Free Latissimus Dorsi Flap for Reconstruction of the Anterior Base of the Skull

Abstract—Defects resulting after resection of malignant tumors of the paranasal sinuses involving the anterior base of the skull need an adequate closure. In addition to such avital tissue as fascia lata, fat, or ceramics, in recent years we used free muscle flaps from the latissimus dorsi for reconstruction. We performed this reconstructive method in seven patients after radical tumor resection. The operation was performed in cooperation with the neurosurgeon. In three cases a transfrontal in combination with a transfacial approach was used and in four cases only a transfacial approach was chosen. The flap was tailored as a pure muscle transplant if only the base of the skull had to be repaired and the surgical cavity had to be obliterated. In three cases a skin paddle was left on the muscle to perform a closure of the orbit and the hard palate. In four patients we performed primary reconstruction, in three cases secondary reconstruction, which was necessary because cerebrospinal fluid (CSF) leakage occurred after primary reconstruction with avital tissue in addition to insufficient pericranial flap. None of the patients with primary reconstruction developed CSF leakage. There was no free flap failure. The aim of this reconstruction is a safe closure of skull base defects to prevent infection, meningitis, brain abscess, and brain herniation. (*Skull Base Surgery*, 5(4):207–212, 1995)

Craniofacial resection of malignant tumors of the paranasal sinuses involving the base of skull (Fig. 1) has become a standard procedure¹ carried out in cooperation between the neurosurgeon and the ear, nose, throat (ENT) surgeon. The neurosurgeon performs the transfrontal osteoplastic craniotomy. Also in cases in which no transfrontal approach is needed, the neurosurgeon is consulted for examination of the base of the skull and repair of the dura. The ENT surgeon performs the facial access by an extended lateral rhinotomy. This enables an en-bloc resection of the roof of the ethmoid and cribriform plate together with the overlying dura. After resection and repair of the dura, some structural support is needed to prevent herniation of the brain and to seal the endocranium from the nasal and paranasal cavities. If the paranasal sinuses are completely removed, in addition to the defect of the cranial floor, large excavations result, which give rise to further problems, such as speech alteration and chronic crusting and secretion. Free microvascular muscle trans-

plantation for these purposes is an ideal reconstructive method, since it can be tailored in accordance with the local conditions. The reconstruction of the base of the skull must perform a reliable seal between the cranial cavity and upper respiratory tract to prevent cerebrospinal fluid (CSF) leakage and pneumoencephalus. Furthermore, it must provide a barrier to the spread of bacteria from the upper respiratory tract to the subarachnoid and epidural spaces and prevent brain herniation by structural support.^{2,3} Besides local flaps such as the pericranial flap^{2–4} and temporalis muscle flap,⁵ free flaps became more and more accepted. Regarding free flaps, the latissimus dorsi flap has been described for reconstruction of the anterior base of the skull^{6–8} and a variety of other flaps, such as the tensor fascia lata flap,⁹ the rectus abdominis flap,¹⁰ and even the vascularized omentum graft have been used.¹¹ In our hands the latissimus dorsi muscle flap is ideal for reconstruction of the anterior base of the skull.

Figure 1. Adenocarcinoma of the ethmoid infiltrating the anterior base of the skull.

METHODS

Reconstruction of the anterior base of the skull with free latissimus dorsi flap was performed after tumor resection from the paranasal sinuses and base of the skull (Fig. 2). In addition to an extended lateral rhinotomy, a frontal osteoplastic craniotomy was performed or only a transfacial approach was chosen. The flap is harvested parallel to the tumor resection in a lateral position to save time. Depending on the defect, the flap is tailored either as a pure muscle flap (Fig. 3) or as a musculocutaneous flap with a small skin paddle on the muscle (Fig. 4). The technique of raising the flap starts with an incision along the posterior axillary fold to the midpoint of the iliac crest. First, the anterior edge of the muscle is exposed and the vascular pedicle is dissected. It enters the muscle

12 cm caudal to the axilla. The muscle is lifted from the underlying serratus anterior muscle. The flap is incised in the desired size and the attachment of the muscle to the humerus is cut. The vascular pedicle is followed into the axillary fold, including the subscapular vessels. After the dural defect is closed, the muscle is positioned to the base of the skull to seal the defect and give support to the brain. There is no need for fixation of the flap to surrounding tissue, since it fills the whole cavity and thus stays in position. Fibrin glue can be placed on the base of the skull for a watertight seal. It is important to remove all the mucosa from the area where the flap is positioned. The nasal air passage is maintained by a silicone tube, which stays 10 days. In cases in which the dura has been rejected, a spinal lumbar drain was inserted for 7 days.

The microvascular anastomoses preferably were performed with the facial vessels, but in two cases the temporal vessels were used. In case of orbital exenteration a skin paddle was left on the muscle to provide an external lining (Fig. 5). For this purpose, the muscle also can be covered with split skin (Fig. 6). This especially is recommended for obese patients, since the skin paddle is too bulky. If the eyelids could be preserved, a pure muscle flap was used to obliterate the orbit. After resection of the conjunctiva from the inner surface of the lower and upper lid, they are sutured together over the muscle. In these cases a prosthetic globe was introduced. If the eyelids had to be sacrificed, an eye prosthesis was attached to the skin over the muscle.

RESULTS

Reconstruction of the anterior base of skull with a free latissimus dorsi flap was performed in seven patients, six men and one woman. The average age was 51 years and ranged from 34 to 62 years. The patients had malignant tumors of the paranasal sinuses involving the anterior base of the skull. Histology of the tumors revealed adenocarcinoma in three cases, carcinoma inverting papilloma in two cases, and transitional cell carcinoma and esthesioneuroblastoma in one each. In all patients the ethmoid sinuses were involved. In five patients an orbital exenteration had to be performed. The maxillary sinus as well as the sphenoid sinus were involved in five patients (Table 1). In all but one case the dura was infiltrated by tumor and had to be rejected. A primary reconstruction was performed in four cases, and in three cases a secondary reconstruction was necessary. In three patients a combined transfrontal and transfacial approach was carried out. In four cases a transfacial approach was sufficient for tumor resection (Table 2). In all patients in whom primary reconstruction of the base of the skull was performed, no CSF leak, meningitis or other perioperative complications were seen. In three patients reconstruction was performed with avital tissue in addition to a pericranial flap because the flap was not large enough to cover the whole

Figure 2. A: Reconstruction of the anterior base of skull with free muscle flap. B: Obliteration of the orbital socket with a free muscle flap in addition to reconstruction of the anterior base of skull.

Figure 3. Free latissimus dorsi muscle flap.

defect. These patients developed postoperative CSF leak and meningitis and secondary reconstruction with the latissimus dorsi flap was carried out. No further CSF leakage was seen. Three patients had a spinal lumbar drain in the first operation. For secondary reconstruction, a spinal lumbar drain was not needed in any case. In all patients the flap was inserted in a way to maintain normal nasal air passage (Fig. 7).

In five patients a pure muscle flap was used that was covered with split skin for external lining of the orbit in two patients. In another two patients a skin paddle was left on the muscle.

Three patients developed local recurrence, one patient died of distant metastases. Local recurrences were detected by computed tomography (CT) scan, since nasal endoscopy was limited by flap obstruction of the surgical cavity. All flaps survived, and there was no flap necrosis. Postoperative radiotherapy was performed in six cases and did not alter the flap. In one patient preoperative

radiotherapy was performed; he was operated on because of residual tumor formation. In all cases the flap overfilled the defect in the early postoperative period, but within a few weeks the flaps atrophied and the patients regained a normal contour.

There were no complications seen at the donor site. Since the flap mostly was taken as a pure muscle or only with a small skin paddle, skin closure of the donor site was without tension and without complications. There was no functional impairment at the donor site.

DISCUSSION

Defects in the anterior cranial floor resulting after tumor resection of the paranasal sinuses require sufficient closure to avoid complications, including meningitis, brain abscess, or brain herniation. There are a variety of techniques described to perform structural support of the

Figure 4. Free myocutaneous latissimus dorsi flap.

Figure 5. Obliteration of orbital socket with latissimus dorsi myocutaneous flap.

anterior base of the skull. All techniques must satisfy three criteria: (1) A reliable seal between the cranial cavity and the upper respiratory tract to prevent CSF leakage and pneumoencephalus; (2) a barrier to the spread of bacteria from the upper respiratory tract to the subarachnoid

Table 1. Involved Sinuses

<i>Sinus</i>	<i>No. Patients</i>
Ethmoid and antrum	1
Ethmoid, antrum, and orbita	1
Ethmoid, antrum, and sphenoid	1
Ethmoid, orbita, and sphenoid	2
Ethmoid, antrum, orbita, and sphenoid	2

and epidural spaces; and (3) prevent brain herniation by structural support. These criteria cannot be guaranteed by some techniques, such as reconstruction with avital tissue. In these cases there is always a risk of postoperative CSF leakage. Further development in reconstructive surgery introduced vital tissue for the repair of defects at the base of the skull and thus reduced the rate of such complications as CSF leak, meningitis, and subdural abscess.¹²⁻¹⁴

For reconstruction of the anterior base of the skull, vital tissue is preferable to avital tissue. The reconstruction method with vital tissue can be separated into two techniques: pedicle and free flaps. There are a wide variety of local and regional flaps. As a local flap for reconstruction of the anterior skull base, the inferiorly based pericranial flap can be used.^{2,3} The galea flap, which is taken from the galea aponeurotica layer of the scalp, is useful for small moderate midline defects. The temporalis muscle flap⁵ is suitable for reconstruction of moderate to

Table 2. Surgical Approach

<i>Surgical Approach</i>	<i>No. Patients</i>
Transfacial	2
Transfacial, orbital exenteration	2
Transfrontal, transfacial, orbital exenteration	3

Figure 6. Split-skin grafting of free latissimus dorsi flap used for orbital obliteration.

Figure 7. Obliteration of antrum in addition to reconstruction of anterior base of the skull by maintaining an air passage through the nasal cavity.

Figure 8. Structural support to the base of the skull and to the orbit by a free latissimus dorsi flap after radical tumor resection.

large defects. Pedicled myocutaneous flaps such as the pectoralis major flap or the trapezius flap are versatile flaps but must be tunneled for a long distance and are difficult to get to the base of the skull. The cutaneous territory of the pectoralis major flap often is extended beyond the sixth rib to gain more length. This, however, can lead to necrosis of the distal part of the flap. The advantage of pedicled flaps is the easier dissection and the fact that there is no need for microvascular anastomoses. The disadvantage is the limited length of the pedicle. Local flaps like the forehead flap are not advisable because of inadequate cosmetic results. The only acceptable local flaps are the pericranial flap^{15,16} and the temporalis muscle flap.⁵ These local flaps, however, do not have enough bulk to fill into orbital defects. If the lids can be preserved after orbital exenteration, the defect to the orbit is not sufficiently closed by just adapting the lower to the upper lid. In our experience this kind of closure will not withstand postoperative radiotherapy and the defect will reopen. In these cases a muscle flap should be used also for obliteration of the orbit in addition to skull base repair. The shape and size of the flap can be adapted to the anatomic situation. For these purposes, muscle flaps are ideal tissue transfers, since they possess enough bulk and good vascularization. This is an ideal precondition for a healing process without infection.

The advantage of free muscle flaps is a safe closure of the skull base and protection from infection. They are able to reline the nasal cavity, to replace empty eye sockets and antral cavities, and restore cosmetic symmetry. Furthermore, orbital exenteration in some cases can be avoided despite loss of all supporting structures, since the muscle flap keeps the orbital contents in position (Fig. 8). Our small series shows that after reconstruction with the free latissimus dorsi flap no complication, such as CSF leakage and meningitis, occurred, whereas in reconstructions with primary avital tissue complications oc-

curred several times. Furthermore, free flaps are flexible and can be harvested in any size and shape to adapt to the individual conditions. Reconstruction of the anterior base of the skull with tensor fascia lata, the rectus abdominis and the latissimus dorsi flap are described by several authors.^{9,10} The latissimus dorsi flap is a reliable and versatile flap for reconstruction after tumor resection in the head and neck.^{8,17-19} This was first described by Olivari²⁰ and it is one of the most frequently used flaps in reconstructive surgery, since the vascular pedicle has a constant course without anatomic variations. The vessel diameter is between 1.5 and 2.5 mm and thus ideal for microvascular anastomosis. The complication rate of the rectus abdominis donor site is higher than that of the latissimus dorsi flap.

One disadvantage of complete obliteration of surgical cavities must be regarded critically. This is the limited follow-up by transnasal endoscopy. CT scan and magnetic resonance imagery remain the only reliable methods of discovering recurrences. However, the advantage of obliteration and a reduced crusting and infection of large cavities justifies this method. On the other hand, if a recurrence appears after such a radical operation of paranasal cavities and base of the skull, the prognosis becomes very poor and the benefit of further surgical procedures will be limited.

Reconstruction with free muscle flaps guarantees a safe closure of skull base defects and prevents infection, meningitis, brain abscess, and brain herniation. The functional and cosmetic result is also improved by obliteration of the large cavity.

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