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The pedicled temporoparietal fascial flap

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The pedicled temporoparietal fascial flap has played a role in reconstructive strategies for defects of the head and neck for well over a century. Although partially succeeded by more recent microvascular free tissue transfer techniques, this well-vascularized and pliable flap has remained an important tool in the reconstruction of locoregional defects of the temporal bone, orbitomaxillary complex, and anterior skull base. Furthermore, with little donor site morbidity and relative ease of harvest this flap is likely to remain a key tool in the reconstructive armamentarium of head and neck and skull base surgeons. In this article we review the anatomy, operative technique, potential complications, and applications of the pedicled temporoparietal fascial flap.

Introduction

Over a century ago Brown and Monks were the first to separately report on the utility of the vascularized pedicled temporoparietal fascia flap (TPFF) for the purposes of locoregional reconstructions including the eyelid and auricle.[1,2] Over the ensuing century the versatility of this flap has been extensively reported on in both the context of pedicled regional flaps as well as free tissue transfer reconstructions. With excellent vascularity, durability, flexibility and pliability secondary to its ultrathin structure, the pedicled TPFF has served as a valuable reconstructive tool for oral cavity defects, complex craniofacial defects, periorbital and auricular reconstructions, temporal bone defects, scalp defects, and anterior skull base defects, to name a few.[3-9] As a free tissue flap, the TPFF has also demonstrated utility in a variety of distant microvascular procedures including laryngeal framework reconstructions and resurfacing of upper extremity wounds.[10,11] This is made possible by the flap's pliability allowing draping of composite cartilage grafts as well as its rich axial vascular supply, which can help heal devascularized wounds and serve as a healthy skin graft recipient site.[8,10] This article will mainly address the subject of pedicled TPFF for head and neck reconstruction including relevant anatomy, operative technique, potential complications, and applications.

Relevant anatomy

The superficial temporoparietal fascia (STF) is a highly vascular fascial layer that is in continuity with the superficial musculoaponeurotic system (SMAS) of the head and neck. This fascia is found below the superior temporal line and it is bound superiorly by the galea aponeurotica, anteriorly by frontalis muscle, posteriorly by occipitalis muscle and inferiorly by the investing fascia overlying the mimetic muscles and parotid gland. The STF lies in the middle of

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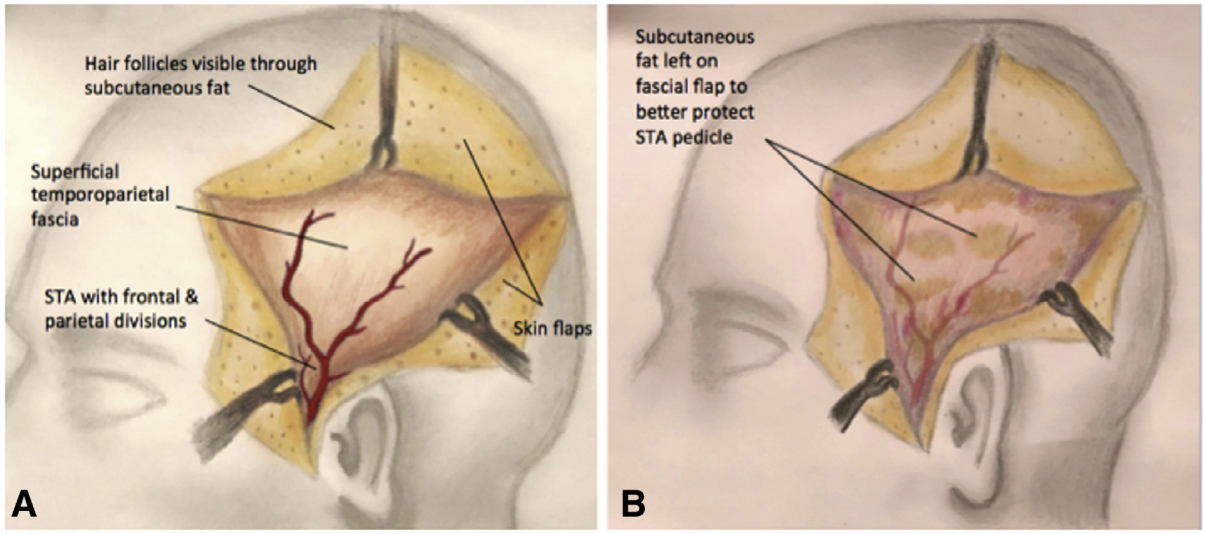

Figure 1 Temporoparietal fascial flap harvest: (A) raising all subcutaneous tissues with skin flaps; (B) Similar exposure but raising skin flaps through a more superficial subcutaneous plane leaving fat on the fascia. The latter technique may require more frequent hemostasis while encountering more vascular subcutaneous tissues. STA, superficial temporal artery.

the 5 layers in the temporoparietal scalp (refer to chapter on the temporalis muscle flap for an excellent illustration of this anatomy). It can be found directly deep to the skin and subcutaneous tissue to which it is firmly attached and superficial to the deep temporalis muscular fascia and muscle. The plane between the muscular fascia and the STF is occupied by loose areolar tissue, which allows for the natural mobility of the temporal scalp with joint movements of the STF and SMAS system. The STF is also bound to the zygomatic arch along with the SMAS.

The primary vascular supply of the superficial TPFF consists of the superficial temporal artery and vein. The superficial temporal artery is the terminal branch of the external carotid artery and can be found approximately 3cm superior to the root of the helix where it branches into the frontal division anteriorly and parietal division posteriorly (Figure 1A). The first portion of the superficial temporal artery lies deep to or within the parotid gland and then courses superficially as it moves posteriorly over the zygomatic process.[12] It can be easily palpated in this pretragal location. This segment of the artery can have a tortuous course and is also the location where it gives off the middle branch of the artery that supplies the temporalis muscle and deep temporal fascia. Careful dissection of the pedicle at this region can further increase its length.[13]

The blood supply to the pedicled TPFF is mainly derived from the parietal branch while the frontal branch can be ligated roughly 3 cm from the bifurcation, corresponding to the most anterior dissection of the flap.[13] The frontal branch continues anterior-superiorly to anastomose with the supratrochlear and supraorbital arterial systems while the parietal branch traverses posterior-superiorly toward the vertex of the skull. One may find 2 parallel small parietal branches in roughly 7.5% of patients.[13] Similarly, the superficial temporal vein may arise as a single branch or duplicate branches and mostly follows the artery superficially. Of note in up to 30% of cases, the vein may take a divergent course and travel up to 3cm posterior to the artery.[14,15] Despite various branching patterns in this flap's pedicle, if necessary, the use of a Doppler can aid in sufficiently tracing and dissecting the vascular supply to allow for adequate rotation.

The anterior limit of elevation for the TPFF is the region of the frontal branch of the facial nerve. This nerve courses through the temporoparietal fascia roughly 1.5 cm lateral to the lateral canthus and it is at risk of injury if excessive dissection is carried out.[13] The auriculotemporal nerve, a sensory branch of the trigeminal nerve, can also be found adjacent to the superficial temporal artery within the temporoparietal fascia. Due to manipulation of this nerve and the subcutaneous dissection carried out for flap harvest there is often scalp paresthesia following surgery.

Surgical technique

Preoperative planning for a TPFF harvest should include a thorough history of prior radiation, trauma or surgical intervention to the temporoparietal region as these factors may reduce the reliability of the flap's blood supply. Embolization procedures of the external carotid artery system as well as a history of vasculitis may also render the superficial temporal artery unusable. When in doubt, Doppler ultrasonography can be used to confirm the presence of blood flow in this artery.

Skin incisions for the harvest of pedicled TPFF are often tailored to the procedure to be performed. It is also possible to raise the fascia with overlying scalp for reconstruction of cutaneous defects in the mid and lower face. Figure 2 demonstrates various incisions that can result in adequate exposure for flap harvest. In cases where the skin incision overlaps the flap itself, as is often the

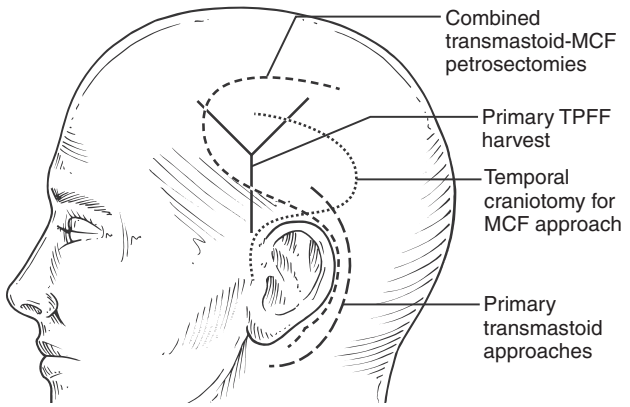

Figure 2 Various skin incisions that can be used to harvest the temporoparietal fascial flap. MCF, middle cranial fossa; TPFF, temporoparietal fascial flap.

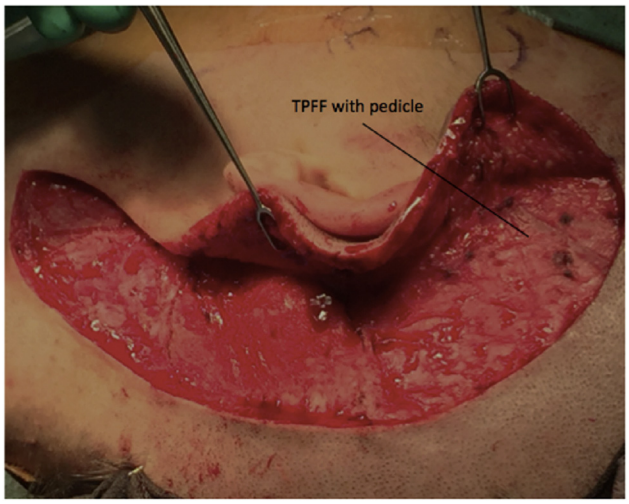

Figure 3 Raising the skin flap in a posterior to anterior direction under constant retraction using skin hooks.

case, it is imperative to take extra precaution not to cut beyond the most superficial subcutaneous tissue, and carry the dissection at the strict level of the subcutaneous fat lobules. We prefer to make all skin incisions with a sharp blade rather than electrocautery as this poses less risk of damaging the underlying flap vasculature. If electrocautery is to be used, a needle tip on cutting mode is preferable for precise dissection. Skin incisions should also be made in the direction of hair follicles to avoid damaging them and prevent alopecia along the incision.

When possible we prefer to raise the skin flap overlying the TPFF from a posterior to anterior direction in order to avoid injury to the pedicle early on (Figure 3). The challenge in doing so is that the STF is usually more tightly adherent to the subcutaneous tissue posteriorly. To aid in the delicate dissection, skin hooks are used to provide as much tension as possible along the plane of the dissection (Figure 3). The aid of an assistant with this constant retraction cannot be stressed enough. A sharp blade is used to painstakingly separate the STF from the subcutaneous fat with broad strokes to maintain adequate visibility along the plane of dissection (Figure 1A). Using magnification with loupes or microscope also helps in some occasions ensuring that dissection is carried in the proper plane. Multiple fresh blades should be used to carry out a sharp and meticulous dissection. Avoiding an often highly vascular subcutaneous fat plane is an important advantage of elevating the skin flap just superficial to the STF. However, sharp dissection along this plane also carries a higher risk of injury to the fascial flap or its blood supply.

An alternative strategy is to dissect through the subcutaneous tissue leaving fat up and fat down to better protect the fascia flap and blood supply (Figure 1B). However, this technique also carries a higher risk of injury to the hair follicles and adnexal structures, which may result in alopecia in hair baring areas. This plane of dissection is generally bloodier, requiring frequent use of cautery for hemostasis. If cautery is necessary, it should preferably be done with a fine-tip bipolar to avoid excessive thermal injury. The same principle of constant retraction with skin hooks along the skin flap applies to this technique.

Once identified, every effort is made to gently dissect subcutaneous tissue off the pedicle until reaching the area of the zygomatic root. Having raised the skin off the STF and preserved the fascia's blood supply, one can proceed with cuts to the fascia along a desired flap length, maintaining the pedicle in continuity. If a longer flap is desired further skin can be undermined along the appropriate plane posteriorly and superiorly past the temporal line. Here the periosteum can be incorporated to the flap although the blood supply to these distal areas may become more random and tenuous. The flap is then raised off the deep temporalis fascia and temporalis muscle by swiftly dissecting the loose areolar tissue plane between these layers. Caution is still necessary not to injure the pedicle along its deep aspect while approaching the zygomatic root.

As previously mentioned, the degree of rotation and size of this pedicled flap can allow for reconstruction of defects as distal as the oral cavity and anterior skull base. Reconstruction of inferior mastoid defects with a pedicled TPFF may require partial drilling of the zygomatic root to allow for a wider degree of rotation in the flap.

Depending on the type of intervention the patient is undergoing, the TPFF harvest can be done at various times during the surgery. In combined neurosurgical procedures that may entail a temporal craniotomy or other lateral skull base approach, we recommend performing the harvest first after agreeing on the most appropriate skin incisions. This places less risk on the flap and its pedicle during development of the surgical corridor. Once raised the flap can be rotated anteriorly and secured safely in a moist surgical sponge, away from the direct surgical field (Figure 4). At the time of reconstruction the flap can be rotated back into the defect.

Due to the extensive undermining necessary for the harvest of the TPFF, efforts should be made to close off the resulting subcutaneous dead space. This can be accom-

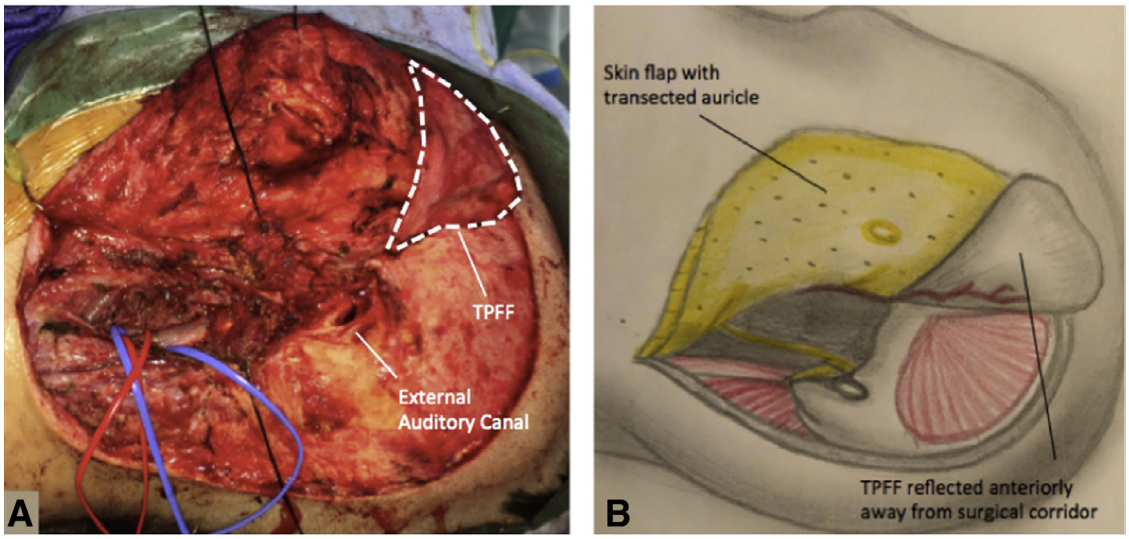

Figure 4 (A) Surgical exposure for a combined transotic-infratemporal and middle cranial fossa approach to the lateral skull base; (B) Illustration of this exposure with the TPFF raised and secured anteriorly. TPFF, temporoparietal fascial flap.

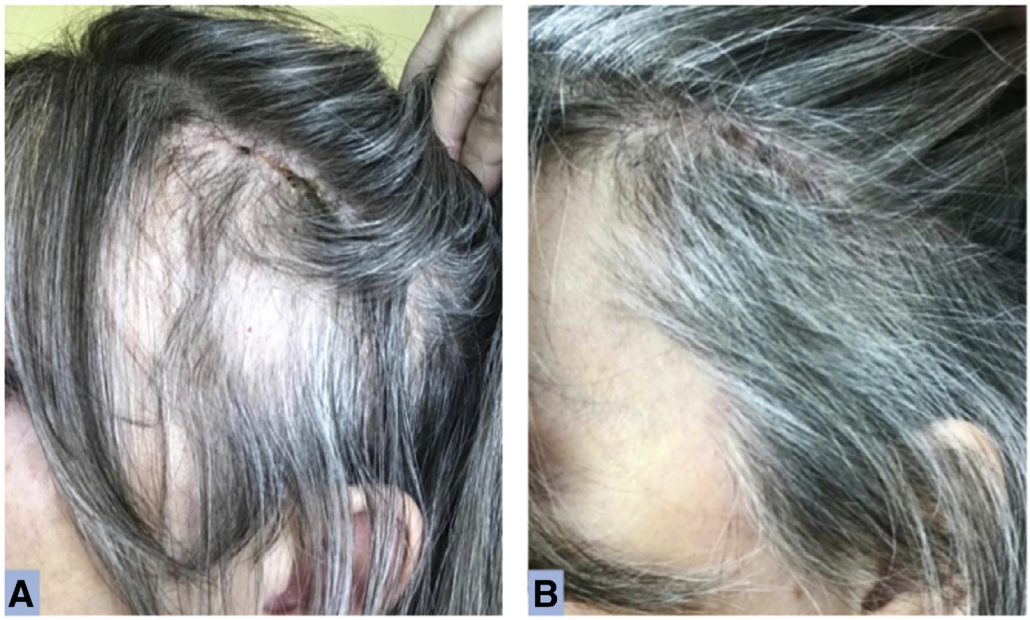

Figure 5 (A) Temporal alopecia following a temporoparietal fascial flap harvest; (B) The same patient 6 months after surgery demonstrating regrowth of hair in this area.

plished by placing several interrupted sutures to approximate the dermis to the deep temporalis fascia. We also like the use of a compressive dressing over the skin at the conclusion of the surgery but with care not to apply too much pressure around the zygomatic root where the pedicle is located. The use of a drain in the donor site is often unnecessary and in cases requiring dural repairs this is not advocated to avoid postoperative cerebrospinal fluid (CSF) leaks.

Complications

The most common complication of a TPFF harvest is secondary alopecia due to injury to hair follicles (Figure 5A). While it helps with visualization, excessive electrocautery for hemostasis during skin flap elevation should be avoided to minimize thermal injury and devascularization of follicles and adnexal structures. Even with a careful dissection alopecia can develop along the skin incision line. Prior radiation or surgery to the temporoparietal region can further predispose the patient to alopecia due to radiation side effects on small vessels at this level.[13] Paresthesia of the scalp is also a common but less consequential result of flap harvest. Fortunately both of these complications often resolve with time (Figure 5B).

As a pedicled flap, the vascular supply to the TPFF can be compromised if an unrecognized injury to the pedicle occurs during flap harvest or if excessive compression or

kinking occurs while in-setting the flap. This will essentially result in the use of a nonvascularized fascial graft for reconstruction. In cases with a well-vascularized wound bed, adequate healing can still occur under these circumstances. However, in selective cases with poorly vascularized tissues wound breakdown may occur.

Finally, it is imperative to avoid injury to the frontal branch of the facial nerve coursing near the anterior limit of dissection for a TPFF harvest. An in-depth knowledge of this nerve's anatomy is critical to maintain a safe dissection. Although the previous dogma considered the depth of the facial nerve at the level of the zygomatic arch to be superficial and within the STF, new anatomical studies have disproven this notion.[16] Part of the previous confusion stemmed from the confluence of various fascial layers in the vicinity of the zygomatic arch. In a thorough anatomical study, Agarwal et al. demonstrated that in fact while crossing the zygomatic arch, the frontal branch travels deep to the TPF within the loose areolar tissue layer.[16] With a 95% confidence interval, the nerve then transitions into the undersurface of the TPF layer at a transition zone 1.5-3 cm superior to the arch and 0.9-1.4cm lateral to the orbital rim.[16] Beyond this point it is at highest risk of injury with manipulation of tissues at the level of the TPF. Furthermore, it is also important to note that multiple rami may be found in this vicinity in contrast to the previous single-ramus belief.[17] With this knowledge in mind, the nerve can be avoided altogether during a TPFF harvest by limiting anterior dissection to at least 2-3 cm from the lateral orbital rim or roughly the natural position of the hairline. If an anteriorly based skin incision is made it is extremely important to carefully cut just to the level of the subcutaneous tissues above the TPF. A facial nerve monitor probe should be used for these cases to aid in dissection of these more precarious regions of the harvest. In addition, electrocautery should be avoided in this area to prevent thermal injuries to the nerve.

Applications

Various reconstructive options have long existed for otologic and lateral skull base surgery, particularly for mastoid and tympanomastoid obliterations. These include the use of free tissue grafts consisting of bone, cartilage, muscle, fascia, perichondrium, or fat.[7] Although these are viable options in the majority of cases, as previously stated, the presence of devascularized tissue in the wound bed often requires a vascularized flap like a pedicled TPFF for proper wound healing. Examples of cases that may necessitate this technique include temporal bone resections for cancer (Figure 6), chronic osteomyelitis, osteoradionecrosis, granulomatous disease or chronic infections requiring several revision surgeries.[7] Furthermore, although there has been an overall decrease in soft tissue complications following cochlear implant (CI) surgeries with modifications to surgical techniques, the TPFF remains an important tool in the otologic surgeon's armamentarium for management of revision surgeries in extrusion cases.[18,19] The pedicled TPFF may also serve as a valuable reconstructive option for large lateral skull base defects in hearing preservation surgeries such as spontaneous Cerebrospinal Fluid (CSF) leak repairs, where middle ear obliteration with external canal closure is less desirable. Even with ablative procedures that lead to large defects such as a jugulotympanic paraganglioma resection, the pedicled TPFF may also serve as a better tool for preventing postoperative iatrogenic CSF leaks than other free graft methods.[20]

Aside from the local otologic and neurotologic applications the pedicled TPFF has long been an important component of microtia auricular reconstructions.[21,22] Whether using an alloplastic framework or cartilage allograft, it is crucial to ensure adequate coverage with soft tissue and skin to avoid framework extrusion and infection, which result in suboptimal cosmetic outcomes.[21-23] As with revision CI cases necessitating a healthy vascular bed for the implant, the pedicled TPFF may be utilized by plastic surgeons in complex microtia reconstructions for framework coverage. Similarly, auricular amputations have been successfully repaired using the TPFF to cover a de-epithelialized amputated auricle.[24]

The refinement of free tissue transfer for head and neck reconstructions has significantly improved cosmetic and functional outcomes for orbitomaxillary defects, particularly when there's a need for vascularized bone flaps to re-establish midface projection. Nevertheless, the pedicled TPFF remains a good alternative for selective cases. Orbital cavity lining for future prosthetic use, coverage of exposed radiated bone, and coverage of orbital floor mesh reconstructions are examples of scenarios that may still benefit from a pedicled TPFF without the need for a free tissue transfer.[25]

The expansion of complex endonasal anterior skull base procedures has also benefitted from the pliability of the pedicled TPFF. Using a tunneling technique through the infratemporal fossa this flap has been successfully used for CSF leak-proof reconstructions of clival and nasopharyngeal defects following expanded endonasal approaches. This could be particularly useful in those cases where the standard workhorse nasoseptal flap is no longer a viable reconstructive option secondary to prior procedures or radiation damage.[26]

The pedicled TPFF remains an option for other regional soft tissue reconstructions of the scalp, face or even oral cavity. Free tissue transfers have largely supplanted pedicled flaps for these applications. Nevertheless, when incorporated into a fasciocutaneous flap design the TPF and temporal skin can serve as a convenient alternative for selected cases. These may include reconstruction of soft tissue defects of the eyelid, infraorbital region, malar region or even nasal dorsum.[27] Furthermore, pedicled temporal fasciocutaneous flaps have been successfully used for hair restoration procedures in cases of hair loss following soft tissue trauma or severe burns to the eyebrow, beard or moustache regions.[27] Greater donor site morbidity results

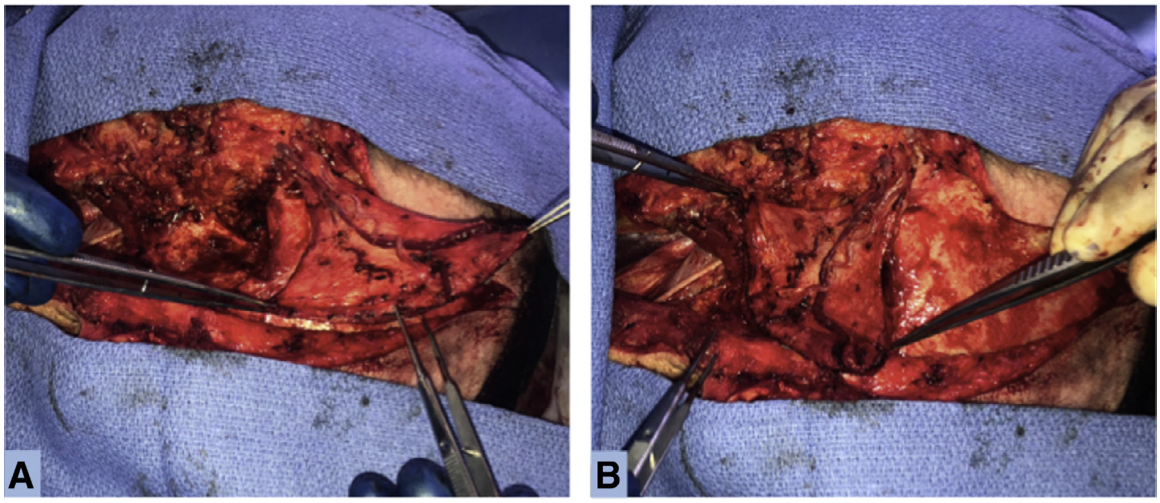

Figure 6 Rotation of a pedicled and vascularized temporoparietal fascia flap into a lateral temporal bone resection defect for better contouring and wound healing inpreviously radiated field.

from incorporating skin into these flaps but nonetheless, direct closure of the scalp defect is still feasible with judicious undermining in most cases when necessary skin grafts can also be used.[27]

Conclusion

Offering minimal donor site morbidity, ease of harvest and versatility the pedicled TPFF and its associated fasciocutaneous temporal flap are likely to continue serving as reliable tools in the reconstruction of locoregional head and neck defects, despite the multitude of microvascular reconstructive options presently available to surgeons.

Disclosure

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

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