How I Do it

Use of Acoustic Doppler Sonography to Ascertain the Feasibility of the Pedicled Nasoseptal Flap After Prior Bilateral Sphenoidotomy

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Objectives/Hypothesis: Blood supply to the Hadad-Bassagasteguy pedicled nasoseptal flap may be interrupted by surgery of the pterygopalatine fossa, posterior septectomy, or large sphenoidotomies. This would preclude its use for reconstruction of skull base defects after expanded endonasal approaches (EEA). We present a novel method to ascertain the patency of the nasoseptal artery after prior surgery, and consequently the availability of the nasoseptal flap, using acoustic Doppler sonography.

Study Design: Retrospective clinical review.

Methods: Four patients who underwent EEAs were evaluated intraoperatively with acoustic Doppler sonography. The mucosa that covers the inferior aspect of the rostrum of the sphenoid sinus was scanned with the tip of the probe. Reflection of sound waves representing intravascular blood flow was assessed.

Results: In three patients, the artery was identified in at least one side. One remaining patient showed no acoustic signal suggesting loss of the nasoseptal artery bilaterally, therefore necessitating the use of a fat graft for the reconstruction.

Conclusions: Acoustic Doppler sonography seems to be a feasible and effective way to ascertain the availability of the nasoseptal artery. It is a relatively inexpensive and simple technique that can be performed by any endoscopic surgeon.

Key Words: Nasoseptal artery, skull base surgery, reconstruction, vascularized flap, expanded endonasal approaches, previous sphenoidotomy, Doppler sonography.

INTRODUCTION

Reconstruction of dural defects resulting after expanded endonasal approaches (EEA) is paramount to achieving good surgical outcomes. Separation of the cranial cavity from the sinonasal tract, obliteration of the dead space, and preservation of neurovascular and ocular function are the main reconstructive goals. Small dural defects can be effectively repaired with free tissue grafts; however, when these are applied to large defects the result is variable. Thus, repair of large defects is best accomplished with vascularized flaps. Pedicled flaps are frequently used to reconstruct the cranial base after EEAs, as the resulting defects are of considerable size and complexity and because vascularized tissue promotes reliable, fast, and complete healing.

The Hadad-Bassagasteguy flap (HBF), or pedicled nasoseptal flap, comprises the nasal septum mucoperiosteum and mucoperichondrium based on the nasoseptal arteries. Its pedicle contains the nasoseptal arteries that cross the rostrum of the sphenoid sinus enclosed in a strip of mucoperiosteum, which is located between the
lower limit of the sphenoid ostium and the superior part of the posterior choana. HBF has proven to be a reliable and versatile flap for skull base reconstruction, providing a large surface area with a wide arc of rotation. These characteristics allow the reconstruction of extensive defects of the anterior, middle, clival, and parasellar skull base.3,5–7

Sphenoidotomies with significant inferior extension can disrupt the blood supply to the flap, therefore precluding its use. In addition, EEA customarily requires a large posterior septectomy, which may also eliminate the possibility of harvesting the HBF by disconnecting the remaining septal mucoperiosteum/mucoperichondrium from the pedicle of the HBF. HBF is our preferred reconstructive option; however, it is avoided in patients with prior sphenoidotomies or posterior septectomy, as these procedures are likely to injure its pedicle. Alternative reconstructive techniques have to be considered for patients who have undergone such surgeries (Fig. 1).8 We deemed that a method to ascertain the viability of the vascular pedicle would be very useful in such cases. Endoscopic visualization can evaluate the integrity and dimensions of that portion of the mucoperiosteal paddle located between the remaining septum and the sphenoid rostrum. However, this does not guarantee the viability of the flap pedicle.

In this article we present a novel technique to ascertain the viability of the nasoseptal artery in patients with prior sphenoidotomy or partial posterior septectomy using acoustic Doppler sonography. We illustrate its use in four case examples.

MATERIALS AND METHODS

Four patients presented skull base lesions requiring an EEA. All patients had undergone previous bilateral sphenoidotomies and/or partial posterior septectomy, but were deemed to have enough posterior septum to connect the remaining anterior septum with the sphenoid rostrum. Intraoperatively, all patients were evaluated with acoustic Doppler sonography (ES-100X MINIDOP; Koven Technology, Inc., St. Louis, MO) to ascertain the patency and blood flow of the nasoseptal artery (Fig. 2A and 2B).

Acoustic Doppler Sonography

After orotracheal intubation, the patient is placed in a three-pin head holder positioned with the neck slightly tilted to the left and turned slightly to the right. The nose is...
decongested with topical 0.05% oxymetazoline applied using 0.50 × 3-inch cottonoids. Using a 0° rod lens endoscope (Karl Storz Endoscopy, Culver City, CA), the middle turbinates of both sides are lateralized for enhanced visualization and to increase the space for the insertion of the acoustic Doppler sonography probe.

The tip of the probe is placed gently on the mucosa to scan the areas between the rostrum of the sphenoid sinus and the posterior nasal septum, and from the superior part of the choana to the inferior limit of the sphenoidotomy bilaterally (Fig. 2C). Sound waves reflected by intravascular blood flow produce an inherent phase shift that is detected according to the Doppler principle; therefore, a characteristic pulsatile sound is heard when the tip of the probe is over a patent artery.

A characteristic pulsatile sound when the probe scans the area between the sphenoid rostrum and the posterior septum is indicative of a patent nasoseptal artery. Lack of a pulsatile sound along the sphenoid rostrum, or interruption of the sound while moving the probe from the sphenoid rostrum to the posterior septum, suggested disruption of the artery.

RESULTS

Four women with a history of prior sphenoidotomies and recurrent tumors requiring EEAs underwent intraoperative Doppler sonography of the nasoseptal artery bilaterally. This group comprised two patients with recurrent pituitary adenomas presenting cavernous sinus invasion, one patient with a recurrent suprasellar craniopharyngioma, and one with a recurrent chordoma. In three patients, the artery was identified in at least one side. One patient showed no sonographic signs of the artery bilaterally, therefore necessitating the use of a fat graft for the reconstruction. In two patients with pituitary adenomas, the nasoseptal arteries were present bilaterally and the reconstruction was completed using an HBF. In the patient with a recurrent suprasellar craniopharyngioma, the nasoseptal artery was present on the right side; however, attempts to raise the nasoseptal flap failed due to an anterior perforation and lack of adequate mucoperiosteum (prior trans-septal approach). No cerebrospinal fluid leak or other complication occurred in any of the four patients (Table 1).

DISCUSSION

Forty years ago, Milton elegantly demonstrated that the viability of a reconstructive flap is dependent upon its vascularity. In 2006, Hadad et al. described the first endonasal pedicled flap for endoscopic skull base reconstruction, the HBF or pedicled nasoseptal flap. Subsequently, other pedicled flaps, such as the transpterygoid temporoparietal fascia, the transfrontal pericranial, inferior and middle inferior turbinate, and the Oliver palatal flaps were described. However, the HBF remains as the preferred option for endoscopic skull base reconstruction.

It is of general concern that the pedicle of the HBF may be unavailable in patients with prior large sphenoidotomies and/or posterior septectomy. These procedures frequently damage the nasoseptal artery, which tenders the flap inadequate for the reconstruction. As the HBF is our preferred reconstructive method, we suggest the use of acoustic Doppler sonography to ascertain the viability of a reconstructive flap based on its vascularity.
flap availability in cases of prior sphenoidotomy and/or partial septectomy.

The use of acoustic Doppler sonography for perioperative planning and evaluation of pedicled flaps is not a new idea. Taylor et al. successfully used acoustic Doppler sonography to identify the dominant cutaneous perforating arteries to plan skin flaps.\textsuperscript{15} Doppler sonography can also be used as an instrument for the assessment of blood flow in microvascular free tissue transfers at the time of the reconstructive surgery.\textsuperscript{16,17} In addition, implantable Doppler is a current option to monitor free microvascular flaps in the postoperative period.\textsuperscript{18} Henceforth, Doppler sonography can be used to assess the patency and blood flow of the nasoseptal artery in select patients. Confirmation of a functional artery suggests that harvesting of the nasoseptal flap is an option for reconstruction.

CONCLUSION

Acoustic Doppler sonography is a feasible and effective way to ascertain the viability of the nasoseptal artery. It is a relatively inexpensive method and simple technique that can be performed by any endoscopic surgeon.

BIBLIOGRAPHY


TABLE I.
Demographics, Pathology, Availability of the Nasoseptal Artery, Reconstruction Method, and Complication Data of Four Patients in Whom the Acoustic Doppler Sonography Was Performed to Evaluate the Competence of the Nasoseptal Artery.

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Age (yr)/Sex</th>
<th>Pathology</th>
<th>Nasoseptal Artery Availability*</th>
<th>Reconstruction</th>
<th>Complication</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30/F</td>
<td>Recurrent pituitary adenoma with right cavernous sinus invasion (Cushing’s disease)</td>
<td>Both sides</td>
<td>Left nasoseptal flap (HBF)</td>
<td>None</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>42/F</td>
<td>Recurrent pituitary adenoma with cavernous sinus invasion (Cushing’s disease)</td>
<td>Both sides</td>
<td>Left nasoseptal flap (HBF)</td>
<td>None</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>49/F</td>
<td>Recurrent suprasellar craniopharyngioma</td>
<td>Right side only</td>
<td>Left middle turbinate flap</td>
<td>None</td>
<td>Right nasoseptal flap attempted but could not be used due to perforation and lack of adequate mucoperiosteum.</td>
</tr>
<tr>
<td>4</td>
<td>38/F</td>
<td>Chordoma</td>
<td>No artery</td>
<td>Fat graft</td>
<td>None</td>
<td>—</td>
</tr>
</tbody>
</table>

*Checked using acoustic Doppler sonography.
F = female; HBF = Hadad-Bassagasteguy Flap.