacing and proper angulation. In auricular defects, three implants are positioned along an arc posterior to the external auditory meatus at the thickest portion of the ear below the antihelix. Currently, in nasal defects, two conventional-length implants are placed at the floor of the nose. The piriform ridge is the primary site, and the glabella is an occasional secondary site. In the orbital region, three implants are placed in the supraorbital rim. At times, the infraorbital rim serves as a secondary site. The length of healing between stage-one and stage-two surgery varies from 4 to 7 months according to the bone quality and radiation status of the implant sites.

Implant Survival

In this study, implant survival was defined as the absence of clinical implant mobility. Since it is difficult to take standardized radiographs in the facial region to assess bone loss, it was not used as a criterion for implant success. Although flange exposure is a sign of bone loss and an indicator of poor long-term

Table 2 Nonirradiated Craniofacial Implants

Implant site	Patients treated	Implants placed	Implants uncovered	Implants buried	Implants failed	Survival rate (%)
Auricular	35	111	97	8	5	94
Nasal	16					
Piriform		27	25	0	5	80
Glabella		6	6	0	4	33
Orbital	9	28	25	2	7	70
Overall	60	172	153	10	21	85

Table 3 Irradiated Craniofacial Implants

Implant site	Patients treated	Implants placed	Implants uncovered	Implants buried	Implants failed	Survival rate (%)
Auricular	2	6	6	0	0	100
Nasal	4					
Piriform		8	6	0	1	83
Glabella		2	2	0	2	0
Orbital	6	19	15	0	11	27
Overall	12	35	29	0	14	52

prognosis, implants with flange exposure were not recorded as failures. Implants that were never exposed, as well as implants that were exposed and later buried per patient request or because of soft tissue and position problems, were not included in the survival rate calculations.

Two methods were used to calculate the percentage of implant survival, or survival rate. The first, a commonly used method, determined the percentage of the total number of exposed implants that survived without regard to the survival time. In the second method, a lifetable analysis was used to calculate cumulative survival rates over time.[20–23] The beginning point for this analysis was stage-one surgery, and the endpoint was either implant failure or the last follow-up visit for implants without mobility.

Results

Of the 182 implants uncovered, 35 failed to integrate, 147 survived, and 10 were buried, for an overall 80% survival. Auricular implants showed the highest overall survival rate of 95%; orbital and glabella implants had the lowest, at 53% and 25%, respectively (Table 1). The mean follow-up period following stage two of all the patients included in this study was 49 ± 40 months. Eighteen patients experienced one or more implant failures; nine of these 18 lost all of their implants.

In the auricular group, only five implants failed to osseointegrate. There were 12 implant failures in the nasal group, six each in the piriform and glabella sites. The six glabella failures included five implants of 3-mm and one of 5-mm length. The two implants that remain in the glabella are 7-mm and 10-mm conventional-type implants. In orbital defects, 40 implants were uncovered, of which 18 failed.

Implant Survival in Nonirradiated and Irradiated Patients

Only two patients with six implants were irradiated in the auricular group; 35 patients were nonirradiated (Tables 2 and 3). One patient received 4,800 cGy, 30 months prior to implant placement, and the other received 5,940 cGy, 49 months prior to implant placement. The latter patient suffered acute soft tissue reactions and wound breakdown at the time of radiation and was treated with hyperbaric oxygen (HBO) on two separate occasions. All implants in these two patients were well integrated at stage two. However, patient one developed a recurrence shortly after implant uncovering, and further surgical resection resulted in removal of all the implants.

Four patients in the nasal group were previously irradiated. The total dose ranged from 5,580 to 6,850 cGy . Of six implants placed in the irradiated piriform group, only one failed to achieve osseointegration (83% survival). In the irradiated glabella, two of two implants failed to osseointegrate (0% survival).

Nine of the 15 patients in the orbital group received radiation anywhere from 7 to 68 months prior to implant placement. Radiation doses ranged from 3,960 to 6,000 cGy. The implant survival was 27% in the irradiated and 70% in the nonirradiated groups.

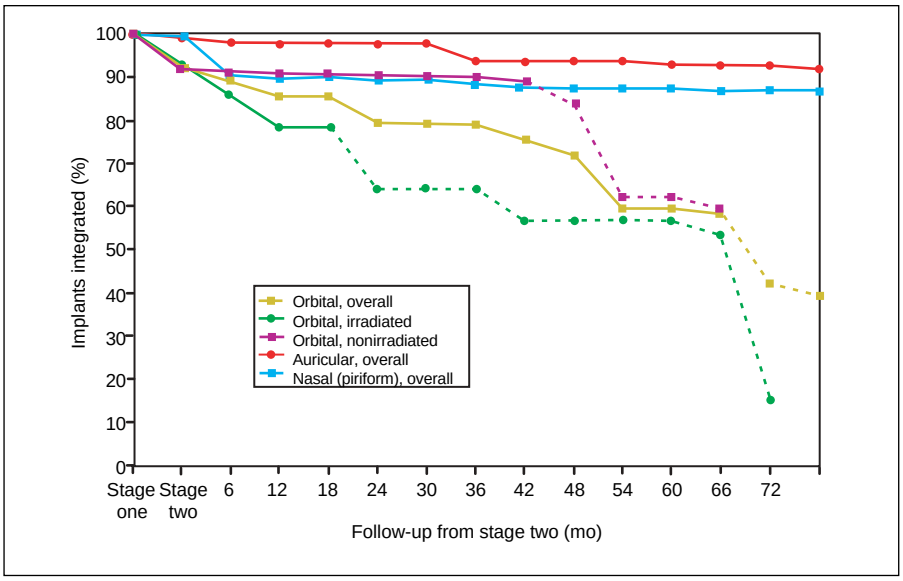

Fig 1 Lifetable analysis: cumulative survival rates. Dotted lines represent rates based upon a sample of 10 or fewer implants and are not considered valid.

Early and Late Implant Failures

Early failures were implants that failed during stage-two surgery, prior to functional loading, or within the first 6 months of functional loading. Late failures were implants that failed integration after 6 months of loading. Of the five implant failures in the auricular group, two were early failures (prior to implant loading), and the remaining three implants were late failures (after 36 months of loading) in a young patient, possibly because of repeated trauma to the head from playing soccer. In nasal defects, seven implants were early failures and five were late failures. In contrast, 13 of the 18 orbital implants were late failures and occurred after functional loading of 42 to 70 months. Seven of the 13 failed implants were implants that required removal because of repeated, uncontrollable infections.

Survival Rates by Lifetable Analysis

The overall implant survival rates for each of the three defects by site and for orbital defects by nonirradiated and irradiated patients are shown in Fig 1. The survival rates remained relatively stable after 6 months for auricular and piriform sites, but a continued downward trend with markedly higher failure rates over time was noted for the orbital sites. The survival rate in the nonirradiated orbital sites was close to 90% at 42 months, after which there was a steep decline. In the irradiated orbital group, there was a steady decline throughout the study period.

Discussion

The choice between surgical reconstruction and prosthetic restoration of large facial defects remains a difficult one and depends on the size and etiology of the defect, as well as on the wishes of the patient. Development and application of osseointegrated implants to facial defects has, in part, changed patient perceptions of facial prosthetics. Implants allow convenient and secure positioning of the prosthesis, leading to greater patient acceptance. Osseointegrated implants overcome many of the shortfalls of conventional retentive methods; however, they are not uniformly successful.

This study represents an analysis of retrospective data. Comparisons of survival rates for different sites are difficult because of many uncontrolled variables including age, sex, configuration of the surgical defect, implant site, implant length, healing time, radiation status, timing of implant placement, and prosthetic design. The limited number of patients and wide variability of defects, treatment approaches, and follow-up procedures place serious limitations on our assessment of implant survival; however, certain trends are evidenced.

The auricular region was found to be the most dependable implant site, with an overall 6-year 92% cumulative implant survival. Similar results were reported by other investigators.[8–11] Because of the relatively low number of implant failures, it was not possible to establish any relationship between implant failure and such variables as implant length, healing time, patient age, radiation status, etc. In our current

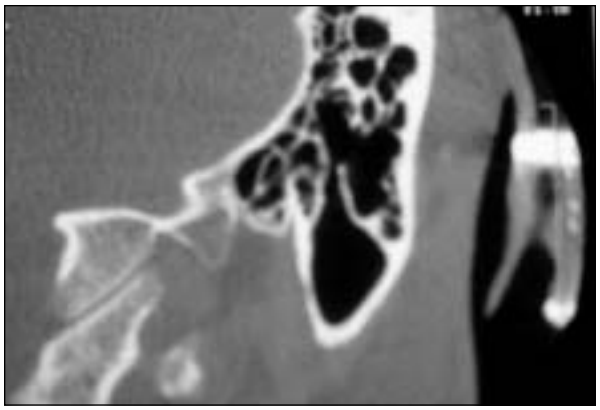

Fig 2a CT scan with radiographic stent used for presurgical evaluation of auricular bone sites.

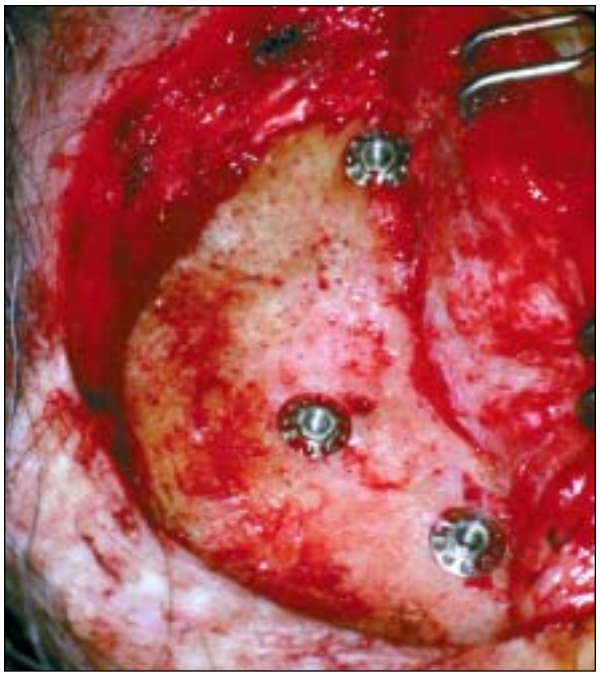

Fig 2b *(right)* Craniofacial implants with complete seating of the flanges in the temporal bone.

protocol, all potential auricular implant patients undergo a presurgical computed tomographic (CT) scan with a radiographic stent with gutta percha markers in position (Fig 2a). This allows for evaluation of the proposed bone sites in an attempt to maximize implant length. The mastoid air cells frequently pose logistical problems at the most inferior auricular implant sites, and occasionally implant position has to be recalculated. Exposure of the air cells at the time of implant placement does not appear to cause any detrimental effects. If there is adequate bone to provide stability, the implant may be left in position; otherwise, a new site will have to be found. The flange is a favorable feature in the auricular site, preventing accidental intrusion into the cranium and providing some initial stability for these very short implants (Fig 2b).

The use of three implants in the auricular region reduces the amount of cantilevering and provides a tripod effect for possible mechanical advantage. All implants are splinted together with a tissue bar, and retention is achieved with Hader clips (Sterngold ImplaMed). Magnets are occasionally used in combination with clips in cases requiring long cantilevers. Hader clips provide a very high level of retention in comparison to magnets, especially in the auricular region, where lateral or sheer forces can easily displace the ear.[24] This is an important consideration for young and active patients.

The primary implant site for nasal defects is the piriform ridge at the base of the nose. The 6-year cumulative survival rate at the piriform/nasal site (87%) was very encouraging. The survival rate was 89% for

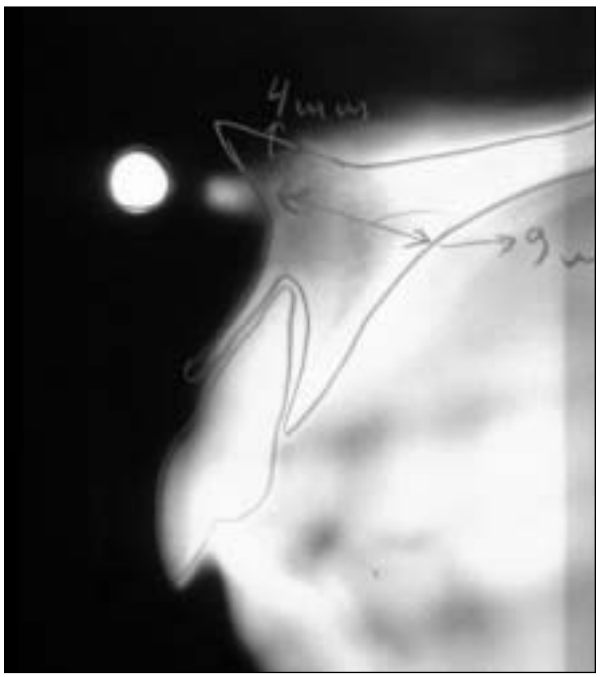

Fig 3 Tomograms of a nasal patient are used to determine implant length and angulation to avoid the tooth roots.

7-mm or longer nonflange implants and was only 73% for craniofacial-type implants. In the majority of patients, with careful planning, there is usually adequate bone for conventional-length implants. Occasionally, the glabella is used as a secondary

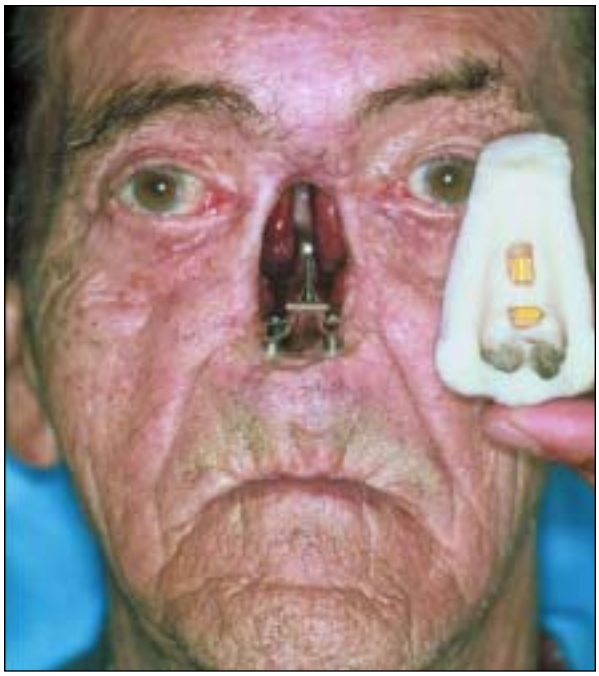

Fig 4a Horizontal and vertical Hader bar design used in nasal defects.

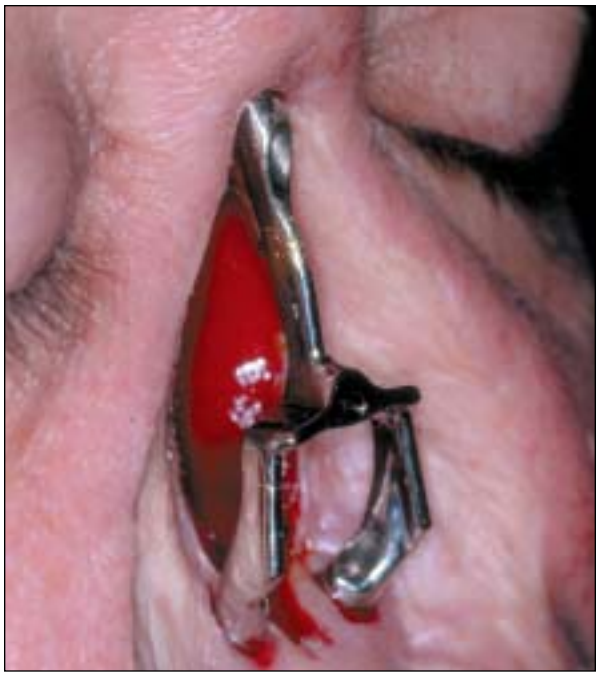

Fig 4b Glabella implant splinted to the piriform implants via segmented tissue bar and set screw.

implant site for nasal defects; the primary consideration is the degree of pneumatization of the frontal sinus and the quantity of overlying bone. In those cases where 7-mm or longer implants were placed in the glabella, the implant survival outcome was more favorable.

In our current practice, nasal patients are initially screened with a panoramic radiograph followed by tomograms (Fig 3). The tomogram radiographs are used to determine the most favorable implant angulation to avoid the root tips of the teeth. In some patients, the piriform ridge may be sharp on the superior aspect, requiring recontouring prior to implant placement. Use of nonflange-type implants alleviates the need for perpendicular implant placement to the bone and countersinking for the flange. The piriform implants are splinted together with a combination of vertical and horizontal Hader bars (Fig 4a). This configuration allows for secure retention without rotation around the bar. In patients in whom an implant is placed in the glabella, the two separate tissue bars are connected with a set screw (Fig 4b).

Orbital implants demonstrated a high rate of complications and failures. All implants placed in the orbital region were craniofacial flange-type (3 to 4 mm) implants. Our overall cumulative 66-month survival rate within this group was a discouraging 59%, with a trend toward further decrease over time, especially in the irradiated group. Thirteen of the 18 failures were late failures after 42 or more months of functional loading. A large number of patients experienced repeated infections and inflammatory episodes of the soft tissues around the implants (Fig 5a). These episodes, once begun, were persistent and did not respond well to local measures or systemic antibiotics as compared to other sites. Previous studies reported similar soft tissue problems[25] and variability in long-term integration of orbital implants.[8–11] Almost all patients with skin-penetrating implants demonstrate soft tissue problems at some point during the follow-up period. Most of these problems are resolved with conservative measures. In our clinic, these measures include increased emphasis on improved hygiene with soap and water, use of a hydrogen peroxide: chlorhexidine mixture (1:1), and more frequent follow-up visits. Soft tissue thickness is an important factor; a thin and immobile soft tissue bed has been shown to lead to fewer periimplant tissue complications.[26] This is difficult to achieve in the orbital region, where soft tissue thinning may have the undesirable effect of displacement of the eyebrow.

We further surmise that the high rate of implant failure in the supraorbital rim is secondary to compromised blood supply in this region. Trauma to the periosteum at the time of surgical resection and during implant procedures reduces the blood supply, and the addition of radiation therapy further compounds this problem. The remodeling capacity of this

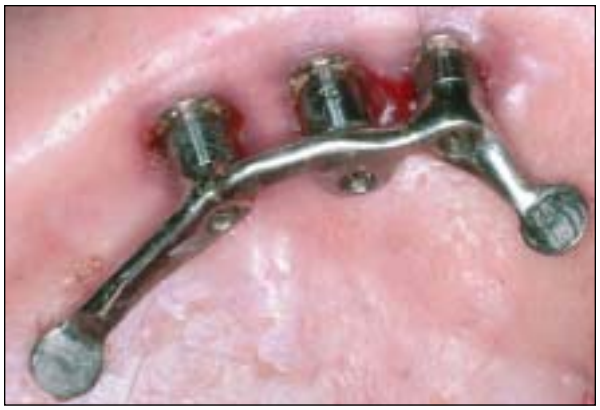

Fig 5a Soft tissue problems and flange exposure of orbital implants.

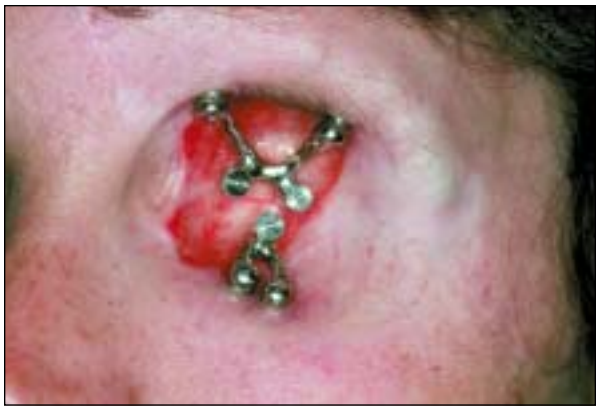

Fig 5b Tissue bars with magnets are routinely used to retain orbital prostheses.

poorly vascularized bone might be responsible for the many implant failures following functional loading. Perhaps the use of conventional-length, non-flange-design implants, as demonstrated by other studies,[27,28] and/or extended healing periods may be required to increase the amount of bone apposition to the implant[29] and improve long-term survival. In orbital defects, tissue bars with magnets are used in attempts to minimize the amount of stress delivered to the implants (Fig 5b). Extension of the silicone base into the defect further stabilizes the prosthesis and reduces the possibility of lateral displacement.

The risk of osteoradionecrosis based on data from our study and other reports appears to be almost zero[12]; however, the doses employed were generally below 6,500 cGy. Therefore, the principal concern is the long-term predictability of implants placed in irradiated bone.[30] HBO may be useful in enhancing the viability of irradiated bone, thereby providing a more suitable implant bed and more predictable results.[31–34] In the past, HBO was not part of our treatment regimen for a variety of reasons, including cost, availability of treatment centers, length of treatment, and concerns regarding effect of HBO on tumor status. Currently, we are using HBO in selected patients.

Conclusion

Osseointegrated implants provide a viable option for treatment of patients needing a variety of orofacial prostheses. Implants can overcome many of the difficulties encountered in retaining large facial prostheses. Our findings indicate predictable high survival rates for implants in the auricular and piriform/nasal sites and a less favorable outcome in the orbital region, especially in irradiated sites. Survival rates remained relatively stable after 6 months for auricular and piriform sites, but a continued downward trend with higher failure rates over time was noted for the orbital region. Implant-retained facial prostheses are not the treatment of choice for all patients with facial defects; patients must be carefully evaluated and fully informed.

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Literature Abstract

Histologic and histomorphometric evaluation of peri-implant bone subjected to immediate loading: An experimental study with Macaca fasicularis.

The hard tissue reactions around immediately loaded grade II titanium implants in the posterior mandible were studied in a primate model. The mandibular second premolars and molars were extracted and allowed to heal in six monkeys. Thirty-six implants were placed in the posterior mandible. Eighteen implants were immediately loaded on one side of the mandible (test group); on the contralateral side, the implants were loaded after osseointegration (control group). Second-stage surgery in the control group was performed on the same day as implant placement in the test group. The prosthetic protocols were identical in both groups: 1 month of provisional acrylic resin restorations followed by definitive splinted metal crowns. Oral hygiene was maintained regularly under general anesthesia. The monkeys were sacrificed after 3 months of implant loading. The implants were evaluated histologically and histomorphometrically. There were no adverse soft tissue reactions, all implants were osseointegrated in compact bone with no soft tissue at the interface, and there were no mechanical failures of implant components. There was a higher density of bone between threads in immediately loaded implants. The result of this study was in favor of immediate loading; however, similar results may not be obtained in humans with different implant systems.

Romanos GE, Chooi GT, Chong HS, Swaminathan D. *Int J Oral Maxillofac Implants* 2002;17:44–51. **References:** 57. **Reprints:** Dr George Romanos, Dental School Frankfurt, Department of Oral Surgery, Theodor-Stern-Kai 7, D-60590 Frankfurt, Germany. e-mail: Dr.G.E.Romanos@t-online.de—*Ansgar C. Cheng, Toronto*