An Adverse Implication of Radiation Therapy for Implant-Retained Maxillofacial Prostheses

Tadashi AKAMATSU, Ushio HANAI, Megumi KOBAYASHI, Takahiko KUROKI, Yotaro TSUNODA and Muneo MIYASAKA

Department of Plastic Surgery, Tokai University School of Medicine

(Received May 27, 2015; Accepted June 3, 2015)

We report the 19-year postoperative course of a patient whose maxillary defect was reconstructed with maxillofacial implant-retained facial prostheses. The patient received 60 Gy of radiation therapy. Adjunctive hyperbaric oxygen therapy was administered and four 4.0-mm long maxillofacial implants were inserted. Four years and 6 months after insertion surgery, two of the four implants were lost and the others showed bone regression in the surrounding bone. All implants were replaced with Epitec System maxillofacial implants placed in non-irradiated bone. Eleven years and 6 months after replacement, the Epitec System has been maintaining good and firm osseointegration. Appropriate selection of implant sites and no history of radiation therapy are keys to successful implant reconstruction. However, adjunctive hyperbaric oxygen therapy is believed to be effective, osseointegrated implant should be inserted at a point appropriately distant from an irradiated lesion.

Key words: Maxillofacial implant, Prostheses, radiation , irradiated, Epitec system

INTRODUCTION

Silicone facial prostheses have been used to reconstruct facial tissue loss associated with tumor resection in the maxillofacial region or extensive facial injuries [1–3]. In 1981, Branemark and his co-workers developed a maxillofacial implant system that provided secure support for a facial prosthesis through implant placement in the bone [4–6]. They dramatically improved the practical usage of prosthesis. However, maxillofacial implants are prone to loss of osseointegration in cases that had undergone preoperative radiation therapy [7–9]. To the best of our knowledge, few detailed failure cases or long-term outcomes of maxillofacial implants have been reported, although several case reports on implants are available [10, 11].

CASE REPORT

A 67-year-old woman underwent maxillectomy because of maxillary cancer. Periorbital soft tissue and the contents of the orbit, maxillary bone, and zygomatic bone in the affected side were surgically removed. **(Fig. 1)** Her cheek skin was preserved intact. She received 60 Gy of radiation therapy before the tumor resection surgery. The periorbital tissue defect and naso-orbital fistula was closed with a rectus abdominis muscle flap. The flap was used to close the oral side of the defect and to increase the fullness of the cheek soft tissues. One year after primary surgery, the patient selected implant-retained maxillofacial prostheses for periorbital reconstruction instead of reconstruction with autologous tissue. Before maxillofacial implant insertion surgery at the age of 68, adjunctive hyperbaric oxygen therapy was administered. She was given 100% oxygen at 2 atmospheres of pressure for an hour each day over the week before and for two weeks after surgery. Implant insertion surgery was performed under general anesthesia, and four 4.0-mm long maxillofacial implants (Nobel Biocare Holding AG, Switzerland) were inserted in the frontal bone (the intraorbital wall of the supraorbital margin) **(Fig. 2)**. The postoperative course was favorable and without complication.

Three months after implant insertion, abutments and a short bar framework were fabricated to connect the maxillofacial implant fixtures with each other. The prosthesis was attached to the framework with clips

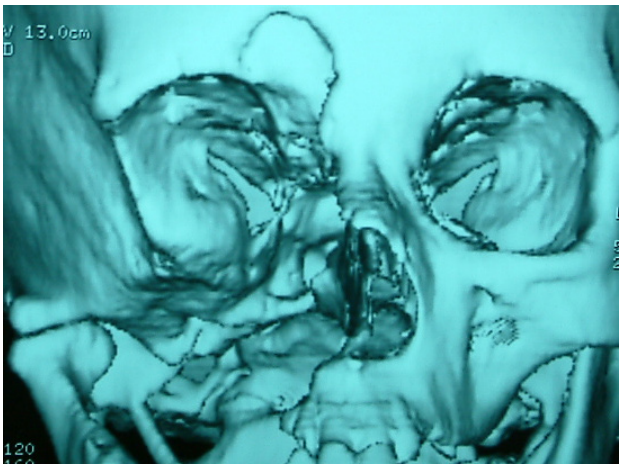

Fig. 1 The maxillary bone, zygomatic bone, naso-ethmoidal bone, and a part of frontal bone removed in the affected side were evident in the 3D view of the CT examination.

Tadashi AKAMATSU, Department of Plastic Surgery, Tokai University School of Medicine, 143 Shimokasuya, Isehara, Kanagawa 259-1193, Japan
Tel: +81-463-93-1121 Fax: +81-463-93-7231 E-mail: akamatu@is.icc.u-tokai.ac.jp

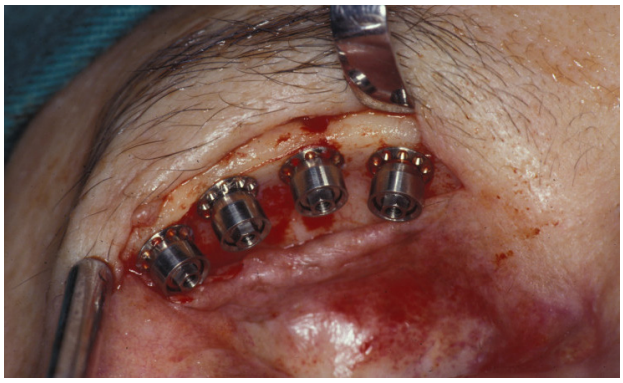

Fig. 2 Photograph taken at the implant insertion surgery. Four 4.0-mm long maxillofacial implants (Nobel Biocare Holding AG, Switzerland) were inserted in the frontal bone of the intraorbital wall.

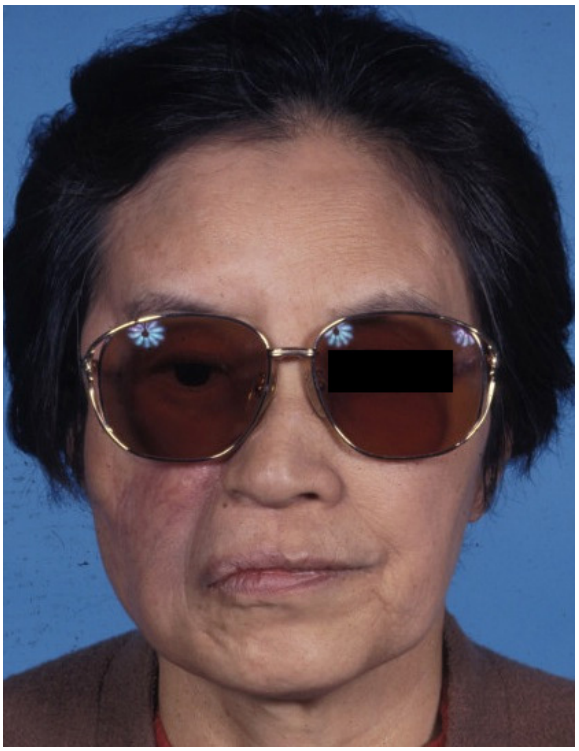

Fig. 3 Photograph of maxillofacial implant-retained prosthesis.

that were built in the prosthesis. Because she actively participates in local social activities, the prosthesis is essential for her daily life. **(Fig. 3)**

Complications

The condition of the skin adjacent to the implants deteriorated gradually because the implant sites involved an eyebrow that was preserved intact for cosmetic reasons. Moreover, bone resorption progressively occurred around the implants. Three years after implant insertion surgery to improve the soft tissue condition, all soft tissues in the region were removed and split-thickness skin was grafted on the cortical bone. The graft survived, the skin condition was much improved, and the skin inflammation was resolved. However, bone resorption slowly progressed around

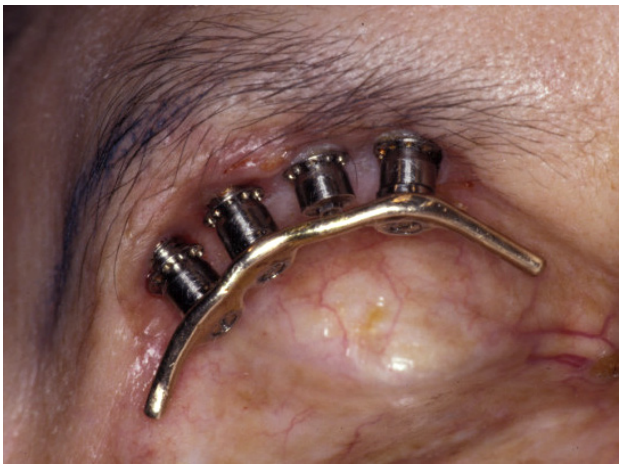

Fig. 4 Photograph at four years after implant insertion surgery. The exposed implant bases are shown due to the bone resorption slowly progressed around the implants.

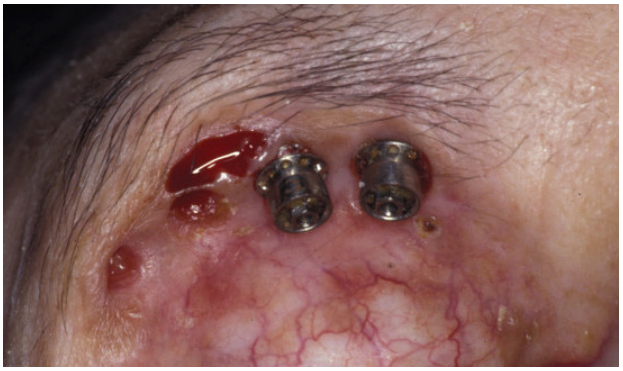

Fig. 5 Four years and 6 months after insertion surgery, two of the four implants were lost and the others had become unstable because of bone resorption.

the implants. **(Fig. 4)** Four years and 6 months after insertion surgery, two of the four implants were lost and the others had become unstable because of bone resorption. **(Fig. 5)** Seven years and 5 months after insertion surgery, all lost and unstable maxillofacial implants were successfully replaced with Epitec System maxillofacial implants (Stryker Inc., MI, USA), under favorable soft tissue and bone conditions. The Epitec System is constructed of a ladder frame and small screws which allows the implant placed appropriately distant point from irradiated bone. **(Fig. 6a, b, c, d)** Eleven years and 6 months after replacement, the Epitec System has been maintaining good, firm osseointegration to the frontal bone. However, a slight skin inflammation and gradual regression of the surrounding skin flap have been observed. **(Fig. 7)**

DISCUSSION

Wilkes and Wolfaardt have proposed that a patient's postoperative hospital visits can be every 6 months or *ad libitum* [12]. With regard to the daily maintenance of implants, the skin around them should be in favorable condition because poor skin condition at implant sites often results in the uncomfortable use of

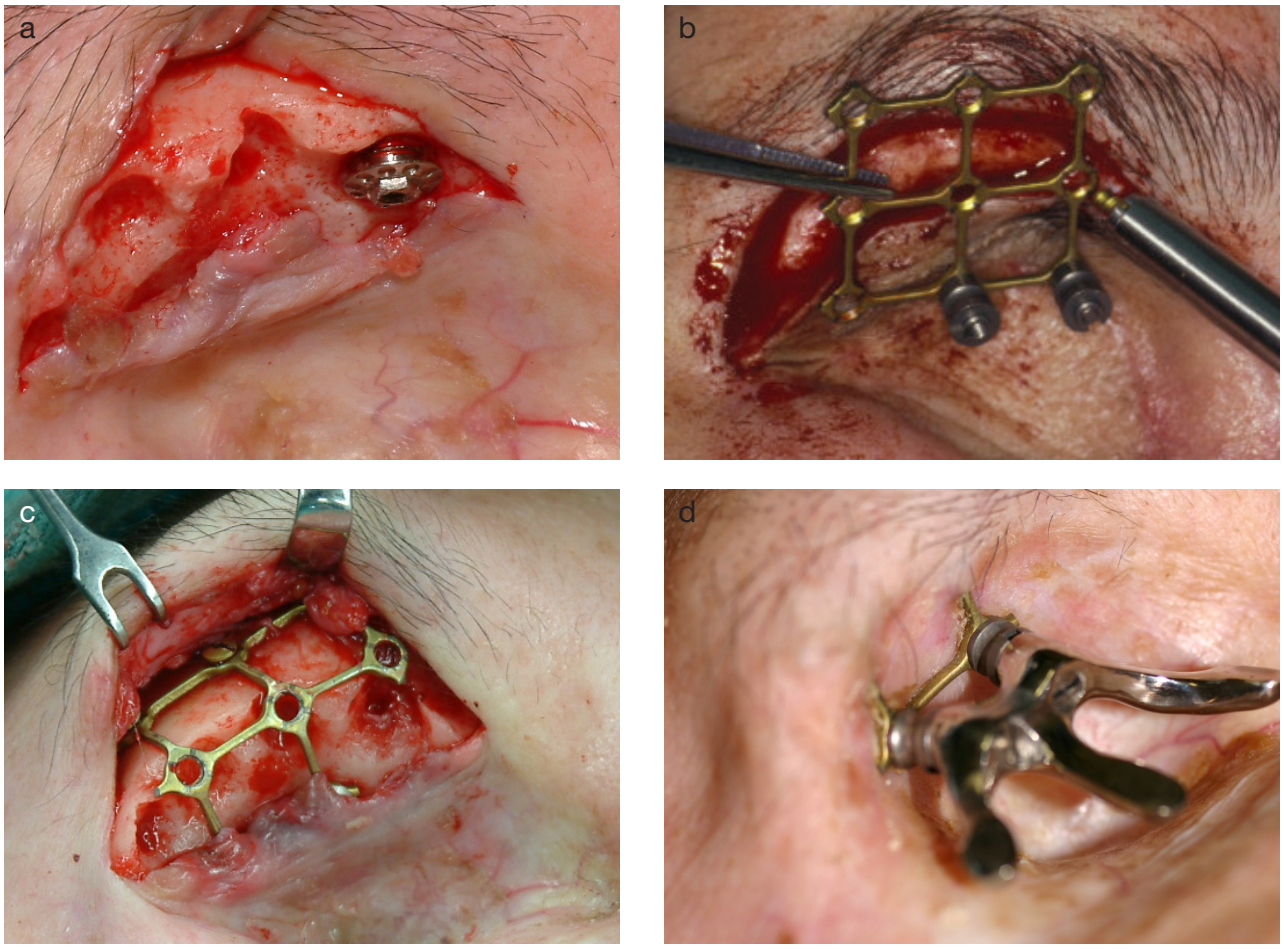

Fig. 6 a: Photograph taken at the replacement surgery seven years and 5 months after initial surgery. All lost and unstable maxillofacial implants were removed.
b: The Epitec System (Stryker Inc., MI, USA) is constructed of a ladder frame and small screws which allows the implant placed appropriately distant point from irradiated bone.
c: The ladder frame was bended to cover the surface of frontal bone.
d: Photograph after installation of retaining frame to Epitec System maxillofacial implants. The soft tissue and the bone are in favorable conditions.

prostheses or issues in maintaining prostheses. In our case, the patient's skin condition depended on the preoperative designs of implant-retained prostheses, such as implant sites, skin thickness, and skin movability. Tjellstrom and Hakansson have reported that only 3.6% of 806 auricular or temporal implants caused adverse skin reactions during a 4- to 14-year follow-up, and all reactions were mild [11]. In our patients with poor skin condition at implant sites, implants had typically been placed in or adjacent to a hairy region. Hairy skin is thick because of hair roots. Thick soft tissue around an implant is likely to deepen skin pockets around the implant and causes difficulty in cleaning. If a hairy region is involved in an implant site, the skin around the implant should be replaced with a split-thickness skin graft. Eyebrows are usually preserved intact during reconstruction of orbital defects. When the margin of prosthesis in contact with the supraorbital skin is placed along the lower edge of eyebrow, it renders the prosthesis esthetically adequate. Maxillofacial implants in the periorbital lesion are typically placed in the intraorbital wall of the supraorbital margin because of bone thickness. For this reason, implant sites in these cases involve eyebrows.

Effects of previous radiation therapy on implants

Tjellstrom *et al.* have reported that maxillofacial implant loss was more frequent in irradiated regions than in non-irradiated regions (39% vs. 5%) and that most losses in irradiated regions occurred during the first 3 years after implant placement [8]. The result of a recent study showed improved survival rates for implants. Plata *et al.* have investigated 225 osseointegrated dental implants in 30 patients who had received radiotherapy and reported that there were still significant survival differences between implants placed in patients with irradiation (92.6%) and without irradiation (96.5%) [13]. Late adverse effects of radiation therapy on bone tissues include acellular changes, fibrosis, and avascularization. These effects are likely to block a dynamic physiological process of bone resorption and apposition, and cause bone necrosis, bone resorption, and decalcification [14, 7]. Furthermore, they can severely inhibit osseointegration. Therefore, the functional outcome of implants placed in previously irradiated bones is usually poor. In our case, Epitec System implants were placed in non-irradiated regions after the previous loss of implants in irradiated regions. These replaced implants have been in clinically very

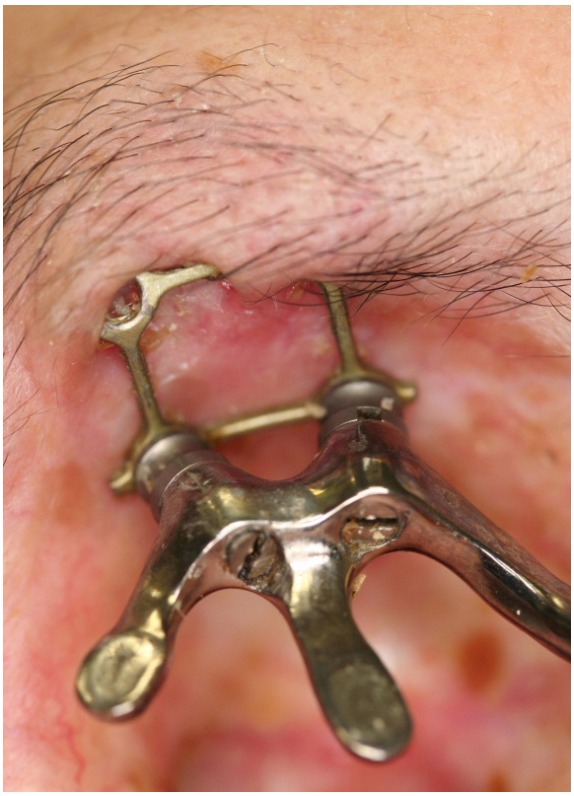

Fig. 7 Photograph at eleven years and 6 months after replacement, the Epitec System has been maintaining good, firm osseointegration to the frontal bone. However, a gradual regression of the surrounding skin flap have been observed.

good condition, maintaining secure osseointegration and sufficient retention of prosthesis. The advantage of Epitec System maxillofacial implants is a long retention ladder frame for supporting the prosthesis under the skin flap, which helps with inserting the implant at a sufficient distance from the irradiated site [15–17]. However, in our case this long subdermal frame resulted in chronic skin inflammation and regression of the surrounding skin flap.

Adjunctive hyperbaric oxygen therapy

Hyperbaric oxygen therapy, before and after implant placement, appears to increase the implant success rate. Tjellstrom *et al.* have described that 5 (13.8%) of 36 Branemark maxillofacial implants placed in the temporal bone were lost in previously irradiated patients without hyperbaric oxygen therapy, whereas none (0%) of the six same implants were lost in patients with the therapy [9]. In addition, a prolonged interval between radiation therapy and implant placement did not improve implant outcome. The implant loss rate was lower for 4 mm-long fixtures than for 3 mm-long fixtures. The researchers propose that hyperbaric oxygen therapy should be performed at 2.5 atmospheres of pressure over 90 min for 20 days before implant placement and for 10 days after the placement [7, 9]. Recently, Ueda *et al.* have reported that with hyperbaric oxygen therapy at 2–3 atmospheres, the survival rate of an osseointegrated titanium implant placed in irradiated patients was 92.3% [18]. Adjunctive hyperbaric oxygen therapy results in increased oxygen tension in irradiated ischemic bone and provokes capillary angiogenesis and bone formation [19]. These histopathological alterations improve healing capacity and increase osseointegration.

However, in a retrospective study of 365 implants placed in irradiated tissue, Shaw *et al.* have reported no significant effect on implant survival using adjunctive hyperbaric oxygen therapy [20]. In our case, hyperbaric oxygen therapy revealed no improvement in osseointegration.

CONCLUSION

Analysis of this case has shown that appropriate selection of implant sites and no history of radiation therapy are keys to successful implant reconstruction and the prevention of complications. However, adjunctive hyperbaric oxygen therapy is believed to be effective, osseointegrated implant should be inserted at a point appropriately distant from an irradiated lesion.

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