Editors' Choice

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Long-term outcomes of lateral skull base reconstruction with a free omental flap and facial nerve reconstruction

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ABSTRACT

In lateral skull base reconstruction, it is necessary to seal the defect in the lateral skull base, fill the dead space, and, sometimes, reconstruct the facial nerve. However, this procedure is difficult to perform with a standard musculocutaneous flap. Therefore, for such cases, an omental flap is used in our hospital because of its flexibility. In this study, we report our experience with the procedure (lateral skull base reconstruction with a free omental flap) and its long-term outcome and facial nerve reconstruction, with special focus on facial nerve recovery. This study is a technical note and a retrospective review. It was conducted in Nagoya University Hospital. Overall, 16 patients (12 women and 4 men; mean age: 55.1 years) underwent lateral skull base reconstruction with a free omental flap after subtotal temporal bone resection or lateral temporal bone resection during 2005–2017. The main outcome measures were postoperative complications and facial nerve recovery: Yanagihara score and House-Brackmann grading system. Complications included partial necrosis and minor cerebrospinal fluid leakage in 2 patients. Facial nerve recovery could be observed more than 12 months after surgery, with a mean Yanagihara score of 19.6 and House-Brackmann grade of 3.60. The free omental flap is a reliable method for lateral skull base reconstruction, especially in cases where facial nerve reconstruction is needed. To the best of our knowledge, this is the first report on facial nerve recovery after lateral skull base reconstruction.

Keywords: skull base, reconstruction, omental flap, facial nerve

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INTRODUCTION

After subtotal temporal bone resection or lateral temporal bone resection, it is necessary to seal the defect in the lateral skull base, fill the dead space, and, sometimes, reconstruct the facial nerve. Although a pedicled flap or a free flap is usually used for lateral skull base reconstruction, it is difficult to fill the deep and complex space using this approach, particularly when there is a need to surround the facial nerve with a standard musculocutaneous flap. As an alternative, the facial nerve can be reconstructed with a long graft running along the floor of the defect and covered with a flap (Fig. 1). In such cases, an omental flap is used for lateral skull base reconstruction.[1]

In this study, we report our experience in lateral skull base reconstruction with a free omental flap and the long-term outcomes together with facial nerve reconstruction.

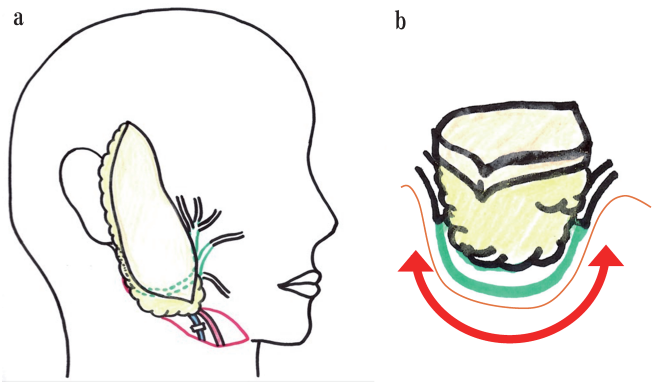

Fig. 1 Lateral skull base reconstruction with a standard musculocutaneous flap
Fig. 1a: The standard musculocutaneous flap is transferred after the facial nerve is reconstructed.
Fig. 1b: The facial nerve is reconstructed with a nerve graft running along the floor of the defect in an indirect pathway.

MATERIALS AND METHODS

Surgical procedure

The omental flaps were harvested by a plastic surgeon who has a board certification in general surgery; the harvest was performed by laparotomy in all cases and used for reconstructing the defect. The facial nerve was either resected or suspended in the patients. When the facial nerve was resected, it was reconstructed using a sural nerve graft, hypoglossal-facial nerve anastomosis and a great auricular nerve graft, hypoglossal-facial nerve anastomosis, or direct suturing in the shortest way. (Fig. 2a). The deep space under the facial nerve was filled with the proximal part of the omental flap. Then, the distal part of the omental flap was turned over, and the facial nerve was sandwiched inside the folded flap (Fig. 2b). With this procedure, we could perform facial nerve reconstruction in the shortest distance (Fig. 2c). When there was a skin defect, it was closed either directly or with a skin graft.

Patients

This study is a technical note and a retrospective review. Patients undergoing reconstruction of the lateral skull base defect with a free omental flap after subtotal temporal bone resection

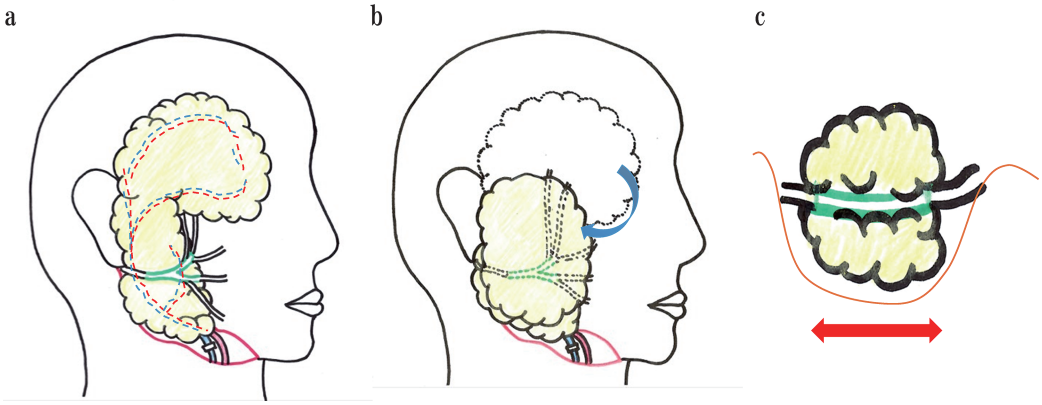

Fig. 2 Lateral skull base reconstruction with an omental flap
Fig. 2a: The omental flap is transferred and the deep space is filled with the proximal part of the omental flap. Then, the facial nerve is reconstructed with a nerve graft or other methods.
Fig. 2b: The distal part of the omental flap is turned and used to sandwich the reconstructed nerve.
Fig. 2c: The facial nerve is reconstructed in the shortest distance.

or lateral temporal bone resection at our hospital from 2005 to 2017 were identified. Patients with a history of parotidectomy or idiopathic facial paralysis were excluded. Their clinical data were analyzed retrospectively from patients' medical records. We then recorded the number of patients who underwent subtotal temporal bone resection and lateral temporal bone resection.

Patients underwent resection for the following types of carcinomas: squamous cell carcinoma of the external auditory canal, squamous cell carcinoma of the parotid gland, adenoid cystic carcinoma of the parotid gland, recurrent adenocarcinoma of the parotid gland, giant cell reparative granuloma of the mandibular bone, and chondroblastoma of the temporal bone. The excision was performed by a team comprising neurosurgical and otolaryngological physicians. All patients had an accurate resection according to the surgical navigation system.

Following resection, the small dural defect was reconstructed by the neurosurgeon using fibrin glue, whereas the large defect was reconstructed using the fascia lata. Structural reconstruction of skull base defects was not undertaken in any of the cases. Prophylactic lumbar drainage of the cerebrospinal fluid was not used routinely.

Outcomes

The main outcome measures were postoperative complications and facial nerve recovery, measured using Yanagihara score and House-Brackmann grading system.

Ethical considerations

The study was performed in accordance with the principles of the Declaration of Helsinki. All study participants provided informed consent, and this study was approved by the Nagoya University Hospital Institutional Review Board (approval no. 2020-1764). The identity of the patients has been protected.

RESULTS

Sixteen patients who underwent reconstruction of the lateral skull base defect with a free

omental flap after subtotal temporal bone resection or lateral temporal bone resection were enrolled. Mean patient age was 55.1 years (range: 32–77 years). 12 patients were female and 4 were male. Overall, 15 patients underwent subtotal temporal bone resection, and 1 patient underwent lateral temporal bone resection. Five patients received postoperative radiotherapy, with a mean dose of 56.0 (40–60) Gy.

Patients underwent excision of squamous cell carcinoma of the external auditory canal (n=10), squamous cell carcinoma of the parotid gland (n=1), adenoid cystic carcinoma of the parotid gland (n=1), recurrent adenocarcinoma of the parotid gland (n=1), giant cell reparative granuloma of the mandibular bone (n=1), and chondroblastoma of the temporal bone (n=2).

The facial nerve was reconstructed in 14 patients and suspended in 2 patients. The facial nerve was reconstructed using a sural nerve graft or a great auricular nerve graft (n=9), hypoglossal-facial nerve anastomosis and a great auricular nerve graft (n=2), hypoglossal-facial nerve anastomosis (n=2), or direct suturing in the shortest way (n=1). In all cases, the reconstructed or suspended facial nerve was covered with the omental flap (Fig. 3, 4). The clinical, ablative, and reconstructive surgery data are summarized in Table 1.

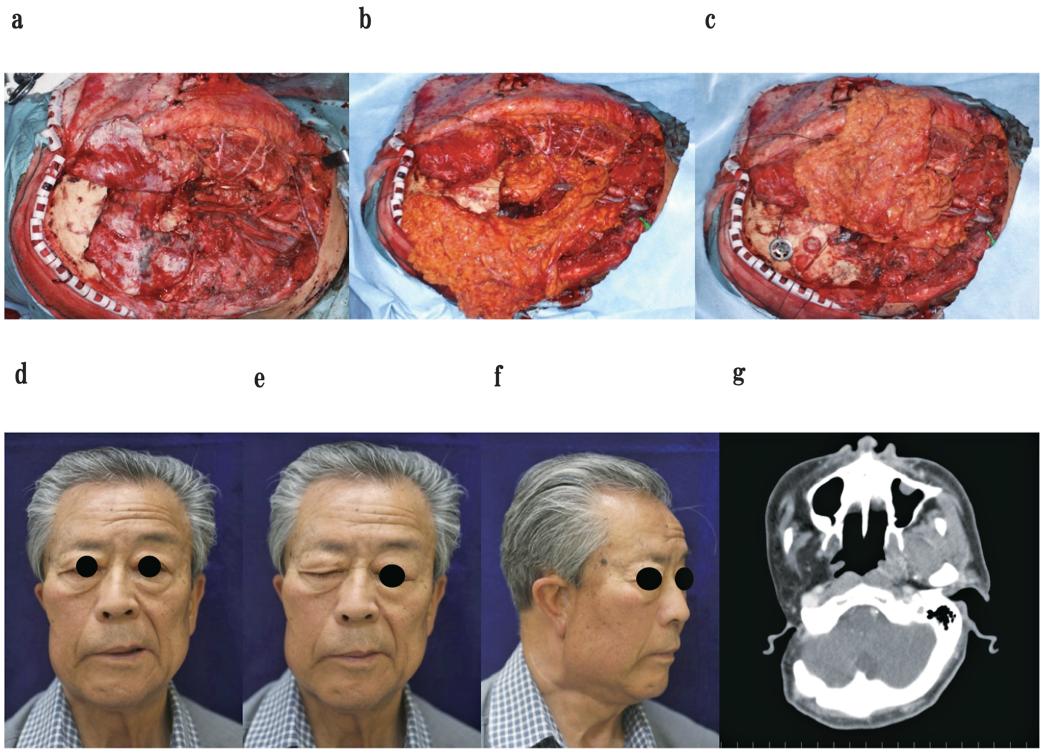

Fig. 3 Case 3

Fig. 3a: Lateral skull base defect following subtotal temporal bone resection of a squamous cell carcinoma of the right external auditory canal.

Fig. 3b: An omental flap is transferred to the deep space of the defect. Then, the facial nerve is reconstructed using end-to-side anastomosis to the hypoglossal nerve.

Fig. 3c: The distal part of the omental flap is turned over and is used to sandwich the reconstructed nerve.

Fig. 3d-g: Case 3 appearances (**d** resting, **e** eyelid closure, **f** oblique angle) and computed tomography (CT) (**g**) after 22 months. Yanagihara score is 22 and House-Brackmann grading system (H-B GS) is 3.

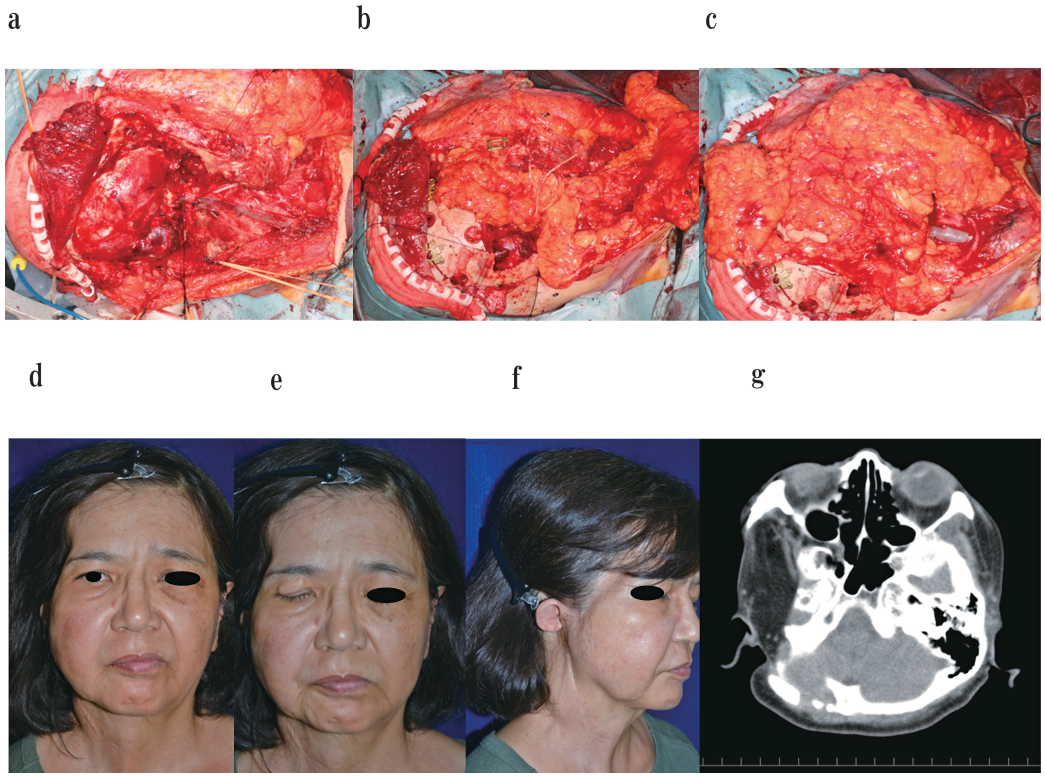

Fig. 4 Case 7

Fig. 4a: Lateral skull base defect following subtotal temporal bone resection of a squamous cell carcinoma of the right parotid gland.

Fig. 4b: An omental flap is transferred to the deep space of the defect. Then, the facial nerve is reconstructed with a sural nerve graft.

Fig. 4c: The distal part of the omental flap is turned and is used to sandwich the reconstructed nerve.

Fig. 4d-g: Case 7 appearances (**d** resting, **e** eyelid closure, **f** oblique angle) and CT (**g**) after 42 months. Yanagihara score is 24 and House-Brackmann grading system (H-B GS) is 3.

Flap survival was 100% for all lateral skull base reconstructions. Two omental flaps had distally partial necrosis which was treated with conservative treatment. There was no ileus and no abdominal wall hernia at a donor site after harvesting an omentum. Although partial necrosis and minor cerebrospinal fluid leakage occurred in 2 patients, they were treated conservatively. In all patients, facial nerve recovery could be observed more than 12 months after the operation, as determined using the Yanagihara score and the postoperative House-Brackmann grading system, with mean scores of 19.6 and 3.60, respectively. Fifteen patients have survived without disease and 1 patient has survived with distant metastasis (Table 2).

Table 1 Patients and methods of reconstruction

	Age (years)	Sex	Primary lesion	Histopathology	UICC TNM Classification	Type of temporal bone resection	Preoperative facial nerve paralysis	Facial nerve defect	Facial nerve reconstruction	Postoperative radiation therapy (Gy)	Follow-up period (months)
Case 1	32	F	Temporal bone	Chondroblastoma	N/A	STBR	–	–	Intact	N/A	26
Case 2	56	F	External auditory canal	Squamous cell carcinoma	T3N0M0	STBR	–	+	Sural nerve graft	N/A	74
Case 3	74	M	External auditory canal	Squamous cell carcinoma	T3N0M0	STBR	–	+	Hypoglossal-facial nerve anastomoses	60	24
Case 4	73	M	Parotid gland	Adenocarcinoma	T4bN1M0	STBR	–	+	Sural nerve graft	40	84
Case 5	63	M	Parotid gland	Adenocystic carcinoma	T4N0M0	STBR	+	+	Sural nerve graft	60	132
Case 6	62	M	Mandibular bone	Giant cell reparative granuloma	N/A	LTSR	–	+	Direct suture	N/A	105
Case 7	56	F	Parotid gland	Squamous cell carcinoma	T4aN1M0	STBR	+	+	Sural nerve graft	60	48
Case 8	42	F	External auditory canal	Squamous cell carcinoma	T2N1M0	STBR	–	+	Sural nerve graft	N/A	128
Case 9	34	F	External auditory canal	Squamous cell carcinoma	T2N0M0	STBR	–	+	Sural nerve graft	N/A	92
Case 10	43	F	External auditory canal	Squamous cell carcinoma	T2N1M0	STBR	–	+	Sural nerve graft	N/A	71
Case 11	77	F	External auditory canal	Squamous cell carcinoma	T4N0M0	STBR	–	+	Sural nerve graft	N/A	13
Case 12	43	F	External auditory canal	Squamous cell carcinoma	T4N0M0	STBR	–	+	Great auricular nerve graft + Hypoglossal-facial nerve anastomoses	N/A	13
Case 13	61	F	External auditory canal	Squamous cell carcinoma	T3N1M0	STBR	–	+	Great auricular nerve graft + Hypoglossal-facial nerve anastomoses	N/A	19
Case 14	60	F	External auditory canal	Squamous cell carcinoma	T3N0M0	STBR	–	+	Great auricular nerve graft	N/A	23
Case 15	49	F	Temporal bone	Chondroblastoma	N/A	STBR	–	–	Intact	N/A	30
Case 16	57	F	External auditory canal	Squamous cell carcinoma	T4N0M0	STBR	–	+	Hypoglossal-facial nerve anastomoses	60	33

UICC: The Union for International Cancer Control
STBR: subtotal temporal bone resection
LTBR: lateral temporal bone resection

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Table 2 Complication and postoperative status

	Wound complication	Facial nerve recovery: Yanagihara Score	Facial nerve recovery: H-B GS	Survival status
Case 1	–	38	1	Disease-free survival
Case 2	CSF leakage	26	2	Disease-free survival
Case 3	–	22	3	Disease-free survival
Case 4	–	6	5	Disease-free survival
Case 5	–	6	6	Survival with liver and lung metastases
Case 6	–	20	4	Disease-free survival
Case 7	Partial necrosis of temporal muscle and omental flap	24	3	Disease-free survival
Case 8	CSF leakage	26	2	Disease-free survival
Case 9	–	14	5	Disease-free survival
Case 10	Partial necrosis of temporal muscle	14	5	Disease-free survival
Case 11	–	16	4	Disease-free survival
Case 12	–	6	5	Disease-free survival
Case 13	–	18	4	Disease-free survival
Case 14	–	20	4	Disease-free survival
Case 15	–	40	1	Disease-free survival
Case 16	–	18	4	Disease-free survival

CSF leakage: cerebrospinal fluid leakage
H-B GS: House-Brackmann grading system

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DISCUSSION

Lateral skull base reconstruction requires a watertight dural seal and filling of the dead space with vascularized soft tissue to prevent spinal fluid leakage and cerebral meningitis.[2,3] Many types of pedicled or free flap reconstructions for lateral skull base defects have been reported in past studies.[4-17]

However, the lateral skull base defect resulting from temporal bone resection is often deep, narrow, and three-dimensional, and it is more difficult to fill the dead space with leaving a gap. In these cases, a facial nerve is often resected oncologically and needs reconstruction. In the conventional procedure, facial nerve reconstruction was performed with a long graft running along the floor of the defect and covered with a flap. If the facial nerve is spared, then it is more difficult to fill the space surrounding the "hanging" facial nerve (Fig. 1).

The advantage in our procedure is that the facial nerve can be reconstructed with the shortest distance. The omental flap is flexible and can be processed freely, given its vascular anatomy, as reported in our previous study (Fig. 5).[18] Therefore, an omental flap allows filling of the deep and complex space surrounding the facial nerve, which is reconstructed by the shortest route.

According to our results, the postoperative facial nerve recovery evaluated using the Yanagihara score differs from 6 to 40 points because skull base defects and facial nerve situations must be treated differently. Facial nerve recovery is affected by the level of resection, preoperative facial paralysis, and other factors. Furthermore, the Yanagihara score was low in some cases. We think that there may have been a problem with the scoring method. In the Yanagihara scoring method, facial nerve recovery is evaluated for the function of an intended movement of the face. Even if the reconstructed nerve recovers and the facial muscles move, it is not always possible to perform the intended movement in the same way as that on the other side, and in such cases, the Yanagihara score will be low. In these cases, a standardized evaluation is impossible, but for any type of facial nerve surgery, the shorter the reconstruction distance, the better the recovery.

Past studies on any reconstructive technique involving a standard musculocutaneous flap have not reported facial nerve reconstruction and its recovery. To the best of our knowledge, this is

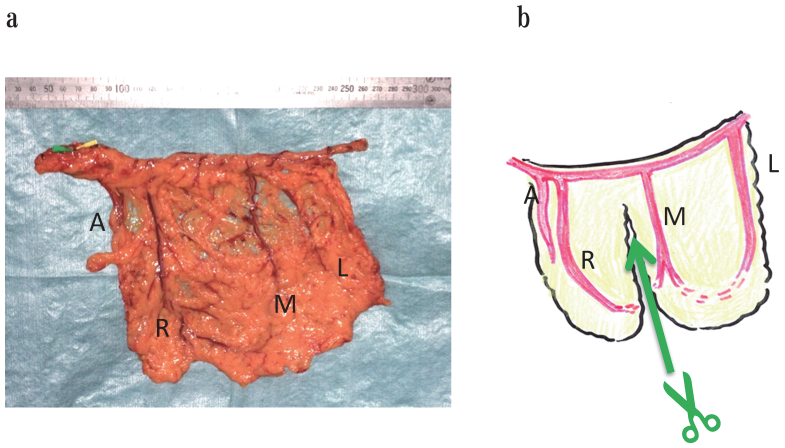

Fig. 5 Anatomy of an omental flap

Fig. 5a: The omental flap is supplied by the right gastroepiploic artery and 4 branches: the left omental artery (L), middle omental artery (M), right omental artery (R), and accessory omental artery (A).

Fig. 5b: According to the vascular anatomy, the omentum can be processed flexibly.

the first study to report on facial nerve recovery after lateral skull base reconstruction.

Postoperative wound complication rates are 0%–35% after temporal bone resection and reconstruction with a standard flap.[3,5-10,13-15] Four of 16 patients (25.0%) in our series experienced wound complications, including 2 patients with cerebrospinal fluid leakage (12.5%). Treatment includes rest and conservative management. This rate is equivalent to those reported previously.[3,5-10,13-15] Although harvesting of a standard flap without laparotomy is less invasive for a donor site than that of an omental flap, there is no complication of the donor site of an omental flap in our cases.

Our procedure may have advantages in terms of tissue regeneration. An omental flap induces hyperperfusion and some tissue growth factors[19] and may promote nerve regeneration.[20,21]

On the contrary, the omentum flap may be involved in cancer progression. A recent study showed that adipose-derived stromal cells from the omentum promote vascularization and growth of endometrial tumors.[22] There has been no local recurrence in these patients to date, but a case of meningioma with malignant transformation during the course of multiple recurrences shortly after cranioplasty using an omental flap has been reported in our previous study.[23] Consequently, these patients should be observed carefully on follow-up.

This study has limitations, which should be considered. The first limitation is the retrospective analysis, wherein we restricted the data to the information maintained in the electronic medical records. Second, statistical analysis of data on complications and facial nerve recovery between patients who underwent omental flap reconstruction and those who underwent other flap reconstructions could not be performed. This reconstructive procedure is novel procedure for lateral skull base reconstruction. Particularly, in cases wherein facial nerve reconstruction is needed, this procedure allows us to reconstruct the nerve in the shortest distance.

CONCLUSION

For lateral skull base reconstruction, it is difficult to fill the deep and narrow dead space and surround the reconstructed or suspended facial nerve where needed with currently available techniques. We reported our experience with lateral skull base reconstruction using a free omental flap. Because of the flexibility of the omental flap, it is easy to fill the three-dimensional space without leaving any gap. Lateral skull base reconstruction with a free omental flap could be a useful option, particularly in cases where facial nerve reconstruction is needed or the facial nerve is intact.

CONFLICT OF INTEREST

The authors have no conflicts of interest directly relevant to the content of this article.

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