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Head and Neck Reconstruction with Venous Flap: A Case Report

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Summary: Venous flaps are nonphysiologic flaps in which the venous system replaces the vascular circuit found in conventional flaps, serving as inflow as well as outflow. Although a main concern with venous flaps has been their reliability, this can be improved by manipulating their physiology using shunt restriction. The soft, pliable tissue provided by venous flaps coupled with the low donor site morbidity and ease of flap harvest make them ideal for coverage of moderate-sized facial defects, which may be too large for local options yet too small for conventional free flaps. We report the use of a large, 70 cm² arterialized venous free flap to reconstruct a complex forehead deficit after basal cell carcinoma resection. Furthermore, we present the first report of the successful use of valvulotomes in the case of a large, reverse flow arterialized venous flap where several in-series valves were found to prevent adequate perfusion of the flap. Upon removal of the valves, complete perfusion of the flap was achieved. *(Plast Reconstr Surg Glob Open 2021;9:e3816; doi: 10.1097/GOX.0000000000003816; Published online 17 September 2021.)*

Skin cancers of the face pose particularly challenging aesthetic and functional problems, and these hurdles become exponentially more difficult as the size of the resultant defect increases. Our patient sustained a large area of tissue loss secondary to cancer excision with resultant disfigurement and sensory deficits. Given the large, 70 cm² defect in our patient, the utilization of a free flap was an optimal choice. In current literature, venous free flaps for tissue defects span a wide variety of uses. Venous free flaps to functional areas, such as the hands and fingers, allow improved suppleness compared with skin grafts, which can result in joint immobility from secondary contracture and scarring.[1] Free venous flaps to the craniofacial area have been described in the literature and furthermore, have been studied to deduce the underlying contributions to flap failure.[2] However, reports of the use of arterialized venous free flaps in facial reconstruction are scarce. Park et al utilized arterialized venous free flaps for facial defects secondary to skin cancers, and published their results with overall flap survival in six out of eight patients. The largest flap size reported in their series was 20 cm² with two inflow vessels and one outflow, ultimately resulting in complete flap loss.[3] Our patient's deficit was 70 cm² after appropriate cancer excision, and we utilized an arterialized free flap with one inflow and one outflow with no flap loss and good cosmetic outcome.

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CASE REPORT

The patient is a 71-year-old man who underwent Mohs excision for a basal cell carcinoma of the forehead at an outside hospital. The defect was initially reconstructed with a split thickness skin graft a week later; however, the final pathology revealed positive margins with multifocal perineural invasion of either microcystic adnexal carcinoma versus infiltrating basal or squamous cell carcinoma etiology. After two more excisions that failed to secure negative margins, the patient was referred to our clinic. On examination, the patient was found to have a large defect of the left forehead, extending down to the calvaria. Oncologic workup revealed no regional or distant metastasis. The patient's medical history included insulin-dependent diabetes, heart disease, and prior transient ischemic attack.

In coordination with otolaryngology, the patient was taken for re-excision with 1 cm margins and burring of the outer table of the frontal bone. The resultant 8 × 13.5 cm defect was then covered with allograft until final pathological findings returned. The report confirmed microcystic adnexal carcinoma with negative peripheral margins.

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Subsequently we proceeded with reconstruction using an arterialized venous flap from the forearm as described below.

Using a vein finder, the venous subcutaneous network of the left (nondominant) volar forearm was mapped after placement of a tourniquet on the proximal arm. Using a template of the defect, a 7 × 10 cm skin paddle was designed over two parallel veins. To respect the valves, the vein chosen for arterial inflow would have retrograde flow and the outflow vein was chosen with antegrade flow. To separate the inflow from the outflow vessels in the flap design, the connecting veins were marked for ligation, creating a shunt restriction (Fig. 1). The recipient site on the left forehead was debrided and additional margins along the periphery of the defect were taken; fresh frozen sections returned negative for residual cancer. The superficial temporal artery was identified, together with a subcutaneous vein.

Under tourniquet with only minimal gravity exsanguination, the skin overlying the venous pedicles was incised to the level of the deep dermis with extreme care taken to avoid injury to the veins. The blue hue of the subcutaneous veins could be appreciated and dissection then proceeded with tenotomy scissors. Once the inflow and outflow veins were properly identified, the remainder of the flap was incised. Dissection then proceeded from distal to proximal in a supra-fascial plane, clipping and dividing any veins at the periphery of the flap except the inflow and outflow vessels. An access incision was then extended from the flap to allow dissection of a longer vascular leash for inflow and outflow. Dissection proceeded until 3 cm were isolated on both the inflow and outflow veins. After division, the flap was placed in a moist Ray-Tec.

The flap was then oriented at the recipient site and the anastomoses were performed (Fig. 2). Upon release of the vascular clamps, pulsations in the inflow pedicle were observed; however, they did not extend to the tip of the flap along the inflow vein. The distal clip was then removed and a valvulotome was passed retrograde in the inflow vein. Upon retrieval of the valvulotome, three valves were cut. The patient was administered a single dose of 5000 units of intravenous heparin. With the arterial inflow fixed, we diverted our attention to the outflow vein. We noted that flow in the recipient vein was very sluggish despite adequate filling of the flap outflow vein, and the flap respectively showed signs of early venous congestion. We decided, under the circumstances, to graft the outflow vein to the larger caliber superficial temporal vein at the preauricular area near the root of the helix. A 6-cm-long vein graft harvested from the left forearm was used to bridge the deficit from the flap to the superficial temporal vein, improving the venous outflow. All incisions and the flap inset were closed using 5-0 nylon simple interrupted sutures. The donor site was covered with a split thickness skin graft. The postoperative course was uneventful, and the patient was discharged on the second postoperative day on 325 mg aspirin daily for 30 days.

DISCUSSION

We believe venous flaps to be an under-utilized technique in microsurgical reconstruction, particularly when it comes to craniofacial reconstruction. To date, only two articles have described the use of venous flaps in the cervicofacial region. The first study, published in 2001, used pre-expanded arterialized venous free flaps from the forearm to reconstruct three burn patients, the largest of which was a 12 × 15 cm flap anastomosed to the facial artery and vein.[4] The second publication in 2010 described a series of eight patients who received local excision of basal and squamous cell skin carcinomas and subsequent reconstruction with arterialized venous free flaps from the forearm.[3] In this report, the largest flap was noted to be a right temporal reconstruction using a 4 × 4 cm venous flap anastomosed to the superficial temporal artery and vein. To our knowledge, our 70 cm^2 flap describes the largest non-prefabricated arterialized venous free flap used for facial reconstruction and the first to incorporate shunt restriction in the flap design.

Since their first description in 1981 by Nakayma et al, venous flaps have been slow to be adopted as a mainstream microsurgical option.[5] However, recent developments in venous flap design have advanced their dependability,

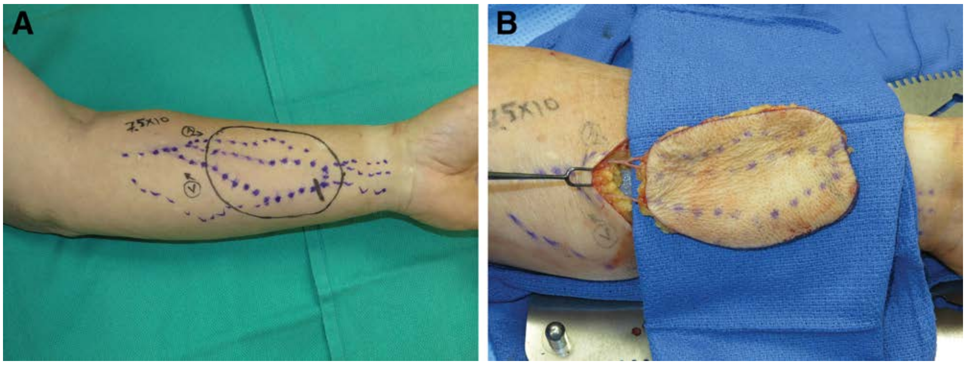

Fig. 1. Venous flap design. A, The subcutaneous vein network is marked using a vein finder. The location of the flap is marked overlying the inflow and outflow veins. The vein that connects the inflow and outflow systems, or where a connection is likely, is clipped to remove the possible shunt. This is marked with the black line. B, The flap isolated on the inflow (radial) and outflow (ulnar) vessels.

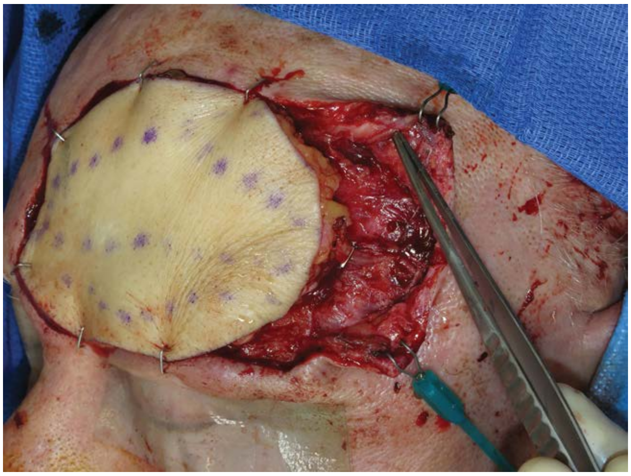

Fig. 2. Flap orientation and inset. After complete tumor resection with burring of calvaria, the 70 cm^2 defect was resurfaced with a venous flap oriented such that microanastomoses could be performed laterally near the superficial temporal vessels. The Debakey pickup marks the orientation of the flap's outflow vessel.

making them more like their conventional free flap counterparts. In 2010, Lin et al described the concept of "shunt restricted" arterialized venous flaps whereby a clip is strategically placed to eliminate the arteriovenous shunt. This results in higher perfusion pressures toward the periphery of the flap and maintenance of physiologic venous pressure in the efferent vein.[6] Lombardo et al then went on to modify this method by introducing the "reverse-flow, shunt-restricted" arterialized venous free flap, placing the inflow and outflow vessels on the same side of the flap.[7]

We have designed venous flaps with both antegrade and retrograde inflow vessels, depending on the defect location relative to the recipient vessels. In this case, it was necessary for both the inflow and outflow to be on the same side of the flap; therefore, the inflow had to be retrograde. While the arterial pressure can often dilate a valve to the point of incompetence, the problem arises when the venous flap is so large that multiple valves, in series, are encountered. Although the arterial pressure is likely sufficient to overcome a single valve, it is not able to do so with multiple valves in series. This is why we used the valvulotome to cut the valves.

Venous flaps have a multitude of potential advantages, such as the ease and speed of harvest, which requires no super-microsurgical expertise. Donor site morbidity is incredibly low, amounting to a little more than a full thickness skin graft, with avoidance of extensive subfascial or intramuscular dissection or harvest of a major vascular axis such as the radial artery. Additionally, these flaps are thin and hair-free when harvested from the volar forearm, making them ideal for use in facial reconstruction. There are, however, disadvantages. These nonphysiologic flaps are known to evolve through various stages of discoloration despite being otherwise well perfused. They essentially bruise secondary to the high-pressure inflow propelled through thin-walled, permeable veins. Pencil doppler and a pinprick bleeding assessment can distinguish this discoloration from frank congestion. Lastly, while raising the flaps is expeditious, venous flaps take 5–10 minutes of rewarming for the flap to adequately perfuse after completion of the microanastomosis.

We note that while using a valvulotome was successful in this case, and we only used aspirin postoperatively, we have since become much more cautious when using the valvulotome. Due to thrombosis of another flap in which we used the valvulotome, we now give these patients a heparin bolus followed by a therapeutic heparin protocol. We also only use the valvulotome once we make sure that all conservative measures failed to result in perfusion of the entire flap and determine that the in-series valves are the cause of the inadequate perfusion; this occurs only in large flaps.

Although venous flaps have had an inconsistent track record over the past four decades, improvements in our understanding of their physiology have allowed us to enhance their reliability through manipulation of their physiology. With further study, we aim to increase their size, predictability, and ultimately their utility within the reconstructive algorithm. As the result in this case exemplifies, excellent functional and cosmetic results can be obtained in facial reconstruction using venous flaps (Fig. 3). As we improve venous flap designs, we will likely see better, faster, and less morbid results in reconstruction of those defects that fall in the gray zone between what local tissue rearrangement and conventional free flaps can cover.

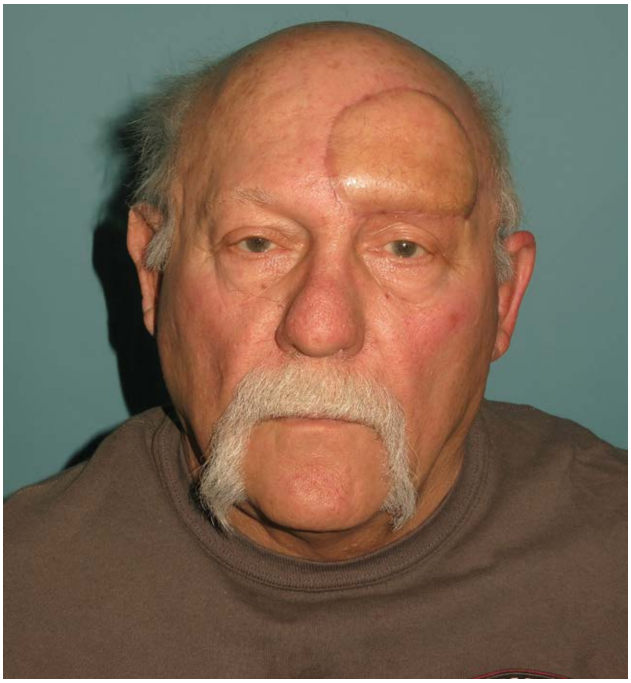

Fig. 3. Postoperative appearance at 3 months. Early in their postoperative course, arterialized venous flaps often appear hyperemic and ecchymotic, which can be mistaken for marked venous congestions. Despite this, the long-term follow-up shows excellent contour and color match.

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PATIENT CONSENT

The patient provided written consent for the use of his image.

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