Endonasal skull base surgery has emerged over the past decade, and in many institutions, has become the preferred method for treatment of benign and malignant pathology of the anterior and middle cranial fossa, including the clivus.1–5 While many of these defects are readily reconstructed with allografts,6,7 local flaps,7–11 and occasional regional flaps,12–15 prior surgery and radiation therapy may limit the availability of these local and regional reconstruction options. Free tissue transfer is the next obvious step in the reconstructive ladder, but the anatomic confines of the endonasal defect create obstacles for flap inset not seen with open lateral skull base defects. We present a case of endonasal free tissue transfer reconstruction of a clival radionecrosis defect with an adipofascial radial forearm free tissue transfer, detailing the reconstructive techniques to overcome the challenges of endonasal flap inset.

CASE REPORT

A 40-year-old male with prior history of palatal split approach for resection of a clival chordoma followed by adjuvant radiation therapy 10 years earlier presented in April 2011 with facial pressure and pain. Secretions were noted in the clival recess on endoscopic examination, and a MRI scan revealed sphenoid sinus mucosal thickening and enhancing tissue in the clivus. The patient underwent functional endoscopic sinus surgery in June 2011, which revealed inflammation without recurrence. The patient experienced transient improvement but underwent revision functional endoscopic sinus surgery with medial maxillectomy in February 2012 for recurrent symptoms. He unfortunately presented 6 months later with a retropharyngeal abscess, which was emergently drained and treated with 3 months of IV antibiotics. Post-treatment imaging revealed resolution of acute cervical osteomyelitis, but persistent osteoradionecrosis of the clivus. He was counseled as to the risks of untreated clival radionecrosis and advised to undergo revision resection of the radionecrosis with vascularized free tissue transfer reconstruction of the skull base, as no local or regional reconstruction options remained. In December 2012, he underwent endoscopic clivectomy and simultaneous free tissue transfer. (See figure, Supplemental Digital Content 1, which displays intraoperative images of the radial forearm adipofascial reconstruction of the clival defect, http://links.lww.com/PRSGO/A289.)

As the defect was entirely intranasal, the decision was made to avoid a skin paddle, and thereby allow for future

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mucosalization of the flap to avoid future sinonasal crusting. Therefore, an adipofascial radial forearm free tissue transfer was planned along right forearm. In addition, the posterior endonasal nature of the defect required not only an endoscopic inset but also a plan for vessel access. After creation of the clival defect and (Fig. 1), a Caldwell-Luc defect was created in the right maxillary sinus through a midface degloving approach. A Risdon incision was used for access to the facial vessels in the neck, and a subcutaneous tunnel created between the Risdon and midface degloving incisions.

Then, a broad adipofascial forearm flap was raised in standard fashion, incorporating the cephalic system. The flap was then “tubed” on itself to protect the vascular pedicle from its future intranasal environment with care to leave the distal aspect broad for flap inset. The forearm flap was introduced into the oral cavity and advanced through the subcutaneous tunnel into the neck. Microvascular anastomosis was then performed in standard fashion to the facial system, and implantable dopplers were applied to allow for both intraoperative and postoperative monitoring. As the flap was designed to follow a circuitous path from the neck, over the mandible, into the maxillary sinus and through the medial maxillectomy defect into the nasal cavity toward the clivus, continuous doppler monitoring was used during inset to detect any signs of compression of flow.

We then commenced with 2-surgeon endoscopic assisted intranasal inset. The distal edges of the flap were tagged with a purple 3-0 Vicryl on one side and black 2-0 silk suture on the other (Fig. 2). This aided with orientation to avoid flap torsion during inset. The sutures were passed sequentially through the Caldwell-Luc defect under direct visualization by the first surgeon and were grasped with forceps under endoscopic guidance by the second surgeon. Maintaining suture orientation, the first surgeon gently advanced the flap through the Caldwell-Luc defect, whereas the endoscopic surgeon guided the flap through the nasal cavity to the clivus. The flap displayed appropriate color and edema, and doppler signals were maintained. The patient was observed with flap checks Q1 hours × 48 hours, then Q4 hours until discharge home on postoperative day 5 with nasal saline spray.

Endoscopic examination at the 1-year follow-up showed durable reconstruction of the clival defect and expected atrophy and mucosalization of the previously bulky adipofascial flap (Fig. 3). (See figure, Supplemental Digital Content 2, which displays 1-year post-operative endoscopic appearance, http://links.lww.com/PRSGO/A290.) Subsequent 3-year follow-up MRI scan revealed durable reconstruction of the skull base without evidence of sinusitis (Fig. 4). (See figure, Supplemental Digital Content 3, which displays 3-year follow-up T1-weighted MRI scan highlighting the durability of the adipofascial flap without sinusitis, http://links.lww.com/PRSGO/A291.) On 4-year clinical follow-up, he remains asymptomatic with preserved nasal airflow and smell.

**Fig. 1.** Endonasal defect after revision debridement of the clival radionecrosis. Prior nasal septectomy allows complete view of the clivus and left posterior nasal cavity. Complete nasal mucosa extirpation was performed from the sphenoid sinus to the nasopharynx and anteriorly to the right medial maxillectomy defect (star). Necrotic clival soft tissue and bone has been debrided, exposing the dural cover to the clivus inferiorly.

**DISCUSSION**

Endonasal free tissue reconstruction is a challenging art, which requires knowledge of endonasal anatomy/function and microvascular skill. With the increased volume of endonasal surgery, the challenge of reconstructing the “multiply-operated” defect will continue to rise as well. Surrounding local and regional flaps may be de-
completed, and native tissue vascularity may be compromised from prior radiation therapy, leaving endonasal free tissue transfer as the sole endonasal reconstructive option to manage these devascularized wound beds and prevent catastrophic neurologic complications. Avoiding the mor-

Fig. 3. One-year postoperative endoscopic appearance. Endoscopic view of the right nasal cavity demonstrating the atrophied and mucosalized flap (dotted line) exiting the maxillary sinus (star) and traveling along the inferior lateral nasal side wall to the sphenoid sinus superiorly and clivus (oval) inferiorly. The nasal airway is widely patent with no signs of crusting or sinusitis. The nasopharyngeal airway is unobstructed.

Fig. 4. Three-year follow-up axial T1-weighted MRI scan demonstrating the durability of the adipofascial flap entering the right maxillary sinus though the prior Caldwell-Luc and then coursing posteriorly to the clivus without evidence of sinusitis.

bid open craniofacial defects also dramatically improves patient quality of life.16

This case demonstrates the benefit of a multidisciplinary approach, using the endoscopic reconstructive skills of each team member for maximized success. This allows for a mindful approach for successful defect reconstruction. In addition, the endonasal environment presents unique challenges to inset, pedicle protection, and flap monitoring. To optimize inset, the mucosa along the defect route to the sinus cavity was denuded to increase flap adherence and avoid future mucocele formation. “Tubing” the flap protected the vascular pedicle during inset from nasal secretions and abrasion trauma. Finally, the avoidance of a skin paddle allows for flap inset versatility, primary donor site closure, and long-term improved sinonasal cavity airflow and function.

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