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Submental flap for reconstruction of anterior skull base, orbital, and high facial defects

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ABSTRACT

Purpose: Large anterior skull base, orbital, and high facial defects can present a challenging reconstructive problem. Limited data exists in the literature on the use of a submental flap for reconstructing such defects. We aimed to describe the feasibility, success, and advantages of using variations of the submental flap for reconstruction of anterior skull base, orbital, and high facial defects.

Materials & methods: Outcomes measured included flap method, flap survival, flap size, reconstructive site complications, donor site complications, and length of hospital stay.

Results: Nine patients were identified that underwent submental flap reconstruction of anterior skull base, orbital, or high facial soft tissue defects. There were 5 pedicled, 2 hybridized, and 2 free submental flap reconstructions. Flap survival was 100%. One flap required leech therapy for early post-operative venous congestion. Average flap skin paddle size was 63.7 cm^2. Average length of hospital stay was 7.3 days. No complications from the donor site were reported.

Conclusions: Different variations on the submental flap are viable options for reconstruction of high defects in the head and neck. Such flaps have a number of unique qualities that are suitable for reconstruction of anterior skull base, orbital, and high facial defects.

1. Introduction

Defects high in the head and neck pose a challenging reconstructive problem. Prominence in a cosmetically sensitive area requires good color and texture match. Local flaps provide a good cosmetic match but are limited in their ability to cover large surface-area defects. Free flaps provide abundant tissue but are sometimes limited in their ability to reach high areas depending on available vessels in the recipient bed and length of the vascular pedicle. The quality of tissue obtained from a free flap is often noticeably different from native tissue in the head and neck.

Anterior skull base defects present a particular problem given their anatomic location. The well-utilized nasal septal flap has difficulty reaching anterior defects, and the pericranial flap lacks a cutaneous component for reconstructing any associated facial soft tissue deficits. Sometimes a cerebrospinal fluid (CSF) leak needs to be repaired as well. Muscular tissue is ideally suited to sealing CSF leaks. However, there is no ideal muscle-containing flap in current use for such repairs. Large defects have traditionally relied on free tissue transfer in the form of muscle-containing anterolateral thigh or rectus abdominis free flaps. Orbital defects are often associated with oncologic resections in the high facial and anterior skull base regions. Such defects can be difficult to reconstruct. Orbital exenteration leaves a large bony cavity in a field that will often be radiated in case of malignancy. This often necessitates reconstruction with a large bulk of tissue in order to fill the dead space. High soft tissue defects, such as in the frontotemporal area can also be difficult. Poor color and texture match from distant free tissue transfer is particularly prominent when placed in high facial areas.

The submental island flap, first described by Martin et al. in 1994, has a number of known advantages in head and neck reconstruction [1,2]. From a cosmetic standpoint, the thin pliable tissue that is harvested has unparalleled color and texture match for head and neck defects, while also having minimal donor site morbidity. The submental flap is also a very versatile flap for reconstruction in the head and neck. The proximity to the head and neck allows it to be used as a pedicled island flap in many situations without the need for microvascular expertise. It has also been described as a 'hybrid flap' with a venous-only anastomoses as a way of increasing reach [3]. Finally, it can easily be harvested as a free flap without difficulty [2,4,5].

The submental flap has been used for lower and midfacial defects

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[6–8]. The use of pedicled and hybridized submental flaps for lateral skull base defects has also been described, demonstrating its potential utility for higher defects [9]. We describe here a retrospective cohort of patients with high head and neck defects reconstructed with either a pedicled, hybridized, or free submental flap.

2. Materials & methods

Institutional review board approval was obtained. Patients who had a submental flap reconstruction for an anterior skull base, orbital, or high facial defect at a single institution between January 2002 and August 2017 were identified from a prospectively collected database. Data were collected including patient demographics, tumor or defect characteristics (histopathology, size, structures involved/resected), type of reconstruction (pedicled, hybrid, free), size of skin paddle, duration of hospital stay, and complications related to the reconstruction (flap loss, dehiscence) or donor site (seroma, hematoma, dehiscence). No comparison group was utilized; results were summarized descriptively.

3. Results

We identified nine patients who underwent reconstruction with a submental flap for anterior skull base, orbital, or high facial defects. All patients had successful submental flap reconstruction. Indications for reconstruction are identified in Table 1. A variety of pathologies were found, such as melanoma, clear cell carcinoma, squamous cell carcinoma, and Merkel cell carcinoma. Two patients had non-malignant pathology, including infected calvarial hardware in one patient and pre-operative suspicion for recurrence in the context of post-radiation orbital pain and ophthalmoplegia after previous treatment for squamous cell carcinoma in another patient (Table 1).

All patients had initial reconstruction attempted with a pedicled flap. If reach was inadequate, hybridization or free tissue transfer was performed. If a pedicled flap was not performed, vessels were first assessed for viability through retrograde flow. Five patients (55.5%) underwent successful reconstruction with a pedicled flap. Of the remaining four patients, only one had viable retrograde flow through the venous system. Two patients (22.2%) had obvious visible valves within the venous facial system (Fig. 1). Subsequently, two patients underwent hybridization with a venous anastomosis. One patient underwent anastomosis to the common facial vein; the other was anastomosed to the external jugular vein. The remaining two patients (22.2%) required microvascular anastomoses of the artery and vein as a free flap due to inadequate reach with hybridization (Fig. 2). Microvascular anastomosis was performed to the internal maxillary artery and retromandibular vein in one patient, and to the superficial temporal artery and common facial vein in the other patient.

Four patients had reconstruction of high frontotemporal soft tissue defects (Figs. 3 & 4). Three of these patients were reconstructed with pedicled flaps. One was reconstructed with a hybridized flap. Two patients had either exposure of intracranial structures or intraoperative CSF leak that required coverage. Repair of the intracranial communication was performed in both patients with the muscular component of the submental flap (digastric and mylohyoid muscle). There was no evidence of persistent CSF leak after surgery in either patient.

Three patients had reconstruction of an orbital defect (Figs. 5 & 6). One patient underwent reconstruction with a pedicled flap, one with a hybridized flap, and one with a free flap. In the hybrid flap patient, the pedicled flap was able to reach the orbit, but the decision was made to hybridize the flap to allow better contouring. Post-operatively, all three patients had excellent color and contour match. There were no cases of orbital fistula. One patient was fitted with an ocular prosthesis at 6 months (Fig. 6).

Mean flap skin paddle size was 63.7 cm^2 (range 15 cm^2 to 140 cm^2). All donor sites were closed primarily. Average length of hospital stay

Table 1
Individual patient data.

Patient	Patient characteristics			Defect				Reconstruction				
	Age	Sex	Problem/diagnosis	Orbital contents	Skin and soft tissue	Facial skeleton	Skull base	Type	Skin paddle (cm)	Vascularity/anastomosis	Flap survival	Reconstruction site complications
1	80	M	Orbital pain post radiation for squamous cell carcinoma	x	x			Hybrid	10 × 4.5	Common facial vein	100%	None
2	66	M	Squamous cell carcinoma	x			x	Free	10 × 6	Internal maxillary artery, retromandibular vein	100%	None
3	77	M	Melanoma		x	x	x	Hybrid	8 × 11	External jugular vein	100%	None
4	70	F	Merkel cell carcinoma (recurrent)		x			Pedicled	10 × 14	Retrograde pedicled (valves posterior facial vein into EJV)	100%	None
5	81	M	Squamous cell carcinoma (recurrent)		x			Pedicled	9 × 12	Anterograde pedicled	100%	None
6	75	M	Calvarial hardware infection and abscess formation	x			x	Free	5 × 3	Superficial temporal artery, common facial vein	100%	None
7	91	M	Melanoma		x		x	Pedicled	4 × 8	Anterograde pedicled	100%	Venous congestion requiring leech therapy
8	66	M	Clear cell carcinoma		x			Pedicled	7 × 5	Anterograde pedicled	100%	None
9	79	M	Squamous cell carcinoma (recurrent)		x		x	Pedicled	5 × 10	Anterograde pedicled	100%	None

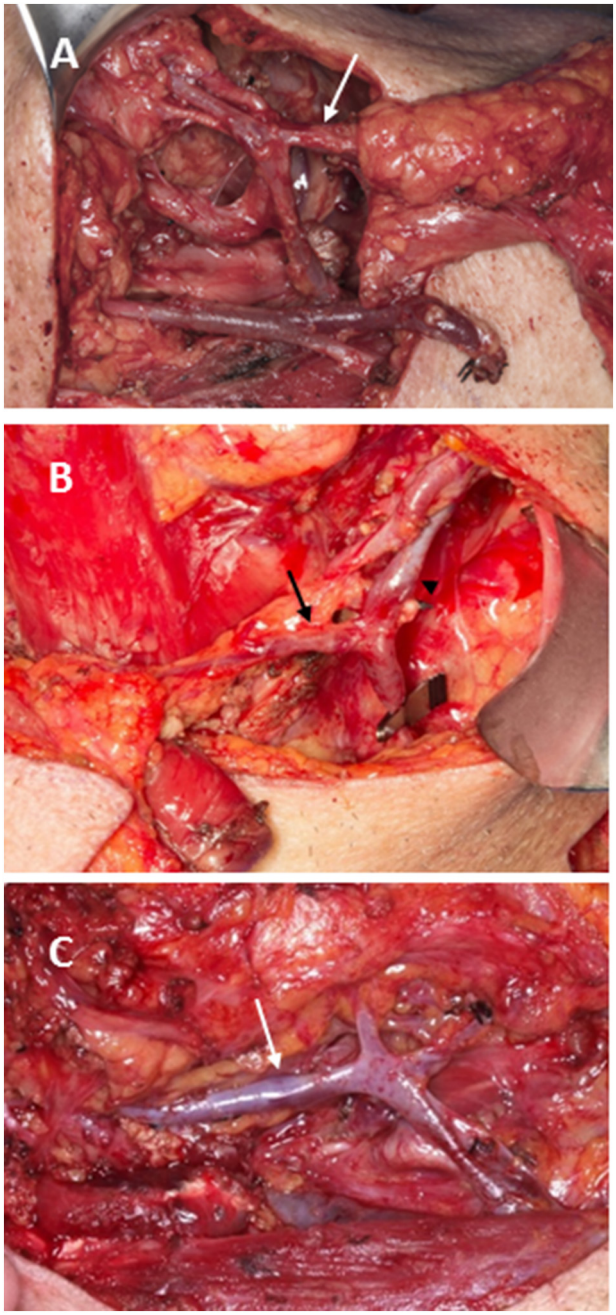

Fig. 1. Vascular pedicle variations.
Panel A) Typical vascular pedicle showing submental vessels (white arrow). Panel B) Submental vascular with clamp on facial vein with valve (black arrowhead) restricting reverse flow out of flap (black arrow). Panel C) Close-up of valve within the facial vein (white arrow).

was 7.3 days. Complications were minimal. Flap survival rate was 100%. There were no cases of partial flap loss. One patient had venous congestion in the early post-operative period and required hirudotherapy for 4 days. The flap survived after this and there was no permanent ischemia or flap loss. There were no donor site complications.

Cosmetic results were excellent overall. Two patients underwent subsequent elective cosmetic revisions. One patient had a small standing cone deformity that was excised from the submental donor site 3.5 years after the initial procedure. The same patient also had minor fat grafting to refine the orbital contour at the same time. One patient underwent minor debulking of the flap 10 days after the procedure. No revision procedures were necessary or desired in any other patients.

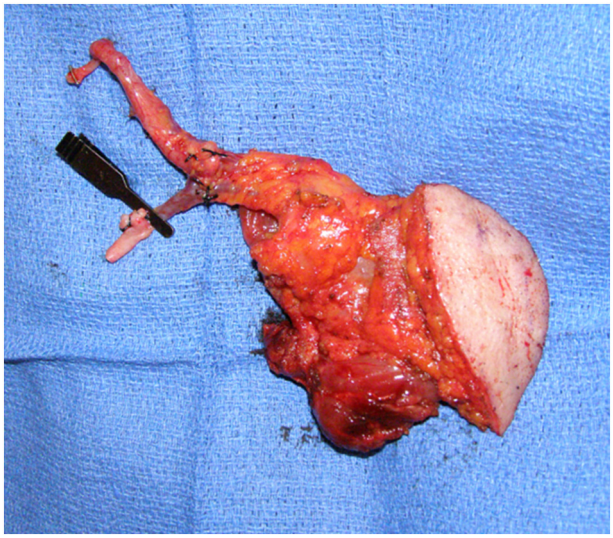

Fig. 2. Example free submental flap type.
Vascular clamp is on the venous pedicle (facial vein). The arterial pedicle is harvested at the level of the facial artery.

4. Discussion

The submental flap has a number of demonstrated benefits in head and neck reconstruction. The thin, pliable tissue lends itself well to resurfacing facial, intraoral, and oropharyngeal defects [4]. The minimal donor site morbidity and cosmetic advantage associated with the submental flap donor site are appealing. The submental flap is already in the operative field for most head and neck surgery, and therefore requires no extra operative setup, equipment, or preparation. The versatility of the submental flap lends itself to reconstruction of complicated defects involving multiple different tissue types. The submental flap can be harvested with different combinations of skin, fascia, muscle, and even bone. The submental flap also has the advantage of superior color match compared to flaps harvested from distant sites.

The reconstruction of defects high in the head and neck presents an ongoing challenge. Reconstruction of the skull base has commonly relied upon vascularized tissue (preferably muscle to seal dural defects) to prevent postoperative complications. The workhorse flaps for reconstruction of large anterior skull base defects have traditionally been the musculocutaneous anterolateral thigh flap and the rectus abdominis flap [10,11]. However, both have the significant disadvantage of excess bulk due to thick adipose tissue deposits at their donor regions. Both of these flaps provide consistent results for anterior skull base reconstruction; however, they typically require multiple cosmetic flap revision procedures for debulking and have poor color match to the facial skin. The submental flap is a musculocutaneous axial pattern flap ideally suited to reconstruction of anterior skull base and orbital defects. Muscle is particularly useful for associated skull based defects or CSF leaks. The flap can include bilateral mylohyoid and anterior bellies of digastric musculature providing excellent support of dural reconstructions [12]. The appropriate amount of muscle can be harvested and adjusted to the defect size.

Orbital defects, particularly with orbital exenteration, present a number of unique reconstructive problems. The risk of orbital fistulas is significant and often requires significant vascularized soft tissue bulk to prevent this complication [13]. The balance between avoiding a sunken cavity and accommodating an eventual ocular prosthesis often necessitates multiple reconstructive stages. The submental flap is uniquely suited to reconstruction in this area. The pliable tissue is similar to the radial forearm free flap, which is commonly used to reconstruct orbital

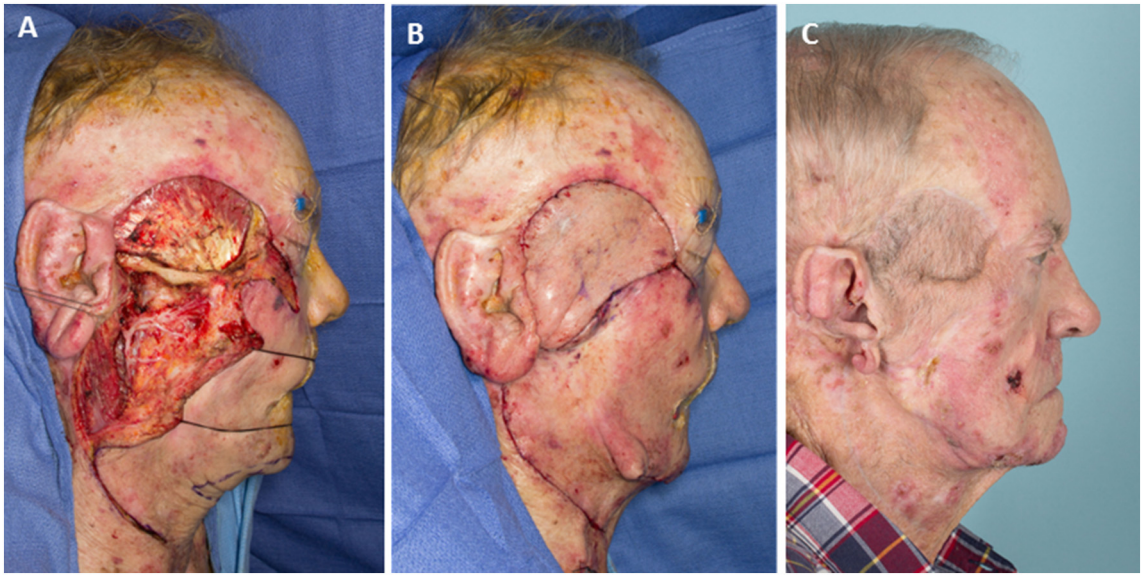

Fig. 3. Example of high facial soft tissue defect reconstructed with pedicled flap.
Panel A) 8 × 10 cm temporal defect. Panel B) Inset submental flap. Panel C) Post-operative appearance at 1.5 years.

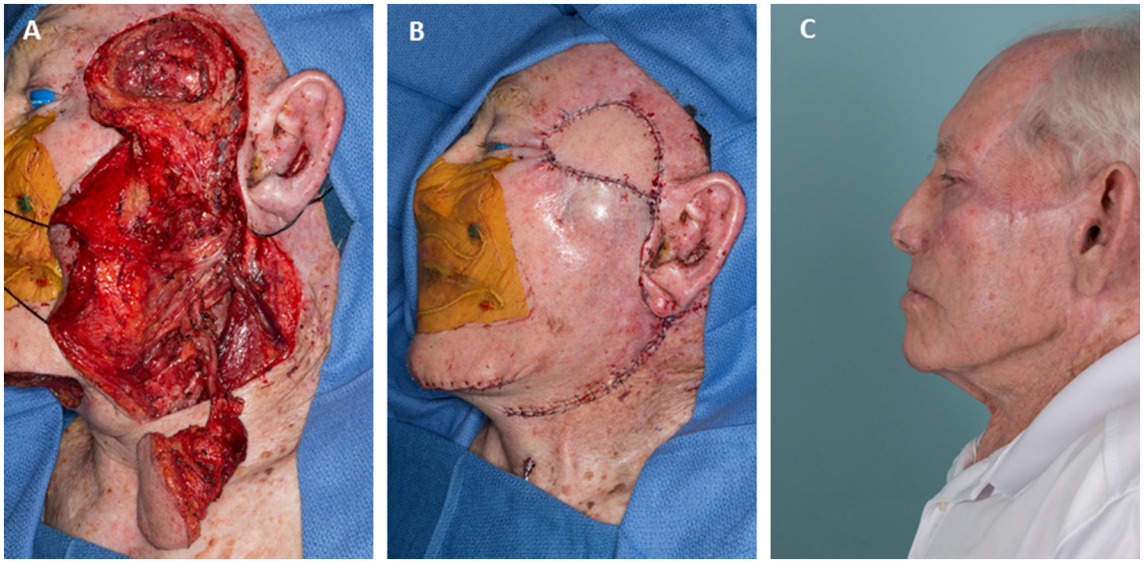

Fig. 4. Example of high facial soft tissue defect reconstructed with pedicled flap.
Panel A) 7 × 5 cm temporal soft tissue and parotidectomy defect with harvested submental flap. Panel B) Inset submental flap. Panel C) Post-operative appearance at 5 months.

exenteration defects. However, the color and texture match is superior to the radial forearm flap and other free flaps. Muscle is also useful for filling dead space in the orbital cavity or sealing associated CSF leaks, a characteristic lacking in the fasciocutaneous radial forearm free flap.

High facial cutaneous and soft tissue defects often rely on local flaps for reconstruction given the need for good color and texture match in this aesthetically prominent area. It can also be a challenge to get pedicled or free tissue to reach certain areas [14]. However, local flaps are sometimes simply not large enough. The submental flap addresses both challenges with the ability to resurface such defects with similar tissue of excellent color match and the potentially large skin paddle that can be harvested from mandibular angle to angle.

The original paper by Martin et al. described use of the flap as a retrograde flow flap based off the facial vessels [2]. The theoretical use of this flap in this manner is appealing for high defects. However, we have often encountered valves in the facial venous system despite good retrograde arterial flow (Fig. 1). While traditionally not thought to contain valves, our experience and recent literature suggests this is more common than previously thought [15]. In one patient we were able to base the flap off retrograde flow through the posterior facial vein. Our experience has shown that a posterior facial vein is more likely to be free of valves, and can often be used for retrograde venous flow if it communicates with the flap drainage pattern. We suggest here that using a retrograde submental flap here has limited utility, except in certain anatomic variants.

Additional advantages of the submental flap include minimal donor site morbidity and shorter hospital stay compared to most free flaps. Our study highlights these advantages, with no donor site morbidity and an average hospital stay of 7.3 days. When a pedicled submental flap can be used, cost-intensive free flap care and monitoring can be avoided. One potential disadvantage of the submental flap is the transfer of hair bearing skin in males. However, this can be advantageous in certain areas such as the temporal scalp. If not desired, we have found that depilation with laser or electrocautery in an outpatient

Fig. 5. Example of orbital exenteration defect reconstructed with hybridized submental flap.
Panel A) Orbital exenteration defect (partial lid sparing, additional incision for facial nerve reanimation procedure). Panel B) Inset flap. Panel C) Post-operative appearance at 21 days.

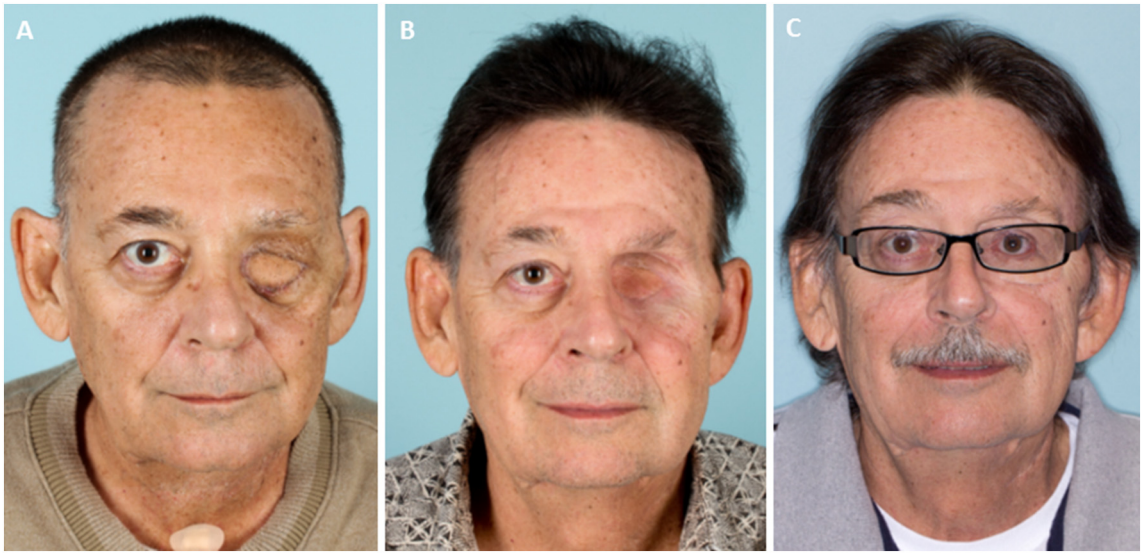

Fig. 6. Post-operative appearance following orbital and anterior skull base reconstruction with free submental flap.
Panel A) One month post-operative. Panel B) Seven months post-operative. Panel C) One year post-operative with ocular prosthesis).

setting is straightforward and easy to do in patients who do not receive post-operative radiotherapy.

We conclude that the submental flap is an excellent option for reconstruction of anterior skull base, orbital, and high facial defects. This versatile flap provides a number of unique reconstructive advantages that are highlighted in this study. It can be used as a pedicled, hybridized, or free flap based on intraoperative factors. Further comparative studies to more traditional reconstructive options will be helpful going forward.

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Declarations

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