How I Do It

Nasoseptal “Rescue” Flap: A Novel Modification of the Nasoseptal Flap Technique for Pituitary Surgery

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Objectives: The introduction of the pedicled nasoseptal flap (NSF) has decreased postoperative cerebrospinal fluid (CSF) leak rates from >20% to <5% during expanded endoscopic skull base surgery. The NSF must be raised at the beginning of the operation to protect the posterior pedicle during the expanded sphenoidotomy. However, in most pituitary tumor cases, an intraoperative CSF leak is not expected but at times encountered. In these cases, a “rescue” flap approach can be used, which consists of partially harvesting the most superior and posterior aspect of the flap to protect its pedicle and provide access to the sphenoid face during the approach. The rescue flap can be fully harvested at the end of the case if the resultant defect is larger than expected, or if an unexpected CSF leak develops. This technique minimized septum donor site morbidity for those patients without intraoperative CSF leaks.

Results: The rescue flap technique allows for binaural and bimanual access to the sella without compromise of the pedicle during the extended sphenoidotomies and tumor removal. If an intraoperative CSF leak is encountered, the rescue flap is then converted into a normal nasoseptal flap for skull base reconstruction. If no leak is obtained, then the patient does not suffer additional donor site morbidity from the full flap harvest.

Conclusions: This new technique allows for sellar tumor removal prior to the nasoseptal harvest, thereby eliminating donor site morbidity for those pituitary tumor patients who do not have an intraoperative CSF leak.

Key Words: Skull base, endoscopic surgery, reconstruction, pituitary surgery, nasoseptal flap.

Level of Evidence: 4.

INTRODUCTION

Reconstruction of large defects with vascularized tissue has proven indispensable for reliably separating the cranial contents from the paranasal sinuses following extended endoscopic endonasal approaches (EEA). The introduction of the pedicled nasoseptal flap (NSF) has decreased postoperative cerebrospinal fluid (CSF) leak rates from >20% to <5% during expanded endoscopic skull base surgery. For patients with high-flow intraoperative CSF leaks, the NSF is an excellent reconstructive technique with a 94% successful rate. The NSF must be raised at the beginning of the operation to protect the posterior pedicle during the expanded sphenoidotomy. In our skull base centers, the NSF is routinely used for all endonasal intradural skull base defects except for pituitary adenomas <2 cm and Rathke’s cleft cysts.

In most intrasellar pituitary tumor cases, an intraoperative CSF leak is not expected; however, if a diaphragmatic leak is encountered the NSF is not available unless it was raised at the beginning of the case. One can raise the entire flap and resuture it onto the septum, but this increases the sinonasal morbidity during the postoperative healing process at the donor site. For these cases in which a leak is not expected but at times encountered, a rescue flap technique was developed to allow for a vascularized reconstruction but only when needed. This minimizes the potential sinonasal morbidity.
in those patients whose tumors are removed without a CSF leak. The rescue flap technique consists of partially harvesting the most superior and posterior aspect of the flap to protect its pedicle and provide access to the sphenoid face during the approach. The rescue flap can be fully harvested at the end of the case if the resultant defect is larger than expected or if an unexpected CSF leak developed. The primary focus of this article is to describe the cadaveric studies that support this technique and to evaluate the potential for bimanual and binarial dissection during a rescue flap dissection. The technique of the NSF harvesting has been well described, and the anatomy of the sphenoethmoidal recess, sphenoid sinus, and sellar region has been finely described by multiple authors; therefore, these will not be elucidated upon.

MATERIALS AND METHODS

Three fresh and five preserved human specimens were used for anatomic dissections in accordance with institutional protocols. Using a standardized method, all specimens were injected with red and blue silicone through the internal carotid artery and internal jugular vein, respectively. Photographs were taken with 0° and 30° rod lens endoscopes coupled to a high-definition camera and monitor (Storz Endoscopy, Tuttingen, Germany). The surgical dissection was performed using paranasal sinus and skull base/neurosurgical endoscopic instruments (Storz).

Surgical Technique

The preparation and initial steps are identical to the NSF harvesting. In brief, the nasal cavity is decongested, the inferior turbinates are outfractured, and one of the middle turbinates (usually the right) is resected to improve visualization and bimanual technique during the pituitary approach. On the side of the middle turbinate resection, one horizontal incision is performed with monopolar extended needle tip guarded cautery over the face of the sphenoid, at the level of the sphenoid ostium (Fig. 1B). This incision is continued medially over the sphenoid rostrum and then anteriorly into the nasal septum (for approximately one-third to one-half of the septum following the sagittal plane) (Fig. 2B). Using an elevator, a mucosal flap is created by raising the mucosa immediately below the incision in a submucopericondrial/subperiosteal fashion, until freeing it to the level (or below) of the floor of the sphenoid sinus (Fig. 1C). A contralateral wide sphenoidotomy is performed with standard sinus instrumentation. A postero/superior (nasal) septectomy is performed, including the septal mucosa contralateral to the flap. The ipsilateral mucosa of the face of the sphenoid and septum is preserved (rescue flap, potential proximal aspect and pedicle of the NSF) and is protected by raising it in the prior step (Figs. 1C and 3A). A wide sphenoidotomy is performed on the ipsilateral (flap side) side above the rescue flap pedicle, preserving the previously raised (rescue) flap. Once bilateral sphenoidotomies are

Fig. 1. Nasal septal and sphenoid face incisions (right nasal cavity).

Only the most postero/superior incision is required for the rescue flap approach. (A) Location of incisions of the traditional pedicled nasoseptal flap. (B) Location of incision for rescue flap approach. (C) An inferior mucopericondrial/periorbital flap is raised downwards (arrow) with an elevator during the rescue flap approach. The flap is elevated from the ipsilateral posterosuperior septum and sphenoid face until reaching the level of the floor (or below) of the sphenoid sinus (not shown in illustration). Arrow in A and B = sphenoid ostium; arrow in C = direction of flap elevation; ST = superior turbinate; FP = potential nasoseptal flap pedicle; IT = inferior turbinate; MS/A = maxillary sinus anthrostomy; CA = choana; S = septum.
performed, the flap is displaced down with a standard Frazier tip suction or rod-lens endoscope for the remaining of the case (Fig. 3A). We sometimes extend our horizontal (superior) incision further anteriorly if the exposure is not optimal, which also decreases the possibility of flap tearing. The remainder of the intrasphenoidal dissection and sellar tumor removal is performed above the pedicle with bimanual access. If no CSF leaks are encountered, the posterior mucosal flap is repositioned (Fig 3B). However, if CSF leaks are encountered, the full NSF flap can be harvested following the standard and previously reported technique by extending the rescue flap incision into standard NSF incisions.\textsuperscript{1,2,9} We do not routinely use Doyle splints or tacking sutures to reposition the flap during a rescue flap approach; however, these can be used if the flap does not reposition well.

RESULTS

The rescue flap technique allows for binaural and bimanual access to the sella without compromise of the pedicle during the extended sphenoidotomies and tumor removal. If an intraoperative CSF leak is obtained, the rescue flap is then converted into a normal nasoseptal flap for skull base reconstruction. If an additional clival approach is needed, the rescue flap pedicle becomes an impediment to this lower dissection and a standard flap should be raised. In eight injected cadaveric dissections, the rescue flap was harvested without compromising bimanual sellar exposure. In addition, all eight specimens had the full flap raised at the end of the sellar dissection without disruption of the sphenopalatine artery. As the mucosal incisions are essentially identical to the ones required for harvesting the posterior aspect of the nasoseptal flap, the sphenopalatine artery is incorporated in the pedicle.

DISCUSSION

Reconstruction of the skull base is intended to separate the cranial cavity from the nasal cavity, therefore avoiding CSF leaks, exposure of vascular structures,
ascending bacterial colonization, and meningitis.\textsuperscript{10–12} Vascularized flaps have shown to be fundamental to decrease the incidence of CSF leaks; however, vascularized tissue is not necessary for small skull base defects without a CSF leak, and its harvest may lead to some degree of donor site morbidity, increased surgical time, postoperative care, and costs.

We have modified our approach for pituitary tumor cases in which an intraoperative CSF leak is not expected, and therefore vascularized flaps for reconstruction not required. In these cases, a rescue flap approach is used, which consists of partially harvesting the most posterior aspect of the flap at the beginning of the case to protect its pedicle and provide access to the sphenoid face. The NSF can be fully harvested toward the end of the case if the resultant defect is larger than expected or if an unexpected CSF leak develops. By avoiding donor site morbidity, a rescue flap approach significantly decreases time spent in postoperative care and could improve overall cost-effectiveness.

**CONCLUSIONS**

This new technique allows for sellar tumor removal prior to the nasoseptal flap harvest, thereby eliminating donor site morbidity for those pituitary tumor patients who do not have an intraoperative CSF leak.

**BIBLIOGRAPHY**