Reconstruction of temporal bone defects: Consideration for use of the submental island flap and temporalis muscle flap

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Abstract. Reconstruction of temporal bone defects: Consideration for use of the submental island flap and temporalis muscle flap. Reconstruction of temporal bone defects after resection of external auditory canal carcinoma is often challenging. In advanced-stage carcinoma, lateral temporal bone resection with adjacent structures, such as the condylar process and parotid gland, is necessary and the subsequent large defect requires flap reconstruction. We present both the submental island flap and the temporalis muscle flap for reconstruction in these patients. Five patients underwent reconstruction following resection of the external auditory canal carcinoma between April 2012 and June 2017. Choice of the flap was determined by the size and site of the defect. Two patients underwent temporalis muscle flap reconstruction following resection of the lateral temporal bone with the condylar process. Three other patients underwent submental island flap reconstruction after lateral temporal bone resection combined with resection of the condylar process, total parotidectomy, and neck dissection. Procedure was successful in all cases without any complications. We consider both methods as ideal options for reconstruction of temporal bone defects.

Introduction

Carcinoma of the external auditory canal (EAC) is a rare form of malignancy. The incidence is approximately one person per million per year.1,2 Although various therapeutic strategies have been proposed, a wide en bloc resection of the tumor with clear surgical margins and subsequent reconstruction of the temporal defect is the treatment of choice.3 Reconstruction of the temporal defect after resection of EAC carcinoma is often challenging. In early-stage carcinoma, lateral temporal bone resection is usually performed. The reconstruction is subsequently performed by a combination of tympanoplasty and canalplasty with skin grafts or various flaps for the purpose of retaining conductive hearing ability.4 In advanced-stage carcinoma of the EAC, on the other hand, lateral temporal bone resection with adjacent structures such as the condylar process and parotid gland, or subtotal/total temporal bone resection is necessary.2,5 In this situation, it is difficult to preserve postoperative hearing ability by reconstruction of the EAC because of the complex and extensive defect. Therefore, the purposes of the reconstruction are to obliterate the middle ear cavity, to fill the complex cutaneous and soft tissue defect and to retain a facial contour. A temporalis muscle flap, a pectoralis major flap, a trapezius flap, a lattisimus dorsi flap or free flaps are usually used to fill the defect.6,7 However, few reports describe which flap to choose for reconstruction of the temporal defect after resection of EAC carcinoma.

The submental island flap was first described by Martin et al in 1993.8 The reliability of this flap has since been described by various authors.8-10 It provides the advantages of adequate texture and color match to facial skin, pliability and a well-hidden donor site. This flap has been widely used for reconstruction of head and neck carcinomas in the lower and middle parts of the face, oral cavity and pharynx.8,9,11 However, few reports show the reconstruction of temporal defects after resection of EAC carcinoma.

We have chosen a submental island flap and a temporalis muscle flap according to the size and site of the defect for reconstruction following resection of the lateral temporal bone and adjacent structures in advanced-stage carcinoma of the EAC. We herein report the consideration for use...
of the submental island flap and temporalis muscle flap with technical tips.

Materials and methods

Seven patients with EAC carcinoma were surgically treated in our institution between April 2012 and June 2017.

Two of seven patients underwent total canal resection and canalplasty with skin graft for early-stage carcinoma.

The other five patients had advanced-stage carcinoma and underwent resection of the lateral temporal bone with adjacent structures. This group included one male and four females, aged 54 to 63 years old. The defects were subsequently reconstructed with a temporalis muscle flap or submental island flap. Patient characteristics, tumor extent, reconstructive procedures, and postoperative results were studied in these five patients.

The choice of the flap was determined by the size and site of the defect. When adjacent small sized structures such as the condylar process were resected with the lateral temporal bone, a relatively small defect was reconstructed with the temporalis muscle flap. When extensive resection of the lateral temporal bone was performed with adjacent structures such as the condylar process, parotid gland, and neck dissection, the defect was relatively large and situated caudally, and was reconstructed with the submental island flap.

Surgical Technique

Temporalis muscle flap

Following resection of the EAC, a T-shaped incision is made at the temporal region (Figure 1). Anterior and posterior scalp flaps are elevated in the plane between the temporoparietal fascia and the superficial layer of the deep temporal fascia. At 2 cm superior to the zygomatic arch, the dissection plane of the anterior scalp flap is deepened into the superficial temporal fat pad, just above the deep layer of the deep temporal fascia to protect the temporal branch of the facial nerve. The periosteum of the zygomatic arch is incised and the posterior portion of the zygomatic arch is osteotomized to maximize the mobility of the temporalis muscle flap. The posterior three-fourths of the temporalis muscle flap is elevated in the subperiosteal plane with a 5-cm apron of pericranium attached to the distal portion of the flap. Preserving the anterior temporalis muscle prevents a contour deformity of the temporal region. The flap is then inset into the temporal defect and secured with 4-0 absorbable sutures and fibrin glue. The zygomatic arch is replaced with the original position with a titanium plate.

Submental island flap

When total parotidectomy and neck dissection is performed with the lateral temporal bone resection, the defect is reconstructed with the submental island flap (Figure 2).

Schematic drawing showing reconstruction with the temporalis muscle flap. (A) A T-shaped incision is made at the temporal region. (B) The posterior three-fourths of the temporalis muscle was elevated with a 5-cm apron of pericranium attached to the distal end of the muscle flap. The posterior portion of the zygomatic arch is temporarily removed. (C) The muscle flap was inset into the defect. The detached zygomatic arch is replaced with the original position with a titanium plate. Two suction drains are placed and the wound is closed in layers.

Schematic drawing showing reconstruction with the submental island flap. (A) An elliptical skin paddle is marked in the submental region. (B) The submental island flap is elevated. The platysma is included more widely than the inferior border of the skin paddle and the skin paddle is de-epithelialized. (C) The flap was inset into the defect.
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forms the common facial vein and usually drains into the internal jugular vein. There is usually a communicating branch between the facial vein and the external jugular vein. However, there are some cases where the facial vein drains into the external jugular vein instead of the internal jugular vein. Preserving at least one of the three venous drainage routes from the submental vein is imperative, as they are the routes to the internal jugular vein, the external jugular vein and the reverse flow route to the facial vein. During parotidectomy and neck dissection, care must be taken not to damage the submental and facial vessels, while preserving oncological safety. Following resection of the EAC, an elliptical skin paddle is designed in the submental region according to the size of the defect. The design can extend from the ipsilateral angle of the mandible to the contralateral angle. The upper limit of the flap is just under the mandibular arch and the lower limit of the flap is outlined by a pinch test for primary closure.

The inferior and ipsilateral borders of the flap are first incised. The platysma is included more widely than the inferior border of the skin paddle. At the upper border of the submandibular gland, the submental and facial vessels are identified and small branches supplying the submandibular gland are ligated. The marginal mandibular branch of the facial nerve is preserved. The upper border of the flap is subsequently incised and the flap is elevated from the contralateral side in the subplatysmal plane. At the contralateral anterior belly of the digastric muscle, the dissection plane is deepened just above the muscle layer. The ipsilateral anterior belly of the digastric muscle is included in the flap. The submental and facial vessels are dissected from the submandibular gland and the flap is raised completely. The flap is then de-epithelialized and inset into the defect and secured with 4-0 absorbable sutures and fibrin glue. The subcutaneous tissue of the inferior cervical skin of the donor site is sutured to the hyoid bone to create a well-defined cervicomental angle. Two suction drains are placed and the wound is closed in layers.

Results

The patient characteristics, tumor extent, reconstructive procedures and postoperative results for the five patients with advanced-stage carcinoma are summarized in Table 1. The TNM classification was based on Pittsburgh staging system for carcinoma of the temporal bone. Two patients underwent the temporalis muscle flap reconstruction following resection of the lateral temporal bone and condylar process. The other three patients underwent the submental island flap reconstruction following resection of the lateral temporal bone, combined with resection of the condylar process, total parotidectomy, and neck dissection. Postoperative radiation therapy, with an average dosage of 66 Gy, was administered to three patients. Postoperative courses were uneventful in both reconstructions, without any flap failures. The cosmetic outcome of the temporalis muscle flap reconstruction was satisfactory. There was no contour deformity in the periauricular region and any temporal dip was inconspicuous. The donor scar was concealed in the haired area. The cosmetic outcome of the submental island flap reconstruction was also good. There was no contour deformity in the cervical or periauricular region, and the donor scar was hidden under the mandibular arch.

Case reports

Case Two

A 63-year-old woman presented with squamous cell carcinoma of the EAC (T3N0M0). Preoperative radiologic imaging demonstrated obliteration of the EAC by the tumor and a defect of the anterior canal wall. She underwent resection of the lateral temporal bone and condylar process. The defect was 4 × 5 × 3 cm in size and reconstructed using the temporalis muscle flap (Figure 3). The posterior three-fourths of the temporalis muscle was elevated with a 5-cm apron of the pericranium attached to the distal end of the muscle. The posterior zygomatic arch was

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### Table 1

<table>
<thead>
<tr>
<th>Case</th>
<th>Sex</th>
<th>Age</th>
<th>Diagnosis</th>
<th>TNM</th>
<th>Level of defect</th>
<th>Flap</th>
<th>Radiation</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>60</td>
<td>SCC</td>
<td>T3N0M0</td>
<td>Lateral temporal bone, condylar process</td>
<td>Temporalis muscle flap</td>
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<td>None</td>
</tr>
<tr>
<td>2</td>
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<td>54</td>
<td>SCC</td>
<td>T3N0M0</td>
<td>Lateral temporal bone, condylar process</td>
<td>Temporalis muscle flap</td>
<td>Post</td>
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</tr>
<tr>
<td>3</td>
<td>F</td>
<td>63</td>
<td>SCC</td>
<td>T3N0M0</td>
<td>Lateral temporal bone, condylar process</td>
<td>Submental island flap</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>54</td>
<td>SCC</td>
<td>T3N0M0</td>
<td>Lateral temporal bone, condylar process</td>
<td>Submental island flap</td>
<td>Post</td>
<td>None</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>57</td>
<td>SCC</td>
<td>T3N0M0</td>
<td>Lateral temporal bone, condylar process</td>
<td>Submental island flap</td>
<td>Post</td>
<td>None</td>
</tr>
</tbody>
</table>
The contour of the temporal region was satisfactory and the temporal dip was not conspicuous at 6 months postoperatively (Figure 4).

**Case Three**

A 54-year-old woman presented with squamous cell carcinoma of the EAC (T2N1M0). Preoperative radiologic imaging demonstrated obliteration of the EAC by the tumor, a defect of the anterior canal wall and lymphadenopathy in the parotid gland. She underwent resection of the lateral temporal bone and condylar process, and total parotidectomy. The facial nerve was also resected with the parotid gland. The facial nerve was reconstructed by sural nerve grafting, masseter nerve transfer and neural supercharging by the hypoglossal nerve after resection of the tumor. The defect was then reconstructed with a submental island flap (Figure 5). The flap was elevated with the anterior belly of the digastric muscle. The flap was de-epithelialized and inset into the defect.

The postoperative course was uneventful. Neither contour deformity of the temporal region cut and detached temporarily, and the muscle flap was inset into the defect. The zygomatic arch was replaced and secured to the original position using a titanium plate.

The postoperative course was uneventful. The patient underwent postoperative radiation therapy.
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Anterior (A), lateral (B) and low-angled (C) appearance at 10 months after surgery. The donor site scar was concealed under the jawline. The cervicomental angle was constructed and no contour deformity was seen in the periauricular region.

nor scar of the donor site were conspicuous at the 10-month follow-up (Figure 6).

Discussion

Our reconstructive goal is to obliterate complex defects and retain facial contour after extirpation of advanced-stage carcinoma of the EAC. Canalplasty and tympanoplasty are not performed to retain conductive hearing ability because the defects are complex and extensive. In addition, in advanced-stage carcinoma of the EAC, patients are likely to undergo postoperative radiation therapy. In that situation, the skin graft used to line the EAC may induce delay of wound healing and osteoradionecrosis. In reconstructions following resection of advanced-stage carcinoma of the EAC, we used the temporalis muscle flap or the submental island flap according to the site and size of the defect.

Pectoralis major flaps, trapezius flaps, latissimus dorsi flap, and free flaps are also reported as a reconstructive option. Compared to these flaps, the temporalis muscle flap and the submental island flap have some advantages. The donor sites of both flaps are located adjacent to the defect. Postural changes to harvest the flap after cancer extirpation are not needed. The harvest of the flaps is relatively easy. Microsurgical vascular anastomosis is unnecessary. The donor site scars of both flaps are concealed, by a haired area or the mandibular arch.

In temporalis muscle flap reconstruction, there are some technical tips to optimize the result. The anterior one-fourth of the temporalis muscle should not be included in the flap to avoid temporal dip. The depressed area of the flap donor site can be concealed in the haired area by preserving the anterior one-fourth of the muscle. Removing the posterior portion of the zygomatic arch temporarily can provide maximum mobility of the flap and avoid bulkiness of the flap above the zygomatic arch by passing the subzygomatic route. The removed zygomatic arch must be repositioned to avoid contour deformity. The pericranium can be attached to the distal portion of the flap to provide some volume according to the defect size. The harvested flap should be larger than the defect, considering postoperative atrophy of the muscle. The disadvantage of the temporalis muscle flap is that the flap does not contain a skin component. When the skin of the auricle or cheek is extensively resected, other flaps including skin component are recommended.

When total parotidectomy and neck dissection are performed with the lateral temporal bone resection, the defect is reconstructed with a submental island flap. The flap is designed by extending the incision for the parotidectomy and neck dissection. In submental island flap reconstruction, preservation of the submental and facial vessels during cancer extirpation is imperative. It is useful to check the course and variation of these vessels and lymphadenopathy around the vessels by ultrasonography and computed tomography. It is also useful to discuss the possibility of preserving the vessels with the head and neck surgeon preoperatively. Though lymphatic drainage from the EAC is not entirely predictable, metastasis tends to happen in the parotid and the upper jugular nodes. If it is impossible to preserve the vessels to ensure oncological safety, other flaps, such as the pectoralis major flap or free flaps are recommended. The submental island flap has many variations and can be harvested as a fascioplatysmal flap, a distally based flap, and an osteocutaneous flap. We used this flap as a musculocutaneous flap, including the platysma muscle and the anterior belly of the digastric muscle. The platysma was included more extensively than the inferior border of the skin paddle to secure a large flap volume. When larger flap volume is required, bilateral mylohyoids and anterior bellies of the digastrics can be included in the flap based on a unilateral submental pedicle. The inclusion of the mylohyoid muscle facilitates harvest of the flap and provides additional muscle bulk. Although the skin paddle was de-epithelialized in our cases, it can be used as skin coverage to obtain facial color match when the cheek or auricular skin is extensively resected.
We reported the consideration for use of the submental island flap and temporalis muscle flap for reconstruction following extirpation of advanced-stage carcinoma of the EAC. Both flaps are excellent methods for that reconstruction because they have a reliable blood supply and an ideal volume for the defect. The donor site morbidity is minimal and the resultant scar is well concealed. We consider both methods as ideal options for reconstruction of the temporal bone defect.

**References**

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