Reconstruction Using Locoregional Flaps for Large Skull Base Defects

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J Neurol Surg B 2015;76:167–170.

Abstract

We present a modified locoregional flap for the reconstruction of large anterior skull base defects that should be reconstructed with a free flap according to Yano's algorithm. No classification of skull base defects had been proposed for a long time. Yano et al suggested a new classification in 2012. The lb defect of Yano's classification extends horizontally from the cribriform plate to the orbital roof. According to Yano's algorithm for subsequent skull base reconstructive procedures, a lb defect should be reconstructed with a free flap such as an anterolateral thigh free flap or rectus abdominis myocutaneous free flap. However, our modified locoregional flap has also enabled reconstruction of lb defects. In this case series, we used a locoregional flap for lb defects. No major postoperative complications occurred. We present our modified locoregional flap that enables reconstruction of lb defects.

Keywords

- ▶ skull base
- ▶ skull base defect
- ▶ locoregional flap reconstruction
- ▶ free flap

Introduction

No new classification system for skull base defects had been proposed for a long time. Yano proposed a classification and algorithm for skull base defects in 2012.^{1–3} The report indicates that a lb defect (extends horizontally from the cribriform plate to the orbital roof) of Yano's classification should be reconstructed with a free flap (▶Fig. 1). However, we believe a lb defect can be reconstructed with only a locoregional flap. To achieve this, we modified the locoregional flap and used it for a consecutive case series of lb defects. No major complications occurred in the case series. We propose this modified locoregional flap could be used to reconstruct lb defects.

Patients and Methods

We retrospectively reviewed three consecutive patients from 2010 to 2012 with reconstructive surgery for skull base lb defects resulting from tumor ablation at the Department of Plastic and Reconstructive Surgery, Osaka City University

Hospital (▶Table 1). The three patients (one man and two women) ranged in age from 55 to 70 years (mean age: 63.3 years). Tumors were carcinoma ex pleomorphic adenoma of the orbita in one patient and squamous cell carcinoma of the frontal sinus in two patients. The lb defects as indicated in Yano's classification occurred in all three patients. No patients received preoperative radiation, and two of the three patients received postoperative radiation (total dose: 50 Gy).

Operative Procedure

The parietal branch of the superficial temporal artery was marked by Doppler flowmetry before the operation. A skin incision was made in front of the marking to preserve the branch (▶Fig. 2A, B). The incision went through to the bony surface. A coronal flap was elevated, including a pericranial flap, over the bone to preserve the pericranial flap. After tumor resection, the pericranial flap at the frontal region and the galeal-periosteal flap at the temporal region were dissected from the elevated coronal flap. The pericranial flap is vascularized by the deep branches of the supraorbital and

received

November 13, 2013

accepted after revision

July 23, 2014

published online

December 24, 2014

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Stuttgart · New York

DOI <http://dx.doi.org/10.1055/s-0034-1390397>.
ISSN 2193-6331.

Fig. 1 Yano's concept³ for classifying skull-base defects. (A) Ia. (B) Ib. (C) Ic.

Table 1 Patient data

	Age, y	Gender	Diagnosis	Anamnesis	Preoperative irradiation	Postoperative irradiation	Bone graft	Complication
1	70	Male	Carcinoma ex pleomorphic adenoma	None	None	50 Gy	Cranial bone	None
2	55	Female	Squamous cell carcinoma	None	None	50 Gy	Cranial bone	None
3	65	Female	Squamous cell carcinoma	Hypertension	None	None	None	Partial necrosis of scalp

supratrochlear arteries; the galeal-periosteal flap is vascularized by the parietal branch of the superficial temporal artery (►Fig. 2C). When the anterior skull base is to be reconstructed, it is advisable to develop a pericranial flap, although it is difficult to perform reconstruction near the anterior clinoid process using a pericranial flap. In this case, a galeal-periosteal flap was used to reconstruct that region. The dead space between the bone and brain was left as a closed wound drain and did not need to be filled with soft tissue.

Results

A postoperative complication was recognized in one case as partial necrosis of the scalp, but it healed conservatively. In all cases, interception of the nasal cavity and cranial cavity was possible without perioperative complications such as infection. We added a bone graft to the skull base in two cases and recognized temporal depression deformities in two cases. The follow-up period was 8 to 33 months (average: 18.7 months).

Fig. 2 The schema of how to design a cranial flap and locoregional flaps. The skin incision is placed just in front of a parietal branch of a superficial temporal artery at the temporal region and backward at the parietal region uncrossing the branch. The dotted line shows a normal coronal incision. The asterisk shows pericranial flap. The dagger shows galeal periosteal flap. (A) The solid line is our incision. (B) The pericranial flap is extended backward sufficiently at the frontal region. (C) The pericranial flap is vascularized by the deep branches of the supraorbital and supratrochlear arteries, and the galeal-periosteal flap is vascularized by the parietal branch of the superficial temporal artery. DNA, dorsal nasal artery; FBSTA, frontal branch of the superficial temporal artery; SOA, supraorbital artery; STra, supratrochlear artery; TBSTA, temporal branch of the superficial temporal artery.

Fig. 3 Case1. (A) Hypointense T1 signal on magnetic resonance imaging (MRI). (B) Hypointense T2 signal on postoperative MRI. (C) Cosmetically acceptable outcome at follow-up.

The tumor recurred in one case during that time; the tumor did not recur or metastasize in the other two cases.

Cases

A 70-year-old man presented with a left 12-year-long exophthalmus. It had increased rapidly over the previous 2 years. The exophthalmus measured right 15 mm and left 27.5 mm using a Hertel exophthalmometer, and the left eyeball was fixed at an infraduction position. Preoperative computed tomography showed a neoplastic lesion with calcification in the left orbit and a bone defect of the orbital roof, anterior clinoid process, and sphenoidal bone. Preoperative magnetic resonance imaging showed a T1 and T2 hypointense neoplastic lesion with some calcified fat inside (►Fig. 3A). It extended to the superior rectus muscle. A biopsy of the tumor revealed a malignant change in a pleomorphic adenoma. Neurologic surgeons subsequently performed the surgery. The skull base defect of the tumor resection was a 1b defect in

Yano's classification. We marked the parietal branch of the superficial temporal artery using Doppler flowmetry before the operation. The neurologic surgeon made a skin incision for a coronal approach in front of the marking. The forehead portion of the coronal flap was elevated under the periosteum to prevent the rebuilding materials from causing damage (►Fig. 4A). After tumor resection, the pericranial flap at the frontal region and the galeal-periosteal flap at the temporal region were dissected from the elevated coronal flap (►Fig. 4B, C). The dura defect was reconstructed by the fascia lata. Most of the anterior skull base defect could be covered by the pericranial flap, and only the back part near the anterior clinoid process was covered by a galeal-periosteal flap. A wide defect of the orbital roof was reconstructed by the inner plate of the skull to prevent any brain beat transmitting to the eyeball. The inner plate was placed between the pericranial flap and the galeal-periosteal flap. A negative pressure 15F drain was inserted into the dead space between the dura and

Fig. 4 (A) The coronal flap is elevated between the pericranium and cranium. (B, C) The pericranial flap and the galeal-periosteal flap are elevated from the coronal flap. (D, E) We leave a closed wound drain in the intracranial dead space.

the flap, and this dead space became smaller spontaneously (►Fig. 4D, E). There were no postoperative complications, but the patient's cancer recurred and he changed hospitals (►Fig. 3).

Discussion

The reports regarding the reconstruction for anterior skull base defects with a free flap are increasing because of the popular belief that the interception of a cranial cavity and the filling of a dead space is important.^{4–7} However, although we agree that the nasal and cranial cavity interception is essential, the filling of any dead space is not always necessary. Therefore, we use a free flap only for cases with evisceration or a history of preoperative extensive radiotherapy. For almost all cases with an anterior skull base defect, we can reconstruct them by using a locoregional flap including a pericranial flap and a galeal-periosteal flap. In these cases, it is vital to make a clear surgical plan and arrange with the surgeon for a tumor resection preoperatively. If a locoregional flap is damaged by the technique for craniotomy or tumor resection, we cannot reconstruct it using only the locoregional flap. It is therefore critical that the oncologist and reconstructive surgeon discuss the procedure preoperatively.

We make a skin incision just in front of a parietal branch of a superficial temporal artery at the temporal region, and backward at the parietal region uncrossing the branch, according to the preoperative discussion. This permits the pericranial flap to be extended backward sufficiently at the frontal region. The galeal-periosteal flap, nourished by the network between the posterior auricular artery and an occipital artery, can be developed widely backward at the temporal region. When a unilateral supraorbital artery is ligated or sacrificed due to tumor extirpation, we recommend using the contralateral pericranial flap. If the bilateral supraorbital artery is ligated or sacrificed due to tumor extirpation, we consider using the pericranial flap for the blood supply by the supratrochlear artery and the frontal branch of the superficial temporal artery through the linking vessel.⁸ It enables the preservation of the supraorbital artery, assuming the oncologist and reconstructive surgeon have thoroughly discussed the procedure preoperatively. In the case of preoperative radiation, we think that the pericranial flap is vascularized by the collateral artery as the local flap after radiation.

We may use the bone graft because the brain beat is transmitted to the eye.¹ In that case, it produces a favorable condition for the bone graft to sandwich the bone between the galeal-periosteal flap and the pericranial flap. The coronal flap for a craniotomy is elevated under the periosteum. This prevents the rebuilding materials from causing damage. Therefore, we can easily develop locoregional flaps.

For preventing hair loss, we elevate the skin flap directly above the temporoparietal fascia so as not to expose the hair roots at the temporal region. And we do not use an electric scalpel. The location of a head frame should be discussed with the oncologist preoperatively. We only experienced three cases, but we think that the cooperation of the surgeons involved allowed for reconstruction of anterior skull base defects with only a modified locoregional flap, without a free flap.

Conclusion

We used the locoregional flap for a consecutive series of three cases with anterior skull base defects (Ib defects). The patients developed no major complications. We believe almost all Ib defects can be reconstructed with only a locoregional flap.

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