Reconstruction of Lateral Skull Base Defects with Radial Forearm Free Flaps: The Double-Layer Technique

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Abstract

Introduction The radial forearm flap has fallen out of favor in lateral skull base reconstruction in recent literature. However, especially when used in a double layer, a radial forearm may be able to provide the thickness of a large flap while taking advantage of the pliability for which the flap is renowned.

Objective To report the results of the double-layer technique of radial forearm free flap reconstruction of lateral temporal bone defects.

Design A retrospective chart review.

Setting A tertiary care institution.

Participants All consecutive patients who underwent lateral temporal bone resections and were reconstructed with free flaps from 2006 to 2012.

Major Outcome Measures Flap success rate, complications, and rate of revision surgery.

Results A total of 17 patients were identified with free flap reconstruction of the lateral skull base. Seven received reconstruction with a double-layer radial forearm flap. Reconstruction-related complications in this group included one case of facial cellulitis. The flap success rate was 100%. These results were comparable with patients who had other flaps.

Conclusions The radial forearm free flap may be an effective reconstruction option for lateral temporal bone defects especially when used in the double-layer technique.

Keywords

- ▶ lateral temporal bone
- ▶ microvascular reconstruction
- ▶ radial forearm free flap

Introduction

Lateral skull base reconstruction has evolved through the decades from local tissue reconstruction to free tissue.^{1–3} These complex three-dimensional defects require pliable tissue that is easily mobile and that is scarce locally. Additionally, a large amount of bulk is needed to obliterate dead space that is more easily obtained from a distant site. Robust and vascular coverage of major vascular structures, brain and dura, and stable reconstruction prevent complications such

as cerebrospinal fluid (CSF) leak, meningitis, or infection.⁴ It is generally accepted that free tissue transfer is the most favorable in this defect due to its reliability, high vascularity, and ability to be tailored to the harvest by flap selection and harvest techniques.

Although many free flap options are available, a few flaps have gained notoriety as poor for lateral skull base reconstruction such as the rectus free flap and the radial forearm free flap.^{5–7} The radial forearm free flap was one of the first well-described soft tissue flaps of free flap reconstruction,

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and it had an early reputation for large vessels, favorable characteristics for vessel geometry, and reliability.⁷ It was initially used extensively in lateral skull base reconstruction, but it has fallen out of favor due to the tutelage that it does not provide enough tissue to seal the complex three-dimensional defect caused by a lateral skull base resection.^{5,6} The radial forearm was described as too small and inadequate for reconstruction in this area.^{6,8} However, at our institution, we have found it to be as reliable when used in a double-layer fashion like other flaps. This study reports the results from the double-layer radial forearm reconstruction of large lateral skull base defects.

Methods

A retrospective review was performed of consecutive patients undergoing free flap reconstruction for large lateral skull base defects at Massachusetts Eye and Ear Infirmary and Massachusetts General Hospital between 2006 and 2012. Inclusion criteria included patients who underwent lateral temporal bone resection, parotidectomy, and auriclectomy or significant postauricular skin resection. Charts were reviewed for demographic information such as age, sex, diagnosis, and history of radiation and/or chemotherapy. The charts were examined for clinical outcomes, perioperative and late complications, undesirable aesthetic outcomes, and need for revision surgery. These results were then compared among the different flaps used for reconstruction.

The double-layer radial forearm flap is harvested with a skin paddle tailored to the size of the skin defect and a large fat pad surrounding the proximal pedicle. Lateral subcutaneous

Fig. 1 Harvested radial forearm free flap with large fat pad surrounding pedicle.

Fig. 2 Folded double-layer radial forearm free flap over lateral skull base defect.

dissection of the proximal arm skin over the fat pad extends more peripherally than is customary to create a bulkier fatty flap (►Fig. 1). Once harvested, the flap is folded in half (►Fig. 2), and the fatty portion of the flap is used to fill in the complex three-dimensional bony defect of the lateral skull base. The portion containing skin is used for the outer layer. The microvascular anastomosis is performed before the cutaneous inset is completed. The final appearance should have a small amount of overcorrection (►Fig. 3).

Results

From 2006 to 2012, 17 free flaps were performed at our institution for large lateral skull base defects. Seven defects were reconstructed with anterolateral thigh flaps, seven with radial forearm in a double-layer fashion, and three with radial forearm in a single-layer fashion. All surgical resections included an auriclectomy, lateral temporal bone resection, and skin resection except for one patient with auricular preservation but significant postauricular skin resection. The pathology was squamous cell carcinoma in nine cases, basal cell carcinoma in four cases, and spindle cell carcinoma, eccrine carcinoma, poorly differentiated carcinoma, and melanoma in one case each. The average patient age was

Fig. 3 Postoperative result of a double-layer radial forearm free flap for a lateral temporal bone, auriclectomy, and parotidectomy defect.

Table 1 Patient characteristics

	Double-layer RFFF	ALT	Single-layer RFFF
No. of patients	7	7	3
Age, y, mean	62.9	71.4	65.3
Sex	7 males	5 males 2 females	3 males
Pathology	5 squamous cell carcinoma 1 basal cell carcinoma 1 melanoma	4 squamous cell carcinoma 2 basal cell carcinoma 1 poorly differentiated carcinoma	1 basal cell carcinoma 1 eccrine carcinoma 1 spindle cell carcinoma

Abbreviations: ALT, anterolateral thigh (free flap); RFFF, radial forearm free flap.

66.8 years (range: 33–89). There were no mortalities in the postoperative period. Nine patients received adjunctive radiation therapy. Five patients had a history of radiation, and two patients had a history of radiation and adjunctive radiation. Five patients also received chemotherapy adjunctively. Patient characteristics were similar among the three groups of reconstruction techniques (►Table 1).

In the double-layer radial forearm group, there was a 100% flap success rate and no major complications related to reconstruction. No vein grafts were required for microvascular anastomosis. There was one minor complication (14%) of facial cellulitis that resolved with antibiotics and no further surgical intervention. All cases had an acceptable aesthetic outcome with no concavity at the reconstruction site at 8- to 49-month follow-up (median: 10 months). No flaps required revision surgery or return to the operating room. Long-term assessment of donor site morbidity showed no patient complaints regarding the donor site or arm dysfunction or contracture.

In the anterolateral thigh group, there was a 100% flap success rate. There were no major complications, but there were minor complications in six patients. At the recipient site, three patients had postoperative wound infections and one patient had a postoperative hematoma. The patient with a postoperative hematoma also developed skull base osteomyelitis. Two patients (29%) required a flap revision after surgery for unsightly bulkiness. Donor site complications included two cases of thigh seroma and one case of thigh hematoma. In the single-layer radial forearm group, there was also a 100% success rate with two minor complications; one case of

arm seroma and one case of arm hematoma with subsequent infection.

Discussion

Reliable and robust reconstruction of the lateral skull base is needed to prevent complications such as meningitis, exposure of great vessels, dura and cranial nerves, and poor cosmetic outcome.^{1–3} Initially, these defects were often reconstructed with rectus free flaps and radial forearm free flaps. However, as the anterolateral thigh (ALT) free flap became more popular in the last decade due to increased reports of its reliability, the two former workhorses were deemed to be poor for reconstruction of these defects.

The rectus free flap was the original workhorse of lateral skull base reconstruction at the beginning of the free flap era. It is a robust flap with a large amount of available muscle, and it was thought that the vascular muscle was needed to seal in the skull base defect and prevent CSF leaks. However, it fell out of favor due to its bulkiness, significant donor site complication of abdominal wall herniation, and the increased favorable results with other flaps. When the rectus flap is used, it has been found to require significant debulking.⁶

Recent authors believe ALT to be the first-line option in lateral skull base reconstruction.^{8,9} O'Connell et al report on 18 lateral skull base defects in which 9 were reconstructed with rectus flaps, 5 with ALT flaps and 4 with latissimus. They concluded that they favor ALT for this defect.⁹ Rosenthal et al divide lateral temporal bone defects into three classes based on the extent of the resection and therefore the size of the

Fig. 4 Radiography comparison of (A) a radial forearm reconstruction of a right lateral skull base defect with (B) an anterolateral thigh reconstruction of a left lateral skull base defect at 1-month postoperatively. The radial forearm shows good contour.

Fig. 5 Radiography comparison of (A) a radial forearm reconstruction of a left lateral skull base defect with (B) an anterolateral thigh reconstruction of a left lateral skull base defect at 6 months postoperatively.

defect. Per their classification, all of our defects are the highest class defects that included a lateral temporal bone resection and total auriculectomy. The authors deem these defects to be most appropriate for ALT or rectus free flaps. The radial forearm free flap was deemed to be only appropriate for the lowest class defects, which were preauricular defects with preservation of the auricle and external auditory canal. Our results contradict these recommendations.

Most of the complications in our study were actually found in the group receiving ALTs and related to wound infections and donor site seromas, which is similar to those in other published series.^{10,11} Gidley et al reviewed the most common complications in 124 temporal bone resections from 1945 to 2005, and they stated that the most common complications were wound complications such as wound breakdown, wound infections, CSF leak, and meningitis.¹⁰ In our series of double-layer forearm patients, the wound infection rate was low compared with the published rates, and there were several advantages of the flap including no need for vein grafts or debulking in a delayed fashion. The radial forearm free flap has the advantage that it often has a longer pedicle than the anterolateral thigh and latissimus free flaps. In our series, no vein grafts were used. Conversely, vein grafts are reported to be necessary in a portion of ALTs.^{8,9}

There is a tendency to overcorrect defects in free flap reconstruction due to the comparative ease of debulking a free flap at a later date compared with trying to increase the bulk. Also, there is a mantra to overcorrect the defect due to the expected amount of volume loss in the postoperative period. However, in the lateral skull base, the volume loss may not be a great percentage. Higgins et al found that the postradiotherapy flap loss in ALTs when used in parotidectomy resection was only 8% at 6 months after radiotherapy.¹² Volume loss in flaps in the lateral cranium may not be similar to that when used in oral reconstruction (►Figs. 4 and 5). An advantage of the double-layer forearm free flap in our series is that no cases required debulking or revision surgery compared with two of seven cases in the ALT group. Similarly,

Rosenthal et al demonstrated a 34% rate of debulking for the rectus free flap and 9% in the anterolateral thigh flap.⁶

Conclusion

Lateral skull base reconstruction requires a hearty flap that is pliable and able to closely fill in the complex defect created by lateral temporal bone resection and cover important structures. Although a variety of flaps are available, the double-layer radial forearm flap shows good results, a low complication rate (despite previous reports of inadequacy in this area), and favorable aesthetic outcomes for correctly selected patients.

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