

Temporalis muscle flap

Liliana Ein, MD, Opeoluwa Daniyan, MD, Elizabeth Nicolli, MD



From the Department of Otolaryngology, University of Miami, Miami, Florida.

KEYWORDS

Temporalis muscle;
 Locoregional
 reconstruction

The temporalis muscle flap is a versatile and reliable myofascial regional flap that can be used for reconstruction of many craniofacial defects due to its close vicinity to the orbit, oral cavity, and anterior and lateral skull base. Its main utility in head and neck reconstruction is for patients with multiple comorbidities who are high risk for free tissue transfer, due to its ease of harvest, reliable vascular supply, adequate bulk, and minimal donor site morbidity. The main focus of this article is to review the key surgical anatomy and technique for raising a temporalis muscle flap, with particular attention to the frontal branch of the facial nerve and vascular supply from the deep temporal arteries. Strategies to avoid potential complications and improve cosmetic outcome are also discussed.

© 2019 Published by Elsevier Inc.

Introduction

The temporalis muscle flap was first described in the late 1800s for treatment of temporomandibular joint ankylosis and orbital reconstruction after exenteration. In 1917, Gillies described using the temporalis muscle to reconstruct malar deformities after trauma.¹ Later in 1934, he described tunneling the temporalis muscle and fascia to corner of the mouth and eyelid for facial reanimation.² Techniques for the temporalis muscle flap have since evolved for many uses in the head and neck. The temporalis muscle flap is generally thought to be a straight-forward, reliable, regional flap with axial blood supply, and adequate bulk and flexibility for many craniofacial defects.³ Although most of head and neck reconstruction has been replaced with free flap reconstruction, there are certain scenarios where a regional flap is a better and safer option for the patient.^{4,5} The goal of this article is to review

the surgical anatomy and technique for raising a temporalis muscle flap and its use in head and neck reconstruction.

Key anatomy

The temporalis muscle is a broadly based, fan-shaped muscle that arises from the superior temporal line, fills the entire temporal fossa, and narrows into a tendinous sheath that inserts onto the coronoid process and anterior portion of the ascending ramus of the mandible. It functions as a muscle of mastication to retract and elevate the mandible, and is innervated by the mandibular division of the trigeminal nerve.⁶ It has a segmental blood supply, with 2 dominant pedicles from the anterior and posterior deep temporal arteries, which are branches of the second division of the internal maxillary artery. The deep temporal artery arises on the deep surface of the muscle in the infratemporal fossa just medial to the insertion on the coronoid process and courses along the undersurface of the anterior and middle portions of the muscle. A third arterial supply comes from the middle temporal artery, a branch of the superficial temporal artery from the external carotid system, which runs along the undersurface of the

Address reprint requests and correspondence: Elizabeth Nicolli, MD, Department of Otolaryngology, University of Miami, 11201NW 14th St, 3rd Floor, Miami, FL 33136-2107.

E-mail address: exn164@med.miami.edu

<http://doi.org/10.1016/j.otot.2019.04.006>

1043-1810/© 2019 Published by Elsevier Inc.

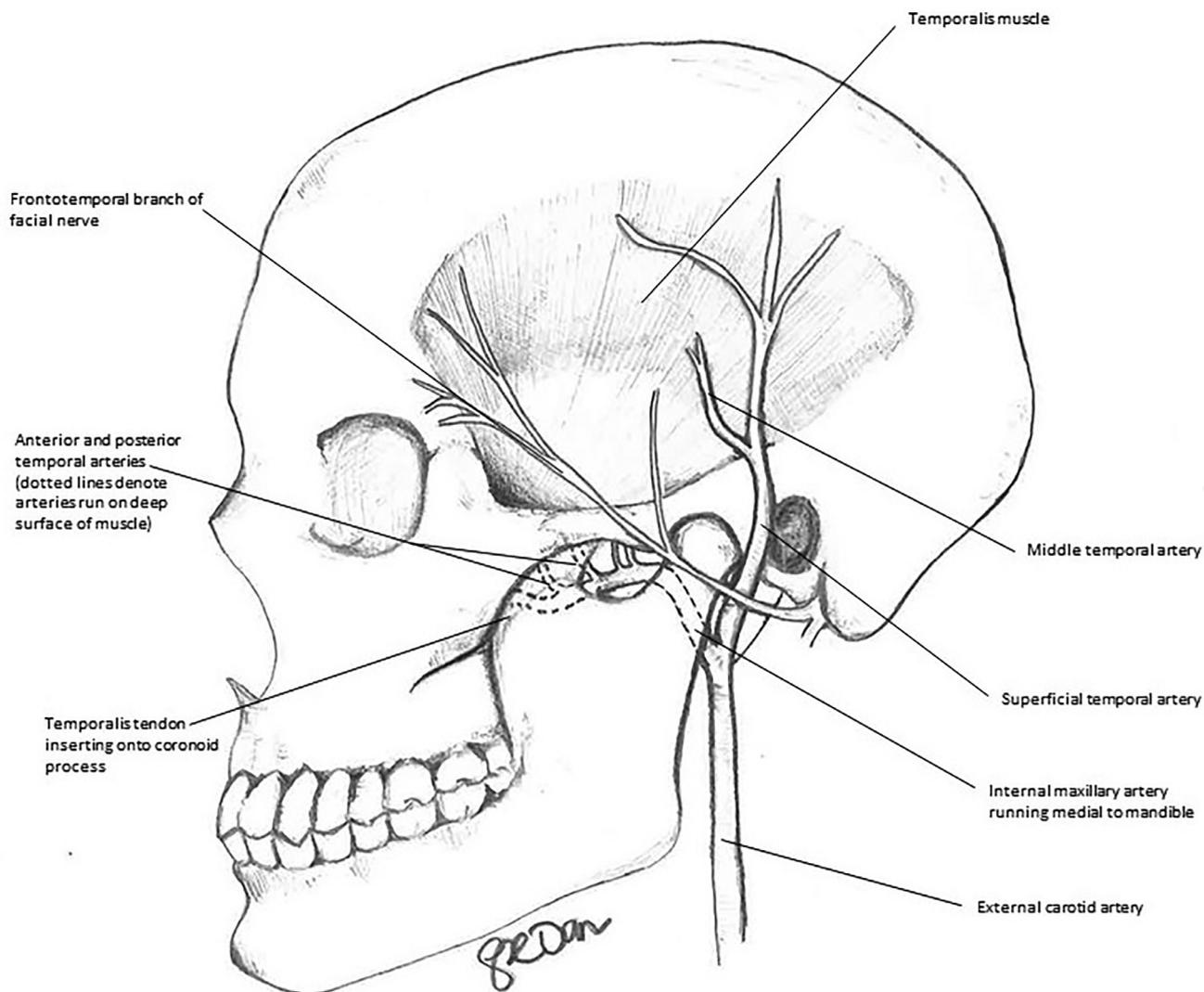


Figure 1 Temporalis muscle arising from superior temporal line and inserting onto coronoid process and anterior ascending ramus. Blood supply comes from the anterior and posterior deep temporal arteries and middle temporal artery. The temporal branch of the facial nerve is seen crossing the midpoint of the zygomatic arch.

posterior margin of the muscle and supplies the overlying deep temporal fascia and the posterior aspects of the muscle (Figure 1). These 3 arteries merge and form a vascular plexus within the superior aspect of the muscle, approximately 1 cm below the temporalis line.^{7,8} The segmental vascular supply gives greater versatility to the flap, as it can be split along a sagittal or coronal plane depending on the size and location of the defect to be reconstructed.^{5,9,10} The redundancy in blood supply can also be attributed to its reliability as a regional flap.³

A thorough understanding of the fascial layers in this area is crucial to avoid injury to the vascular pedicle as well as the facial nerve. The temporal branch of the facial nerve runs within the temporoparietal fascia (TPF) and crosses the midpoint of the zygomatic arch approximately 2.4 cm anterior to the tragus, when measured along a line drawn between the tragus and lateral canthus (Figure 1).¹¹

The layers of the temporal region are different from the layers of the scalp, the latter of which include from the outermost layer down: skin, subcutaneous fat, galea aponeurotica, loose connective tissue (deep fascial layer), and pericranium. Within the temporal region, just deep to the skin and subcutaneous tissues is the superficial temporal fascia, or the TPF, which is continuous with the galea aponeurotica superiorly, frontalis muscle anteriorly, occipitalis muscle posteriorly, and superficial musculoaponeurotic system inferiorly. This layer is supplied by the superficial temporal artery and carries branches of the facial nerve. The TPF should be distinguished from the deep temporalis fascia, which is a thick white fascial layer that directly overlies the temporalis muscle and is continuous with the pericranium above the temporal line. About 1.5-2 cm superior to the zygomatic arch, the deep temporalis fascia splits into the superficial and deep layers, which are separated by the su-

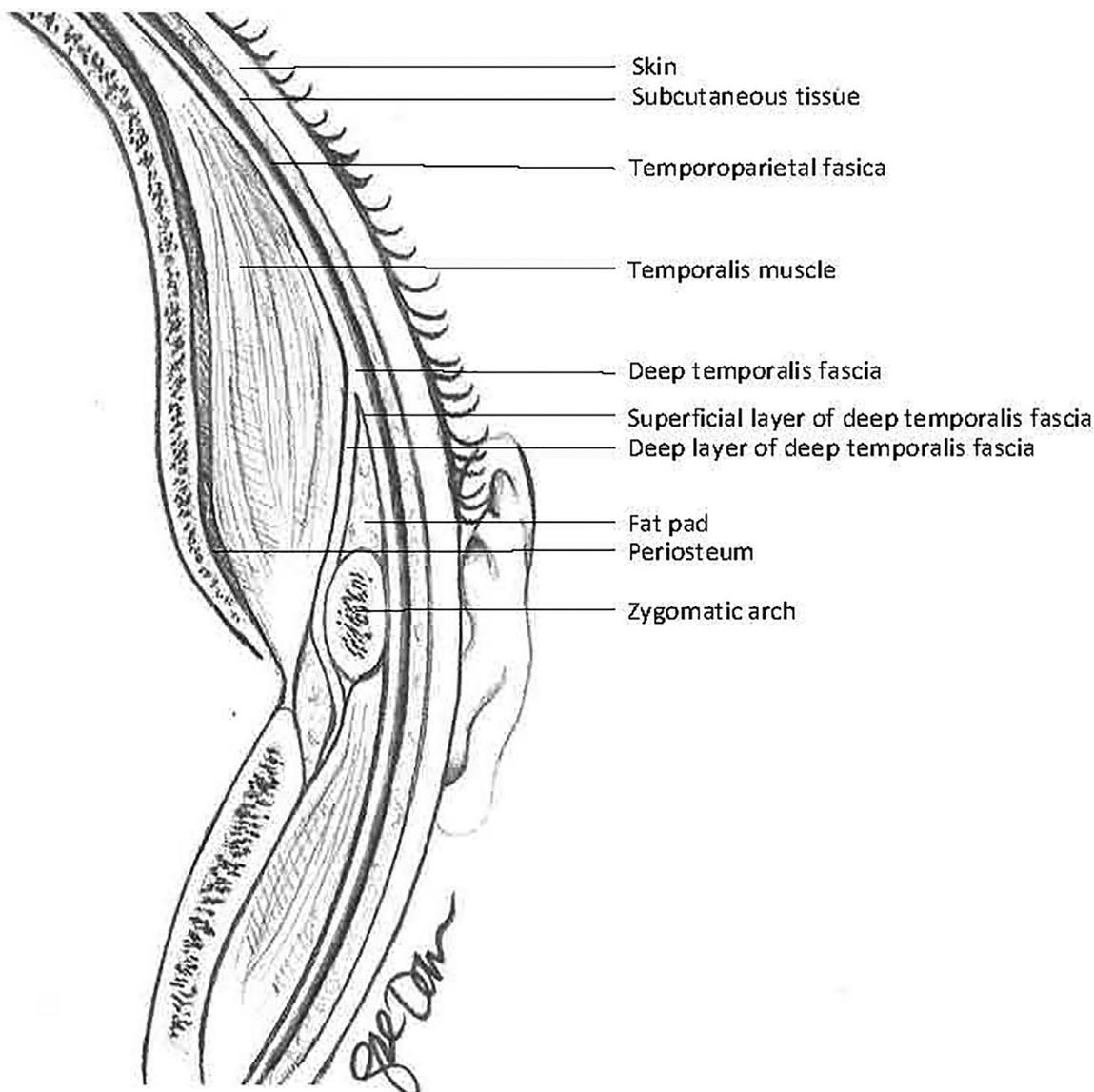


Figure 2 Fascial layers. Note distinction between the temporoparietal fascia, or superficial temporal fascia, and the deep temporal fascia, which splits into superficial and deep layers.

perforated temporal fat pad, and inserts onto the superficial and deep surfaces of the zygomatic arch. The deepest layer is the periosteum of the skull (Figure 2).¹²

Indications

The temporalis muscle is a thin, flexible muscle with a rotational radius of approximately 8 cm and an arc of rotation up to 135°, allowing it to be used for defects involving the temporal bone, anterior skull base, orbit, maxilla, palate, oral cavity, and oropharynx.^{10,13} The flap may be used to fill defects after oncologic resections, to repair cerebrospinal fluid leaks, or to cover mesh or plates used in various types of craniofacial reconstruction.¹⁴⁻¹⁶ Alternatively, the temporalis tendon may be rotated to the oral commissure for reanimation of a paralyzed face.¹⁷⁻¹⁹

Arguably, the main utility of the temporalis muscle flap is in reconstruction of palatomaxillary defects, particularly in elderly patients with multiple comorbidities. While free tissue transfer has become more popular due to greater versatility and flexibility for the reconstructive surgeon, there are still many advantages to using a regional flap. By rotating a muscle that is already in the operative field, there is less donor site morbidity and no need for a second surgical team with microvascular expertise. For elderly patients with multiple comorbidities and cardiovascular disease, a temporalis muscle flap offers decreased anesthesia time, reduced risk of flap loss, shorter hospital stays, and decreased time to start of radiation treatment.^{4,5} Multiple studies have shown that radiation does not seem to have any effect on the outcome of temporalis flap viability.^{5,20} It is also thought to be superior to leaving smaller palatomaxillary defects open to granulate because it leaves

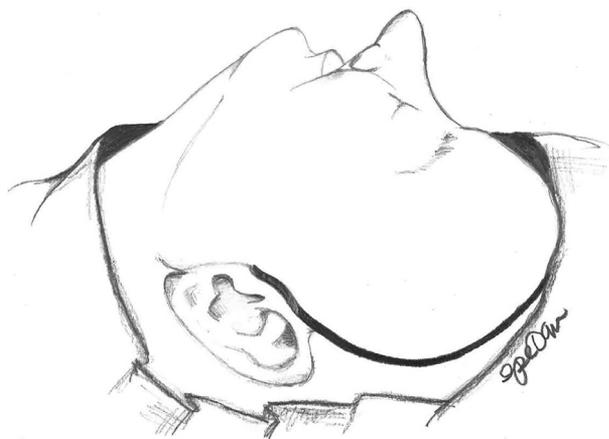


Figure 3 Incision is marked in a preauricular crease and extended onto the forehead in a curvilinear fashion.

a tissue pad on which an obturator can be placed more comfortably for the patient. Therefore, some argue that it should be considered first line treatment for reconstruction of palatomaxillary defects.^{21,22}

Preoperative evaluation

During preoperative work up, a thorough history should be taken, with close attention to whether the patient has ever undergone any surgeries or embolization within the head and neck that could compromise the blood supply to the flap. On physical examination, the muscle should be palpated while the patient clenches the jaw to assess for adequacy of bulk and length of the muscle to be rotated.¹⁰ Edentulous patients may have significant temporal wasting, which may preclude its use. Computed tomography and magnetic resonance imaging can be used in cases of oncologic resection to ensure that tumor removal will not put the blood supply at risk, such as tumors involving the posterior wall of the maxillary sinus where resection will encroach on the infratemporal fossa.¹⁶ For the paralyzed face, smile type should be documented preoperatively so that the muscle is suspended into the correct trajectory to allow for improved symmetry.¹⁸ The patient should also be counseled for potential cosmetic deformities, either from excess bulk over the zygoma if the muscle is turned over the bone and/or temporal hollowing from removing the muscle from the temporal fossa.

Surgical technique

The incision is marked in a preauricular crease and then extended superiorly into a hemicoronal incision (Figure 3). This can be done along the temporal fossa line, or up to 2cm above the line. The incision is placed behind the hairline, if one is present, so that the incision and temporal depression can be camouflaged. Injection with lidocaine with epinephrine may be useful for easier dissection and

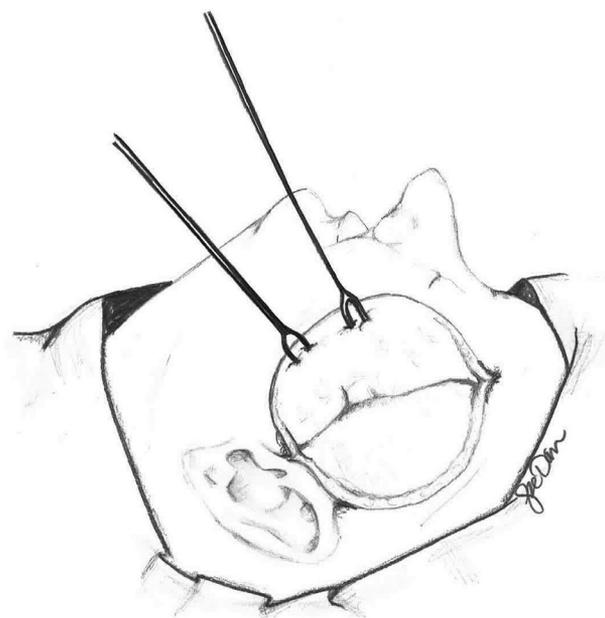


Figure 4 Dissection through skin, subcutaneous tissue, and temporoparietal fascia leads to identification of the deep temporal fascia.

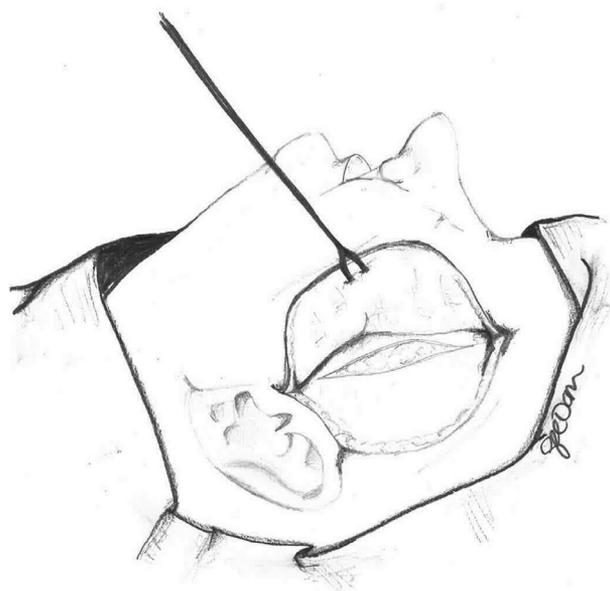


Figure 5 Incision is made in the superficial layer of the deep temporal fascia and dissection is continued within the superficial temporal fat pad in order to protect the branches of the facial nerve.

identification of the fascial layers, but is not necessary. Dissection is carried out through the skin, subcutaneous tissue, and TPF until identification of the deep temporalis fascia (Figure 4). The skin flap with the TPF is then elevated from superior to inferior with lateral extension from the root of zygoma to lateral orbital wall. Approximately 2 cm above the zygomatic arch, the superficial layer of the deep temporal fascia is incised and elevated up with the skin flap, in order to protect the facial nerve (Figure 5). A

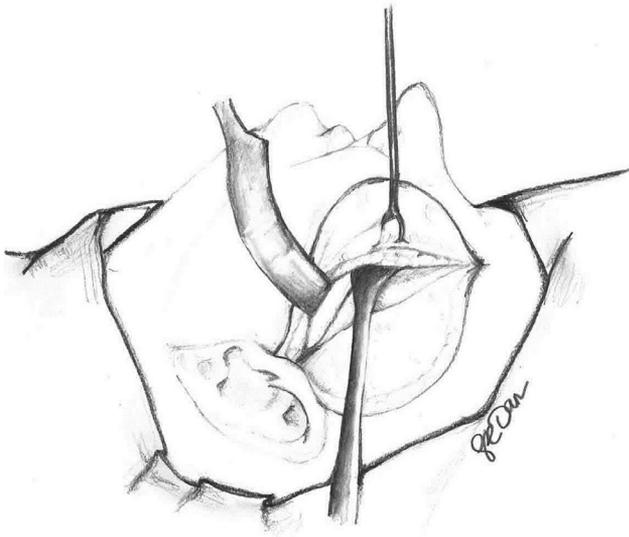


Figure 6 A heavy retractor is used to expose the zygomatic arch and tissues are elevated off the bone in a subperiosteal plane in order to protect branches of the facial nerve.



Figure 7 The temporalis muscle is sharply elevated off the bone with a periosteal elevator in order to preserve the blood supply from the deep temporal arteries, which are present on the deep surface of the muscle.

hemostat can be used to divide the superficial temporal fat pad while protecting the underlying muscle. A heavy retractor is then used to expose the zygomatic arch, and the tissues are elevated off the bone in a subperiosteal plane (Figure 6). These 2 steps of incising the deep temporal fascia and subperiosteal elevation on the zygomatic arch are crucial for protecting the frontotemporal branches of the facial nerve.²³

Assuming the entire muscle is needed for reconstruction, the skin flap is then back elevated, and the edges of the muscle are incised. The muscle is sharply elevated off the bone with a periosteal elevator (Figure 7). Monopolar cautery can be used to lift the firmer attachments as the muscle approaches the infratemporal fossa. Care must be taken to remain in a subperiosteal plane in order to pre-

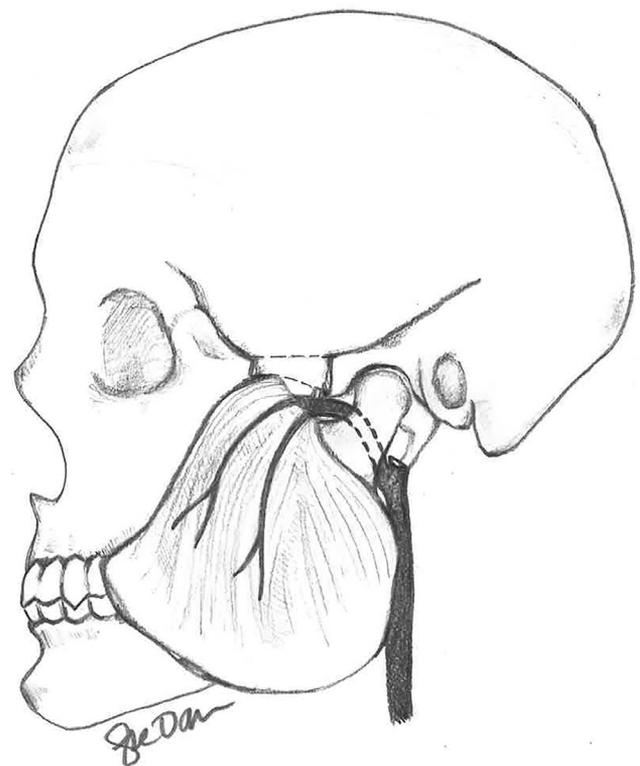


Figure 8 Once freed from its attachments, the temporalis muscle can be rotated through a tunnel under the zygomatic arch to reach the maxilla, palate, oral cavity, or oropharynx. Alternatively, the zygomatic arch may be removed to allow for greater rotation, and then replaced at the end of the procedure.

serve the blood supply, which arises on the deep aspect of the muscle and can be visualized in the infratemporal fossa below the zygomatic arch.²³ In most cases, the muscle can be bluntly tunneled under the zygomatic arch to reach the maxilla, palate, oral cavity or oropharynx (Figure 8). A strong suture is placed on the deep temporalis fascia to maintain correct orientation and then passed through a subcutaneous tunnel. The flap is sutured into place with the fascia facing the oral cavity. The forehead is closed with a suction drain and pressure dressing.

If an increased arc of rotation is needed, the zygomatic arch can be removed with osteotomies, and then replated or wired back into place at the end of the procedure. In addition, a coronoidectomy can be performed which allows the muscle to be rotated as an island connected by its blood supply.⁶ If additional length is needed, the tendinous attachments to the coronoid and ascending portion of the ramus can be dissected off the bone. This can be done from a transoral approach, and can add another centimeter of length to the flap.²⁰ If less bulk is needed, the muscle can be sectioned in the coronal plane. The anterior portion can be rotated to fill the defect, and the posterior portion can be swung forward to prevent temporal hollowing.⁵

Postoperative considerations

The patient is generally kept in the hospital for a few days postoperatively until the drain is removed. Re-epithelialization starts about 2-3 weeks postoperatively and is complete by 4-6 weeks postoperatively.^{19,20} It is common for some of the fascia to slough off during this time. Postoperative physical therapy and speech therapy are initiated to help improve speech and swallow outcomes and to prevent trismus.

Complications

The 2 significant complications associated with the temporalis muscle flap are facial nerve injury and flap loss. Fortunately, rates for both are low. In the largest series of 182 temporalis muscle flaps, there was a 19.2% rate of transient paresis of the forehead branch, 2.7% permanent paralysis, and 1.6% total flap necrosis. Those who experienced total flap necrosis had all been treated with chemotherapy in the past.³ Similarly, in a review of 69 temporalis muscle flaps for palatomaxillary defects, there were no cases of permanent facial paralysis, 6% transient paresis which resolved within 2-3 months, and 94.2% overall flap survival rate, with a few cases of partial necrosis but no cases of total flap loss.⁵ More recent, smaller series have shown even better results with no cases of facial nerve injury or flap loss.^{19,20}

Minor complications may include infection, seroma, hematoma, alopecia, and cosmetic deformity from donor site defect.⁶ In cases of palatomaxillary reconstruction, other complications that can occur include functional outcomes of speech, swallowing, and mouth opening. In general, these outcomes are more closely associated with the size of the defect and postoperative radiation therapy.⁵

Donor site defect

One of the main disadvantages to the temporalis muscle transfer is a significant hollowing in the temporal region that occurs after removal of the muscle. This results in cosmetic deformity, which may affect one's quality of life. Multiple studies have examined the use of various materials to reconstruct this region, either at the time of initial surgery or secondarily. As previously mentioned, one way to address temporal hollowing in the immediate setting is by swinging the posterior portion of the muscle forward if only part of the muscle is used, or by rolling a TPF flap into the depression.⁵ If these options are not available, others advocate for immediate reconstruction with a polyethylene implant or cement cranioplasty, either hydroxyapatite-based or polymethyl methacrylate-based. While risks including infection and foreign body reaction have resulted in removal of implants in the past, more recent studies have shown that these implants can be safe with long-lasting results, even in the face of postoperative radiation.^{14,15,22-24}

Another alternative with satisfactory results is use of autologous fat transplantation. This is usually done as secondary procedure after the defect has healed, with injection of lipophilized fat. The main disadvantages with this approach include the unpredictable longevity of the fat graft, tendency for fat resorption, and possible need for multiple injections.²⁵ However, when used in conjunction with an implant placed at the time of the initial surgery, secondary injection of lipophilized fat allows for better contouring and softening of the edges around the implant.^{14,15}

Conclusion

The temporalis muscle flap is an excellent option for reconstruction of many craniofacial defects, particularly in elderly patients with multiple comorbidities. Advantages over free tissue transfer include decreased operative time, ease of harvest, reliable vascular supply without the need for microvascular anastomosis, minimal donor site morbidity, and shorter hospital stays. When done by an experienced surgeon, rates of facial nerve injury and flap loss are very low. For improved cosmetic outcomes, the donor site may be reconstructed with a part of the temporalis muscle, temporoparietal fascia, various implants, or autologous fat, depending on surgeon and patient preference.

Disclosure

The authors report no proprietary or commercial interest in any product mentioned or concept discussed in this article.

References

1. Speculand B: The origin of the temporalis muscle flap. *Br J Oral Maxillofac Surg* 30:390-392, 1992.
2. Gillies H: Experiences with fascia lata grafts in the operative treatment of facial paralysis: (Section of otology and section of laryngology). *Proc R Soc Med* 27:1372-1382, 1934.
3. Clauser L, Curioni C, Spanio S: The use of the temporalis muscle flap in facial and craniofacial reconstructive surgery A review of 182 cases. *J Craniomaxillofac Surg* 23:203-214, 1995.
4. Zenga J, Nussenbaum B, Rich JT, et al: Reconstruction of composite oral cavity defects with temporalis flaps after prior treatment. *Am J Otolaryngol* 36:97-102, 2015.
5. Wang Y, Cheng J, Yuan C, et al: Reconstruction of palatomaxillary defects following cancer ablation with temporalis muscle flap in medically compromised patients: A 15-year single institutional experience. *Clin Oral Investig* 18:1663-1670, 2014.
6. Hanasono MM, Utley DS, Goode RL: The temporalis muscle flap for reconstruction after head and neck oncologic surgery. *Laryngoscope* 111:1719-1725, 2001 Oct.
7. Chen CT, Robinson JB Jr, Rohrich RJ, et al: The blood supply of the reverse temporalis muscle flap: Anatomic study and clinical implications. *Plast Reconstr Surg* 103:1181-1188, 1999.
8. Koga N. Soft Tissue of the Scalp and Temporal Regions. In: Watanabe K, Shoja MM, Loukas M, Tubbs SR, editors. *Anatomy for Plastic Surgery of the Face, Head, and Neck*. Stuttgart: Georg Thieme Verlag, p. 33-39.

9. Veysiere A, Rod J, Leprovost N, et al: Split temporalis muscle flap anatomy, vascularization and clinical applications. *Surg Radiol Anat* 35:573–578, 2013.
10. Bradley P, Brockbank J: The temporalis muscle flap in oral reconstruction A cadaveric, animal and clinical study. *J Maxillofac Surg* 9:139–145, 1981.
11. Ammirati M, Spallone A, Ma J, et al: An anatomical study of the temporal branch of the facial nerve. *Neurosurgery* 33:1038–1144, 1993 Dec.
12. Koga N. Soft Tissue of the Scalp and Temporal Regions. In: Watanabe K, Shoja MM, Loukas M, Tubbs SR, editors. *Anatomy for Plastic Surgery of the Face, Head, and Neck*. Stuttgart: Georg Thieme Verlag. p. 33–39.
13. Hadlock TA, Lindsay RW, Cheney ML. Temporalis. In: Urken ML, Cheney ML, Blackwell KE, Harris JR, Hadlock TA, Futran N, editors. *Regional and Free Flaps for Head and Neck Reconstruction*. ed 2 Philadelphia, PA: Lippincott Williams and Wilkins. p. 47–58.
14. Smith JE, Ducic Y, Adelson R: The utility of the temporalis muscle flap for oropharyngeal, base of tongue, and nasopharyngeal reconstruction. *Otolaryngol Head Neck Surg* 132:373–380, 2005.
15. Smith JE, Ducic Y, Adelson RT: Temporalis muscle flap for reconstruction of skull base defects. *Head Neck* 32:199–203, 2010.
16. Costantino PD, Bruni M, Dehdashti AR. Temporalis Muscle Transposition. In: Myers EN, Synderman CH, editors. *Operative Otolaryngology: Head and Neck Surgery*. ed 3. Elsevier. p. 1175–1179.
17. May M, Drucker C: Temporalis muscle for facial reanimation A 13-year experience with 224 procedures. *Arch Otolaryngol Head Neck Surg* 119:378–384, 1993.
18. Labbé D, Huault M: Lengthening temporalis myoplasty and lip reanimation. *Plast Reconstr Surg* 105:1289–1298, 2000.
19. Ahmed Djae K, Li Z, Li ZB: Temporalis muscle flap for immediate reconstruction of maxillary defects: Review of 39 cases. *Int J Oral Maxillofac Surg* 40:715–721, 2011.
20. Dallan I, Lenzi R, Sellari-Franceschini S, et al: Temporalis myofascial flap in maxillary reconstruction: Anatomical study and clinical application. *J Craniomaxillofac Surg* 37:96–101, 2009.
21. Yadav S, Dhupar A, Dhupar V, et al: Immediate reconstruction of palato-maxillary defect following tumor ablation using temporalis myofascial flap. *Natl J Maxillofac Surg* 5:232–235, 2014.
22. Available at: <https://www.broadcastmed.com/otolaryngology/4919/videos/temporalis-flap> Accessed July 15, 2018)
23. Rapis AD, Day TA: The use of temporal polyethylene implant after temporalis myofascial flap transposition: Clinical and radiographic results from its use in 21 patients. *J Oral Maxillofac Surg* 64:12–22, 2006.
24. Mandlik D, Gupta K, Patel D, et al: Use of polymethyl methacrylate-based cement for cosmetic correction of donor-site defect following transposition of temporalis myofascial flap and evaluation of results after adjuvant radiotherapy. *J Reconstr Microsurg* 31:668–673, 2015.
25. Cervelli D, Gasparini G, Grussu F, et al: Autologous fat transplantation for the temporalis muscle flap donor site: Our experience with 45 cases. *Head Neck* 36:1296–1304, 2014.