Case History Report: Immediate Rehabilitation with a Prefabricated Fibula Flap Following Removal of a Locally Aggressive Maxillary Tumor

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The present clinical case history report describes an interdisciplinary treatment protocol that combines maxillary tumor resection with immediate reconstruction to achieve functional rehabilitation. A fibula flap that received four dental implants and a split-thickness graft epithelial layer was prefabricated for a 31-year-old man. The flap was designed so that it could be adapted to fit in different extents of tumor resection. Resection and immediate reconstruction were successfully performed 6 weeks after flap prefabrication, with the final bar-retained dental prosthesis delivered 4 weeks later. Int J Prosthodont 2016;29:53–58. doi: 10.11607/ijp.4010

The standard treatment for locally aggressive intraosseous tumors such as myxomas is a wide en bloc resection that includes removal of peripheral margins of sound bone to minimize the risk of recurrence.1 Subsequent bony reconstruction and rehabilitation of masticatory function with an implant-supported prosthesis are often delayed, increasing the risk of facial disfigurement and impairment of speech and mastication.

Vascularized free flap reconstructions are regarded as standard2 and include prefabricated flaps that already contain osseointegrated dental implants for transfer to the defect region. However, detailed information is lacking regarding reconstruction procedures with prefabricated vascularized free flaps simultaneously with resections of intraosseous tumors. This case history report describes an interdisciplinary treatment protocol that combines resection of a bony tumor and jaw reconstruction with a prefabricated vascularized free flap.

Materials and Methods

An otherwise healthy 31-year-old man presented at the Department of Oral and Maxillofacial Surgery of the Erlangen University Hospital, Erlangen, Germany, with complaints of left nasal congestion and loosening of the upper left molars (Figs 1 and 2). An odontogenic myxoma of the left maxilla was diagnosed histopathologically.

The incisional biopsy had been taken through the gingivobuccal sulcus in the region of the maxillary left second molar in a private practice 10 months before. Although the patient was informed on the diagnosis, he refused any further therapy at the time. However, when he became aware of increasing mobility of the maxillary left dentition he decided to seek treatment.

On physical examination the left globe was elevated compared to the contralateral side, although diplopia was not present and superficial sensitivity of the skin in the innervation area of the left infraorbital nerve was not impaired. The left lateral nasal wall within the nasal cavity was expanded against the septum, and an intraoral firm, nontender swelling of the left lateral wall of the maxilla as well as the left hard palate was present. The posterior alveolus was displaced, and the maxillary left molars were mobile and prematurely contacted the opposing teeth. On maximum mouth opening the interincisal distance was 42 mm.
Immediate Rehabilitation with a Prefabricated Fibula Flap

Computed tomography (CT) without contrast material injection revealed an expansive lesion with predominantly soft tissue density interspersed with coarse and streaky calcifications (Fig 3). The medial wall of the maxillary sinus was expanded toward the nasal cavity and abutted the nasal septum. The tumor involved the lateral sinus wall and the sinus floor, which were both expanded and partially destroyed. The left orbital floor was displaced cranially without invasion of the tumor. The lesion, which remained restricted to the maxilla, displaced the soft tissues of the masticator space. The pterygoid process was displaced and deformed, and maxillary left posterior teeth roots showed resorption.

Clinical, radiologic, and histopathological findings confirmed a diagnosis that required a left partial maxillectomy to include the sinus floor. The patient was informed that complete removal of the tumor that affected bony structures could not be confirmed safely by intraoperative frozen section analysis. Consequently, the necessity of a second intervention for complete tumor resection could not be excluded. Nevertheless, the patient was not willing to have surgery done without immediate maxillary reconstruction. Therefore, the decision was made to reconstruct the left maxilla with a prefabricated vascularized free fibula flap with dental implants placed in the prefabricated flap. The patient was informed that these procedures would reduce the time required for definitive dental rehabilitation.

A CT scan of the left fibula was used as the basis for fabrication of a three-dimensional (3D) model (Fig 4). The CT data were sliced by a slicing algorithm using specialized software (ZPrinter, 3DSystems). By means of a 3D printer (Zprinter 650, Z Corporation), the model was generated in an additive process by printing successive layers of powder (VisiJet M3-X, Kisters).

Impressions of mandible and maxilla were recorded with rim lock impression trays (M+W Rim-Lock impression tray, M+W Dental) and alginate impression material (Palgat Plus, 3M ESPE). Plaster casts were made using type IV dental stone (GC Fujirock EP, GC Germany). The cast of the maxillary dentition was placed on a thermoforming unit (Erkoform-3, Erkodent). A thermoplastic sheet was heated until it reached its viscoelastic phase. The sheet was stretched onto the cast by applying vacuum and was allowed to cool down. The three-dimensionally formed sheet was trimmed with a carbide bur (Micro-Kreuzverzahnung fein, M+W Dental) so that only the shape of the maxillary dentition remained. This vacuum-formed template served to determine adequate positions for four dental implants for slight alternatives in the extent of resection at the anterior margin and was used as the basis for the fabrication of a surgical guide for implant placement.

Left partial maxillectomy between the left central and lateral incisor was planned based on the preoperative CT scan. To be prepared for the situation that the macroscopic appearance of the resection margin prompted the need for a wider resection including the central incisor, an additional planning for an alternative reconstruction procedure was made. Plaster cast duplicates were used to simulate the two different extents of left partial maxillectomy. One included the complete maxillary left dentition, while the other retained the left central incisor. It was determined that due to the removable prosthesis design a maximum of four implants would be required with either resection. An approximately 6-cm long segment of the 3D fibula model was required to reconstruct from the maxillary left central incisor to the left second molar with even distribution of the implants (Fig 4). Four implant analogs (Labor Analog, Straumann) were inserted into this fibula segment with a distance of 8 mm between the analogs.

The vacuum-formed template was placed in the two maxillary defects (Fig 5). The procedure aimed at checking that the reconstructive procedure could be carried out successfully for both maxillary defects without requiring any osteotomy in the straight-line
anatomy of the fibula. Based on the positions of the implant analogs in the fibula model a surgical template was fabricated (Fig 6).

**Results**

The first step of surgery was the prefabrication of the bone flap under general anesthesia. Four dental implants 4.1 mm in diameter and 10 mm in length (Straumann bone level RC, Straumann) were placed in predetermined positions in the lateral aspect of the left fibula (Figs 6 to 8). The protocol for the preparation of the implant sites included the use of a screw tap (Gewindeschneider, Straumann) and was chosen according to the manufacturer’s recommendations. The implants were placed monocortically to avoid exceeding an insertion torque of 35 Ncm. Simultaneously, a 0.5-mm split-thickness skin graft with a dimension of 1.5 cm in width and 6 cm in length was harvested from the medial aspect of the left upper arm with a dermatome (Acculam 3Ti Dermatome, Aesculap). The split-thickness skin graft was attached to the fibula segment that contained the implants with interrupted sutures (Vicryl 4-0, Johnson & Johnson).

Six weeks after flap prefabrication the fibula segment that contained the implants was harvested together with an additional adjacent 6-cm-long piece of the fibula under general anesthesia. Both bony segments remained connected by the vascular pedicle. Stage-two surgery of the implants was performed, and healing abutments (Titansekundärteil, Straumann) were fixed to the implants.

Tumor resection was performed as a left partial maxillectomy using a left midfacial degloving approach. The resection included the region where the initial biopsy was harvested. Based on the macroscopic appearance of the anterior aspect of the tumor it was determined that the left central incisor could be spared. The mucosal lining of the medial maxillary wall and the inferior orbital wall was unaltered on macroscopic inspection. Therefore, the underlying bony structures were preserved. Histopathologically, clear resection margins could be confirmed.

Subsequently, the two segments of the fibula flap were transferred to the maxillary defect. The prefabricated segment that bore the dental implants was used to reconstruct the maxillary alveolar ridge. The craniocaudal orientation was chosen in such a way...
that the implant shoulders were placed 3 mm more cranially than the cementoenamel junctions of the central incisors. The superior segment of the flap replaced the anterior wall of the maxillary sinus. The two fibula segments were fixed to the remaining maxillary alveolar ridge with two osteosynthesis plates and 5-mm-long 2.0-mm osteosynthesis screws (Miniplattenosteosynthese, KLS-Martin). The vacuum-formed template was used to check whether the planned position of the prefabricated flap was reached, intraoperatively. The fibula vessel pedicle was guided to the left submandibular region along a tunnel at the lingual aspect of the ascending ramus of the mandible to establish microvascular anastomoses with the superior thyroid artery and the internal jugular vein following a submandibular incision. Directly after the reconstructive procedure an impression of the maxilla was made for the fabrication of a resin provisional prosthesis that replaced the removed upper left dentition with resin denture teeth (SR-Antaris, Ivoclar Vivadent). Multunit abutments with retentive grooves (Provisorische Versorgung, Straumann) were connected to the two middle implants. The provisional prosthesis was connected to the abutments with cold-cured resin (ProBase Cold, Ivoclar Vivadent) and was finished.

The postoperative course was uneventful. The patient was able to leave the hospital 6 days after surgery with the provisional prosthesis. He was advised to adhere to a soft diet for 6 weeks.

Four weeks after the reconstructive procedure, impression copings (RC Abformpfosten, Straumann) were connected to the implants in the reconstructed left maxilla and an impression (Reprosil, Dentsply) was recorded with a custom impression tray (Palatray XL, Heraeus Kulzer) for the fabrication of a bar-retained overdenture (Fig 9). The most distal implant was not included in the prosthetic rehabilitation, because it was positioned within the buccal soft tissue as a consequence of the smaller extent of maxillary resection. The healing abutment was replaced by a cover screw (RC Verschlusskappe, Straumann), and the implant remained in place as a sleeping implant.

The bar was individually fabricated using CoCrMo alloy (Nickel Dental). The unilateral removable denture was locked to the bar with bolts (MK1 Plus Riegel Attachment, MK1). The final prosthesis could be delivered after 4 additional weeks (Figs 10 to 13).
One year after tumor resection and simultaneous reconstruction, there were no clinical or radiographic signs of recurrence of the intraosseous tumor (Fig 14).

**Discussion**

There is limited literature on reconstructive procedures with prefabricated microvascular free flaps simultaneously with the removal of extensive intraosseous tumors. Therefore, the present case history report aimed at describing a treatment protocol that (1) is based on 3D models of the skull and the bone flap, (2) takes into account minimally different extents of bony resection (ie, the width of a central upper incisor) during removal of the tumor, and (3) allows jaw reconstruction with a prefabricated vascularized free flap immediately after tumor resection.

The use of vascularized free flaps has gained wide acceptance in major jaw reconstruction because its success rate is significantly higher than that of nonvascularized bone grafts. However, conventional microvascular reconstruction procedures can leave the patient without a prosthesis for several months until oral rehabilitation can be completed. Therefore, the use of prefabricated bone flaps has been advocated.

Prefabrication of vascularized free flaps is an advanced method in the field of reconstructive surgery. Without prefabrication, additional operations are frequently needed for debulking of the soft tissue portion of the free flap and vestibuloplasty. It has been criticized that masticatory rehabilitation is seldom possible earlier than 6 months after the initial reconstructive procedure in these cases. This time interval can be reduced significantly by prefabrication. The aim of prefabrication is to contour the flap in such a way that the defect is filled with adequate amounts of soft and hard tissue to resemble the original anatomy and support residual tissues. So far, reconstructive procedures with prefabricated flaps have been mostly described for preexisting jaw defects.

The present authors decided to place the implants in the fibula monocortically instead of engaging them bicortically. It has been demonstrated that sufficient implant stability is reached when implants are engaged only monocortically in the fibula. Moreover, implant manufacturers recommend an insertion torque that does not exceed 35 Ncm to avoid compromising the induced healing response of osseointegration. It has also been reported that when 10-mm-long implants with a diameter of 4.1 mm are placed in the fibula, an average torque value of 33 Ncm is reached and the proposed critical threshold is avoided.

Simultaneous resection and reconstruction of the maxilla were prescribed and undertaken for this patient. This approach risks introducing new surgical challenges. The surgeon has to be able to adapt the reconstructive procedure intraoperatively when the extent of the resection has to be increased. In this patient, the flap was prefabricated in a straight line reconstruction of the left maxilla that would have been possible even if larger maxillary resection with inclusion of the left central incisor would have been necessary to achieve clear margins. If the extent of the resection had exceeded the length of the prefabricated flap, the length of the flap could have been extended. This approach would have also allowed folding the fibula flap by including additional osteotomies, if the resection had extended beyond the midline. However, this additional part of the fibula would not have been prefabricated, and consequently would have required a staged approach until complete oral rehabilitation was achieved. In such a case, placement of the prefabricated part of the fibula flap in the anterior maxilla should be considered to allow placement of a provisional prosthesis directly after the reconstruction procedure, at least for esthetic reasons.

In the present case report, prefabrication of the bar-retained prosthesis was not considered. There were two alternatives for maxillary resection and, consequently, two alternatives for maxillary reconstruction,
which warranted the prefabrication of 2 prostheses. This procedure would not have been economical. Therefore, it was decided to start the fabrication of a provisional prosthesis directly after the bony reconstruction procedure and to replace it by the final prosthesis after the initial healing period. With this concept it was still possible to regain full masticatory function within a time frame of 10 weeks which is accepted for this kind of complex rehabilitation.8

The authors preferred a removable bar-retained partial denture over a fixed prosthesis because the use of a split-skin graft does not allow creation of interdental papillae. However, these papillae are mandatory for the esthetic appearance of a fixed prosthesis.10 A removable denture readily facilitates the creation of esthetically appropriate gingival replacement.

**Conclusions**

This case history report describes a maxillary tumor resection with a successful immediate reconstruction using a prefabricated flap. Since it is not possible to predetermine the definitive extent of the planned bony resection, the prefabricated flap is designed in such a way that its shape can be adapted to the actual extent of the resection at the time of the operation. Prosthodontic treatment can then be started directly after the reconstructive procedure. The described interdisciplinary treatment protocol permitted recovery of masticatory function within 10 weeks.

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**References**
