Journal of Plastic, Reconstructive & Aesthetic Surgery (2016) 69, 1266–1274

JPRAS
An International Journal of Surgical Reconstruction
www.JPRASurg.com

Plastic reconstructive surgery techniques for defect coverage of extended skull base defects☆

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Received 1 January 2016; accepted 7 June 2016

KEYWORDS
Skull base defects;
Flap coverage;
AV loop;
Plastic reconstruction;
Aesthetic reconstruction;
Cerebrospinal fluid leakage

Summary *Background and aim:* Large skull base defects are extremely difficult to treat and have a severe impact on patients' physical appearance and functional aspects. These extensive defect zones are mainly caused by trauma, surgical interventions, or wide tumor excision. High-level microsurgical techniques are necessary to provide sufficient treatment. The aim of this study is to describe successful reconstructive strategies for surgical treatment.
Methods: Nine patients with skull base defects were treated in our department from 2008 to 2014 (n = 9). Plastic surgical reconstruction was performed with latissimus dorsi (LD;) (n = 4), LD-scapula flaps (n = 2), vertical rectus abdominis myocutaneous (VRAM) flaps (n = 2), and a greater omentum flap (n = 1). The mean follow-up period was 2.3 ± 2.2 years (0.5–4.5 years). Oncologic diseases (8 patients) and iatrogenic damage (1 patient) caused the massive skull base defects.
Results: In all cases, we achieved the final surgical treatment of large skull base defects by free flaps with permanent wound closure. The mean operating time was 5:53 h (range 4:45 –7:52 h). The primary outcome measures were survival and sufficient defect coverage. Flap survival rate was 100%, and none of the patients deceased during the follow-up period. Furthermore, we demonstrated the surgical key points of LD-scapula flap closure in detail.
Conclusion: Plastic surgical defect coverage by well-perfused tissue flaps of large skull base defects provides an efficient and effective treatment option. Complex skin, soft tissue, and

☆ **Presentation of this work**: 1) DGCH Munich, Germany // 1-5-2015 // oral presentation, 2) DGPRAEC Berlin, Germany //3-10-2015 // oral presentation.

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http://dx.doi.org/10.1016/j.bjps.2016.06.008

dural defects can be successfully covered with these preformed free flaps. The choice of flap is based on the individual case.

Introduction

Large skull base defects including soft tissue, bone, and dura are extremely difficult to treat and have a severe impact on patients' aesthetics and functional rehabilitation.[1,2] The defect zones are mainly the result of trauma or surgical-oncological resection, resulting in facial disfigurement and complex three-dimensional defect zones.[2–4] The skull base is formed out of the caudal parts of the cranium — os frontale, os ethmoidale, os sphenoidale, os temporale, and os occipitale. Oncologic patients often carry a heavy burden due to the severity of their disease. The size and location of these extensive defect zones frequently exceed the range of regional musculocutaneous flaps. The distal area of a pedicled flap, where blood supply is most precarious, is mostly the area of the flap that urgently requires successful defect coverage.[5] The galeal—pericranial and temporoparietal flaps have been described as useful in limited defects.[6] In skull base reconstruction, as in any surgical intervention, the preferred treatment is the simplest procedure that achieves the highest success rate.[6] Free flaps are an extremely powerful tool for defect coverage. However, in order to use free flaps, a high-level expertise in microsurgery and detailed anatomical knowledge of the defect area are needed.[7] The following requirements have to be fulfilled: reconstruction of form, function, and aesthetics; coverage of vital tissue; tissue provision for radiotherapy; and follow-up surgery.[2,6]

Patients and methods

In our retrospective study, we investigated the outcome of plastic surgical reconstruction in 9 patients from 2008 to 2011. All patients presented with extensive skull base defects. Because of the small and heterogenic overall patient group, a direct comparison was difficult. The parameters analyzed included demographic data, patient history, type of free flap surgery performed, time of procedure, complications, and follow-up time.

The study patients included five males and four females. The mean age was 40 years (range 19—84 years). In preparation for surgery, we assessed a detailed history of all the patients. We used preoperative magnetic resonance imaging (MRI) or computed tomography (CT) scans for planning reconstruction after tumor resection in those patients who needed further oncological treatment. For plastic surgical reconstruction, we used latissimus dorsi (LD) flaps in four patients, LD-scapula flaps in two patients, vertical rectus abdominis myocutaneous (VRAM) flaps in two patients, and a greater omentum flap in one patient (Table 1). An interdisciplinary approach was used for all patient cases, with the involvement of ear, nose, and throat (ENT) specialists, neurosurgeons, and maxillofacial surgeons. Plastic surgery was performed directly after tumor resection, which aimed at R0 resections. All patients were operated by the senior author.

Skull base defects were caused by an oncologic disease in eight patients and by iatrogenic damage (craniectomy after cerebral hemorrhage) in one patient. Detailed listing of the primary diseases causing the skull-base defects is provided in Table 1.

The mean follow-up period was 2.3 ± 2.2 years (0.5—4.5 years). Anatomical details for LD, scapula, parascapular, and scapular flaps are shown in Figure 1. We describe the surgical key points of the flaps in the following three case reports (see Figure 2).

Combined LD-scapula flap

A 46-year-old male patient with high-grade sarcoma of the maxillary sinus received a right-sided hemifacetectomy. We accomplished defect coverage by transfer of a combined LD—scapula flap by an experienced plastic surgeon. Figure 1 depicts the procedure. The surgical steps for the combined LD—scapula flap are shown in Figures 3—10.

VRAM flap (extended VRAM flap)

A 29-year-old male patient with a large soft tissue defect in the right mid-facial area received a radical resection of recurrent osteosarcoma in the right frontobasal paramedian area. He had a history of recurring retinoblastoma, which was treated with enucleation, adjuvant chemotherapy, and radiation of the affected zone. The resection comprised all tissue at the frontobasal, suprasellar, parasellar, and intracavernous levels and paranasal plus maxillary sinus. For this patient, we designed a VRAM flap with multiple independently perfused skin regions to reconstruct the palate of the nasal cavity and the outer surface. We harvested the free flap in the abdominal area with dissection of the inferior epigastric artery and its accompanying vein. At the donor site, we preserved the rectus fascia and performed a direct closure of the rectus sheath. A partial deepithelization of the VRAM flap served to fill the cavity of the right nasopharyngeal airway. We placed the VRAM flap in the left nasal defect zone for reconstruction of the right nasal cavity. We then performed an end-to-end anastomosis of the inferior epigastric artery and the right facial artery and venous anastomosis with an accompanying vein. After reperfusion, the skull base defect zone was filled with the muscular part of the VRAM flap followed by wound closure with split skin grafting from the right upper leg.