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CASE REPORT
Reconstructive

A Plastic-neuro Effort: Vascularized Soft-tissue Coverage for Hostile Wound Bed with Multiple Ventricular Shunt Failures

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Summary: Cerebral ventricular shunt placements are the most common neurosurgical procedure performed today, which play a life-long role in the care of patients with hydrocephalus. Complication rates requiring shunt replacement are as high as 25%, and the potential need for multiple revisions throughout a patient's life may result in the formation of scar tissue and compromised wound healing. Without addition of vascularized tissue, patients with scalp scarring and impaired wound healing then enter a cycle of impaired skin closure followed by shunt infection, failure, and revision with little promise of long-term operative or therapeutic success. This plastics-neuro collaboration is the first known report of a free vastus lateralis muscle flap for coverage of a cerebral ventricular shunt, in a patient with congenital hydrocephalus and 17 previous ventricular shunts revisions due to infections and soft tissue exposure from scarring and a hostile wound bed. In the setting of extensive scarring, the free vascularized muscle flap provides soft tissue and vascular supply capable of promoting wound healing, maintaining scalp integrity, and reducing the incidence of shunt infection and the subsequent need for future revision, as supported by the complication-free status of the same patient now 16 months since the date of operation. *(Plast Reconstr Surg Glob Open 2020;8:e3257; doi: 10.1097/GOX.0000000000003257; Published online 23 November 2020.)*

Patients with poor scalp and neck tissue integrity treated for hydrocephalus are especially prone to shunt exposure and infection following seeding of foreign bodies and pathogens, most frequently *Staphylococcus epidermidis*, *S. aureus*, and *Propionibacter acnes*.[1–3] The most effective management for infection is shunt removal, external drainage, and empiric administration of broad spectrum antibiotics vancomycin and ceftazidime.[4] Even so, shunt infection carries high associations with meningitis, encephalitis, and early mortality, reported as up to 30.6% at 10 years.[1,5,6] With nearly half of the total cost of all annual cerebrospinal fluid shunting procedures attributable to revision surgeries,[7] the sequalae of cerebral shunt failure represent an increasing burden for patients, caregivers, and the healthcare system.

CASE REPORT

We describe herein a case of a 49-year-old man with a history of congenital obstructive hydrocephalus, hypertension, morbid obesity, epilepsy, cranial and scalp defects, open neck wound, and 17 previously failed ventriculoperitoneal (VP), ventriculoatrial (VA) and ventriculopleural shunts, presenting with increasing headaches and exposed shunt tubing in the inferior angle of the mandible and the left frontotemporal region 4 centimeters superior-anterior to the patient's external auditory meatus with drainage. A combined procedure was planned at an academic medical center in January, 2019, with Plastic Surgery and Neurosurgery to undergo a left frontal VA shunt combined with a vastus lateralis free flap and split thickness skin graft for coverage of both the scalp and neck defects, with the goal that new vascularized tissue to the head and neck would provide robust soft tissue coverage overlying new shunt to prevent further scalp breakdown and shunt exposure.

The plastic surgery team excised all compromised skin, including previous neck and scalp scarring, resulting

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Fig. 1. Photograph of a 49-year-old male patient's scalp and neck following standard face lift incision and cerebral shunt placement.

in a defect including portions of the burr hole from previous shunt placements. The wound was debrided and irrigated extensively using saline before a dissection of the recipient vessels in the neck was performed. A branch of the internal jugular vein and ascending pharyngeal artery and vein were exposed to provide inflow and outflow of the free flap. A standard face lift incision was used to elevate the skin, allowing for placement of the shunt and the flap (Fig. 1). A new VA shunt was placed by neurosurgery under fluoroscopic guidance. A vastus lateralis flap was harvested from the thigh and brought to the wound overlying the shunt (Fig. 2). Microvascular anastomosis with 8-0 suture was used to connect the ascending pharyngeal artery to the descending branch of the lateral circumflex femoral artery with an end-to-end anastomosis. Two veins were anastomosed using a 3.0 mm coupler. The flap was well perfused following microanastomosis with no evidence of ischemia. Skin grafts from the right thigh and preauricular skin flap were used to cover the remaining soft tissue defects adjacent to the shunt.

The patient's post-operative course was free of any clinical complications. Weekly follow-ups included bacitracin application to drainage holes, cleaning of the incisions, skin moisturization using vitamins A & D, and dressing application by xeroform. By 12-weeks, the skin graft and donor site had healed and the free flap and VA shunt remained fully viable (Figs. 3,4). Most recently, 16 months from the date of his treatment, the patient's left frontal scalp is healthy, well-adhered, and well-perfused. Crucially, he continues to remain free of any signs indicating infection or shunt failure.

DISCUSSION

This is the first report of a free muscle flap for coverage of a ventricular shunt. In patients with history of

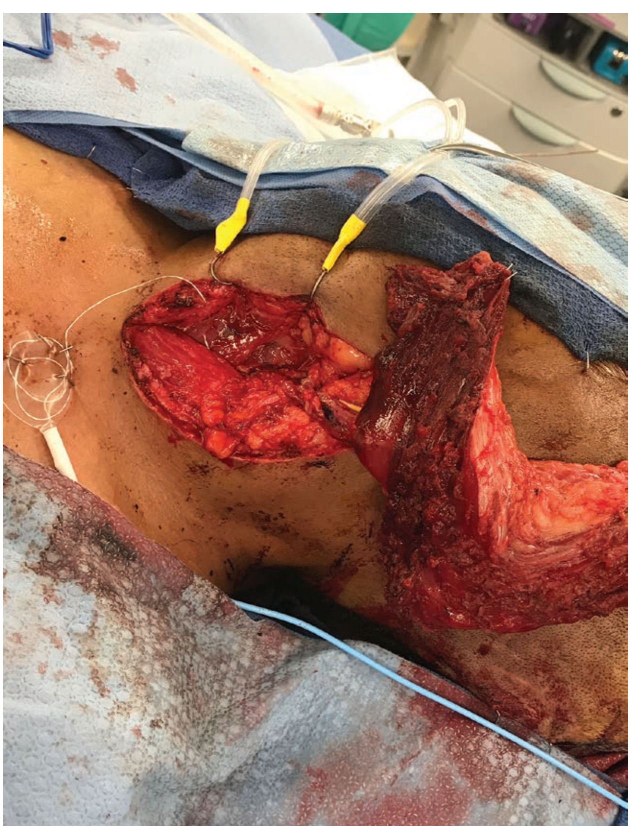

Fig. 2. Photograph of a vastus lateralis free flap transferred to the patient's excised left head and neck wound, by the plastic surgery team.

Fig. 3. Superior view of the patient's fully healed scalp following VA shunt placement with a vastus lateralis free flap and skin graft coverage.

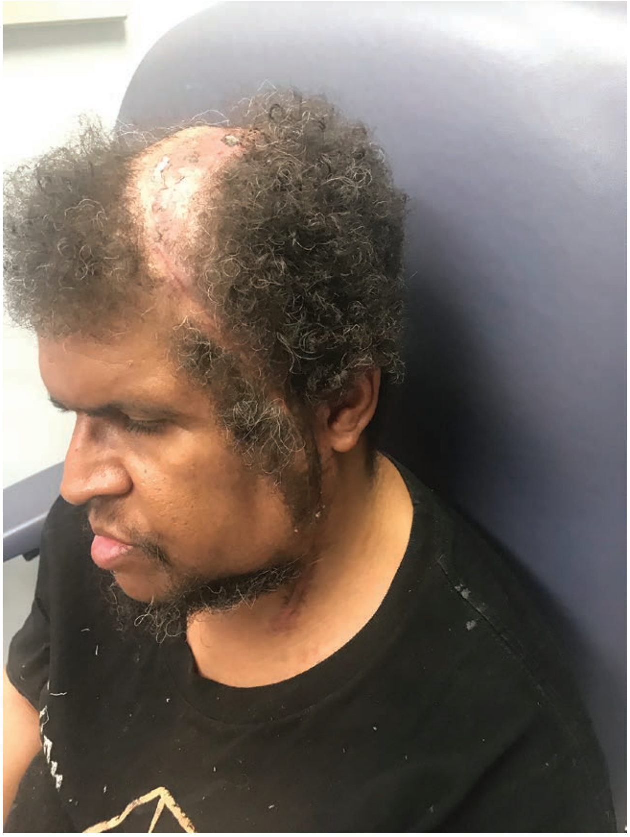

Fig. 4. Lateral view of the patient's fully healed scalp, face, and neck. The patient considered scar revision along the left cheek at a later date.

multiple shunt failures and extensive scarring, a plastic-neuro approach is highly advantageous. With extensively scarred scalp soft tissue, use of the "reconstructive elevator" is warranted with early employment of free tissue transfer.[8] Local flaps, skin grafts, and other adjuncts have a higher failure rate in this setting. By bringing new vascularized tissue to the scalp, reliable coverage is guaranteed and offers a new area to use if further shunt failures ensue.

Review of the literature yields an absence of reports on muscular free flaps for cerebral shunt coverage, only instances of its utility in cranioplasty and scalp reconstruction.[9–12] Furthermore, studies on any free tissue transfer for shunt coverage are limited to use of skin and fasciocutaneous transfers such as the anterolateral thigh flap rather than muscular free flaps.[12–14] Free vastus lateralis muscle flap is advantageous for cerebral shunt coverage because it is harvested in the supine position, has a long reliable pedicle, has minimal donor site morbidity, and allows for a 2-team approach during surgery.[15,16] Usually, only small portions of the VL are used and can be tailored to fill any size defect. Considering the patient's extensive history, this case highlights the potential advantages of a vastus lateralis free flap in assisting patients who require cerebral ventricular shunts but are also at a high risk of infection and shunt malfunction. In addition, we recommend use of a muscle flap to avoid the phenomenon of "sinking flap syndrome," in particular for cases involving larger defects.[17,18] Free muscle flaps are highly vascularized, adhere to bone easily, and add more bulk than free fasciocutaneous flaps. Due to the constant negative pressure generated by ventriculoperitoneal shunts, fasciocutaneous flaps cave in and thin overtime, creating impending exposure.[19] This phenomenon has been described in local scalp flaps as well, leading to significant skin loss and shunt exposure.[20]

Other avenues for shunt coverage in patients with histories of revision include use of acellular dermal matrix grafts to augment scalp soft tissue, or, most recently, the integration of customized cranial implants to lower shunt profile and minimize pressure on the overlying scalp, avoiding dehiscence.[21,22] Still, neither approach offers the low technical demands or relative accessibility of an autologous vastus lateralis free flap while addressing the discussed obstacles of sinking flaps and impaired wound healing.

Supplementation of the common ventricular shunt placement with a plastic surgery approach can potentially alleviate the need for downstream shunt revisions by reducing the risk of infections and soft tissue exposures. Given the chronicity of hydrocephalus, this multi-disciplinary technique provides both patients and physicians an opportunity for more consistent and enduring operative success, decreased rates of infection, and subsequently a reduced need for operative revisions.

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