Hemi-transseptal Approach for Pituitary Surgery: A Follow-Up Study

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J Neurol Surg B 2017;78:145–151.

Abstract

Objectives The hemi-transseptal (Hemi-T) approach was developed to overcome the potential drawbacks of the nasoseptal flap (NSF) in endoscopic endonasal transsphenoidal skull base surgery. In this study, we describe further refinements on the Hemi-T approach, and report long-term outcomes as compared with traditional methods of skull base reconstruction.

Design A retrospective case-control study.

Setting Montreal Neurological Institute and Jewish General Hospital, Montreal, Canada.

Participants Patients who underwent endoscopic endonasal transsphenoidal approach to skull base pathology.

Main Outcome Measures Operative time, CSF rhinorrhea, and postoperative nasal morbidity.

Results A total of 105 patients underwent the Hemi-T approach versus 40 controls. Operative time was shorter using the Hemi-T technique (180.51 ± 56.9 vs. 202.9 ± 62 minutes; $p = 0.048$). The rates of nasal morbidity (septal perforation [5/102 vs. 6/37; $p = 0.029$] and mucosal adhesion [11/102 vs. 10/39 $p = 0.027$]), fascia lata harvest (21/100 vs. 18/39; $p = 0.0028$), and postoperative CSF leak rates (7/100 vs. 9/38; $p = 0.006$) were lower in the Hemi-T group.

Conclusion Advantages of the Hemi-T approach over traditional exposure techniques include preservation of the nasal vascular pedicle, shorter operative time, reduced fascia lata harvest rates, and decreased nasal morbidity.

Keywords

- skull base
- pituitary surgery
- endoscopic endonasal
- nasoseptal flap

Introduction

The endoscopic endonasal approach has expanded the repertoire of available trajectories to many types of skull base

pathology with comparable success rates to classical open approaches.¹ One of the principal challenges of extended endonasal approaches has been mitigating the significant risk of postoperative cerebrospinal fluid (CSF) leak. The development

received

June 15, 2016

accepted after revision

September 13, 2016

published online

November 8, 2016

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Stuttgart · New York

DOI <http://dx.doi.org/10.1055/s-0036-1593816>.
ISSN 2193-6331.

and refinement of multilayered dural reconstruction techniques and pedicled mucosal flaps such as the Hadad-Bassagasteguy vascularized nasoseptal pedicled flap (HBF) have contributed to a dramatic drop in the rates of postoperative CSF leak.^{2,3} Zanation et al⁴ showed that postoperative CSF leak rates dropped dramatically from 20% to nearly 5% after using the HBF as their primary reconstructive technique. Moreover, some reports showed a decrease in postoperative infection rate (meningitis/brain abscess) from 11.5 to 2.4% following the introduction of vascularized pedicle nasoseptal flaps (NSFs) to endoscopic skull base surgery.⁴ Despite this, the HBF had some limitations, particularly for transsphenoidal approaches to pituitary tumors. For example, the possibility of an HBF has to be anticipated prior to performing a posterior septectomy, which would potentially destroy the vascular pedicle. Conversely, the routine harvesting of an NSF for all transsphenoidal pituitary operations would unnecessarily increase the associated nasal morbidity. In light of this, we have adopted a hemi-transseptal (Hemi-T) flap technique, which was described previously in a preliminary series⁵ to overcome some of the HBF limitations and minimize postoperative nasal morbidity. In this study, we report our results in a larger cohort and with longer-term follow-up data on the safety and feasibility of this surgical technique, as well as present technical refinements in the technique since our original publication.

Methods

Identification of Patients and Outcomes

We established a cohort of consecutive patients aged 18 years or older who underwent endoscopic endonasal transsphenoidal approach to pituitary adenomas and other sellar/suprasellar lesions, between July 1, 2010 and July 1, 2015. This study received approval from the McGill University institutional review board.

Our outcome measures included intra- and postoperative morbidity including CSF leak rates, fascia lata harvest rates, and patient-reported nasal morbidity. Other outcome measures

included surgical operative time and long-term appearance of the nasal mucosa, including the development of synechiae, septal perforations, and cartilage necrosis. Baseline endocrinologic and ophthalmologic assessments were performed for all patients before surgery and generally at 3 and 6 months postoperatively. All patients had magnetic resonance imaging (MRI) of the sella as well as computed tomography (CT) of the brain for intraoperative navigation purposes. Follow-up MRI was obtained 3 to 6 months postoperatively, and annually thereafter. Clinical follow-up visits with ear, nose, and throat (Susan Edionwe [SE], Marc A. Tewfik [MAT], and Anthony Zeitouni [AZ]) and neurosurgery departments (Denis Sirhan [DS] and Salvatore Di Maio [SD]) were routinely performed at 2 weeks, 3 months, 6 months, and annually thereafter in the absence of persistent postoperative issues. All patients had ENT follow-up for at least 4 months postoperatively and underwent endoscopic debridement at the follow-up visits.

Hemi-transeptal Flap Technique

The Hemi-T flap technique was described previously.⁵ Since our initial adoption of this technique, technical refinements and ancillary procedures have been developed to allow easier access through the nostril bearing the septal Killian incision, as well as a wider corridor when necessary. We now routinely hold the anterior NSF to the lateral aspect of the internal nasal valve with a horizontal mattress suture through the ipsilateral nasolabial fold (► Fig. 1). A hemostat is then used to provide gentle traction, allowing the neurosurgeon to pass instruments through the septal incision with greater ease and reducing the likelihood of snagging the incision or passing the instrument outside the transseptal corridor. At the end of the procedure, the retaining suture is cut and the septal flap is secured back onto the septal cartilage with a running mattress of 4-0 Vicryl Rapide. The hemi-T incision was done almost exclusively on the left side except in rare circumstances such as an anterior septal deviation to the right. The Hemi-T approach has now been performed on 82 patients without any complication or associated morbidity.

Fig. 1 A view of the horizontal mattress suture holding the anterior nasoseptal flap to the lateral aspect of the internal nasal valve through the ipsilateral nasolabial fold.

In addition, in instances when further lateral sphenoid exposure is required on the same side as the septal submucosal tunnel, an anterior-posterior releasing incision is performed posteriorly in the ipsilateral septal mucosa, approximately 1.5 cm below the skull base, allowing access to the sphenoethmoid recess. The inferior half of the superior turbinate and posterior ethmoid air cells can then be dissected to provide a wider corridor toward the lateral sphenoid recess.

Traditional Flap Technique

The traditional flap technique is equivalent to the “rescue flap” as described by Rivera-Serrano and colleague,⁶ in which only the superior and posterior incisions of the NSF are performed initially, reserving the inferior incision when a flap is required after tumor resection.

Statistics

Baseline characteristics, intra- and postoperative CSF leak rates, and complications were compiled on a master database, and the different approaches were compared using chi-square or *t*-test analysis with 95% confidence intervals. IBM SPSS v.23 (IBM Corp., Armonk, New York, United States) was used for statistical analysis. A *p* < 0.05 was considered statistically significant.

Results

Over a 5-year follow-up period (July 2010–July 2015), 145 patients underwent an endoscopic resection of pituitary tumor or Rathke cleft cyst (RCC), of which 105 reconstructions were performed using the Hemi-T technique. Mean age was 54.7 years (standard deviation [SD] 14.7 years), and mean follow-up for the entire cohort was 18.1 months (SD 11.3 months). Operative time when the Hemi-T approach was used was shorter than with a traditional approach (180.5 ± 56.9 vs. 202.9 ± 62 minutes; *p* = 0.048). Baseline demographic data and results and pathologic diagnoses are included in ►Tables 1 and 2, respectively.

The reconstruction technique used depended on the size of the cranial base defect and grade of CSF leak, a small flap for most cases, and a large (full size) flap for select cases. For large defects with high-flow leaks (i.e., a transtubercular approach), fat graft was placed intradurally, followed by an inlay and overlay of fascia lata, which was then covered with the right posterior septal mucosal flap. In cases where we anticipate a large dural defect such as an extended transplanum approach or more, or if there is a particularly large sphenoid sinus with deep clival recess requiring flap coverage, a full septal flap is harvested from the outset (►Fig. 2). However, for small-flow CSF leaks such as those occurring during a standard transsellar approach for pituitary adenoma were repaired either using the NSF alone or with an inlay of a small amount of fat harvested from the thigh. For higher-flow leaks fascia lata was also used in interposition. Fascia lata was harvested more frequently when the traditional approach was used (►Table 1). The rate of postoperative nasal morbidity was significantly lower in the Hemi-T group as compared with traditional approaches, based on an initial 2-week postoperative endoscopic examination in the clinic, and at last follow-up (►Table 1).

The rate of postoperative CSF leaks varied considerably between the two cohorts. Several comorbidities associated with increased risk for postoperative CSF leak and poor wound healing were identified, for example diabetes mellitus (DM), hypertension (HTN), high body mass index (BMI), and Crohn disease. ►Table 3 presents etiologies and managements of postoperative CSF leaks in both Hemi-T and traditional technique groups.

When only patients with at least 12 months' postoperative follow-up were selected, there were 62 patients from the Hemi-T group and 38 patients from traditional technique group. Mean follow-up in each group was 23.9 and 44.6 months, respectively. The rate of nasal complications in each group was not significantly different from each respective larger cohort, and the overall rate of nasal complications

Table 1 Demographic outcome data for patients who underwent the Hemi-T and traditional approaches for pituitary tumor resection

	Hemi-T	Traditional technique	
No.	105	40	<i>p</i> Value
Age	54.7 ± 14.7	53.7 ± 14.7	NS
Sex (female %)	44 (41.9)	26 (65)	
Ave. follow-up (mo)	18.13	43.5	
Operative time (min)	180.51 ± 56.9	202.9 ± 62	0.048
Intraoperative CSF leak (%)	22/100 (22)	15/40 (37.5)	NS
Postoperative CSF leak (%)	7/100 (7)	9/38 (23.7)	0.006
Fascia lata harvest (%)	21/100 (21)	18/39 (46)	0.0028
Septal perforation (%)	5/102 (4.9)	6/37 (16.2)	0.029
Cartilage necrosis (%)	0/102	1/38 (2.6)	NS
Mucosal adhesions (%)	11/102 (10.8)	10/39 (25.6)	0.027

Abbreviation: CSF, cerebrospinal fluid; Hemi-T, hemi-transseptal; NS, not significant.

Table 2 Pathologic diagnoses for patients who underwent the Hemi-T and traditional approaches for pituitary tumor resection

Pathologic diagnoses ^a	Hemi-T	Traditional technique ^b
Nonfunctioning macroadenoma	45	9
Secretory pituitary adenoma		
ACTH secreting	7	5
GH secreting [†]	14	10
PRL secreting	6	4
Multisecreting tumor NOS	2	0
FSH secreting	1	2
LH secreting	1	0
PRL and FSH secreting	1	0
PRL and GH secreting	1	0
PRL and TSH secreting	1	0
Hemorrhagic (apoplectic) pituitary tumor	8	0
Rathke cleft cyst	6	0
Craniopharyngioma	2	1
MEN1	1	0
Metastatic breast carcinoma	1	0
SUNCT syndrome	1	0
Suprasellar dermoid cyst	1	0
Unspecified ^c	0	6

Abbreviations: ACTH, adrenocorticotrophic hormone; FSH, follicle-stimulating hormone; GH, growth hormone; Hemi-T, hemi-transsphenoidal; LH, luteinizing hormone; MEN1, multiple endocrine neoplasia type 1; NOS, not otherwise specified; PRL, prolactin; SUNCT, short-lasting unilateral neuralgiform headache attacks with conjunctival injection and tearing.

^aPathologic diagnoses are not available on nine patients.

^bOne acromegaly with normal pituitary.

^cHormones secreting adenomas.

Fig. 2 **Left:** This 32-year-old man had previously underwent transsphenoidal and transcranial resection of a large pituitary macroadenoma. He presented to our hospital 2 years later with a large recurrent sellar and suprasellar tumor extending partially along the planum sphenoidale. **Right:** Status post a hemi-transsphenoidal, transtuberculum/transplanum approach and complete resection showing the extent of bony exposure and overlying nasoseptal flap.

Table 3 Etiology and management of postoperative CSF leak in patients who underwent the Hemi-T and traditional approaches for pituitary tumor resection

	Risk factor	Management
Hemi-T		
	DM and HTN	Bed rest
	High BMI (> 35) and postoperative straining	OR for repair
	Macroadenoma (3 patients with no comorbidities)	OR for repair
	Craniopharyngioma and high BMI (> 35)	OR for repair
	One patient with no comorbidities	Lumber drain
Total	7/7	
Traditional approach^a		
	DM, HTN, and bipolar disorder	Mild leak, bed rest
	DM	Bed rest
	DM	Lumber drain
	Crohn disease	Bed rest
	High BMI (> 35)	OR for repair
	High BMI (> 35)	Lumber drain
	High BMI (> 40)	Mild leak, bed rest
Total	7/9	

Abbreviations: BMI, body mass index; CSF, cerebrospinal fluid; DM, diabetes mellitus; Hemi-T, hemi-transseptal; HTN, hypertension; OR, operating room.

^aTwo patients had no identifiable risk factors treated conservatively with bed rest.

remained lower in the Hemi-T group compared with the historical control (19.4 vs. 44.7%, respectively; $p = 0.0036$). Specifically, among the Hemi-T group, four patients had septal perforation, and eight patients developed mucosal adhesions. As for the traditional technique group, 6 patients had septal perforation, 1 cartilage necrosis, and 10 developed mucosal adhesions.

Discussion

Our findings show several advantages of the Hemi-T technique. For instance, in addition to preserving the nasal vascular pedicle, we were able to achieve a shorter operative time, reduce fascia lata harvest rates, and decrease the overall nasal morbidity compared with our earlier cohort. Moreover, the routine use of vascularized septal tissue in all cases was associated with lower overall postoperative CSF leak rate that is comparable to the available literature.^{3,7}

Since it was first introduced, the endonasal approach to the skull base has provided easy and relatively safe access to most skull base pathology with decreased morbidity and mortality as compared with open cranial approach.⁸ However, this procedure is still associated with possible morbidities including optic nerve injury, hemorrhage, postoperative infection, and CSF leak. The latter remains the most common concern postoperatively, and prior to the development of the NSF, it was expected in around 20% of cases when an expanded endonasal approach (EEA) was used.^{9,10} In an attempt to control and reduce intra- and postoperative CSF leak, several methods of sellar reconstruction have been

proposed, including packing the sellar defect with autologous materials, such as abdominal fat,^{11,12} fascia graft and septal mucosa, or heterologous materials including resorbable Vicryl patches and gelatin foam,^{13,14} or fleece.¹⁵ However, these techniques have some limitations¹⁶ with no consensus on their feasibility and whether they should be supported with fixators or postoperative adjunctive management,¹⁷ making multilayered closure the current gold standard reconstructive technique.²

Several factors have been postulated to influence the choice of reconstruction including high BMI and other comorbidities,¹⁸ lesion type, size and location,^{19,20} prior transsphenoidal surgery, and, most importantly, intraoperative CSF leak, which is associated with a sixfold increase in the relative risk of postoperative leak.^{12,21} Clearly, the ultimate goal of considering a vascularized flap reconstruction of the sellar defect is to prevent postoperative CSF leak and preserve the neurovascular and ocular function.^{22,23}

In 1952, Hirsch²⁴ first described the endoscopic closure of CSF leaks using a septal flap. Since then, tremendous reports have described number of different reconstruction techniques. More recently, a vascular pedicle NSF (HBF) was developed.³ The use of this technique was associated with rapid healing and dramatic decrease of postoperative CSF leak from 20 to nearly 5% following expanded endoscopic approach, and received wide acceptance by many skull base surgeons.^{3,25} The strength of this flap lies in its rich vascular pedicle and branching. It is supplied by the posterior nasoseptal arteries, which anastomose with the ethmoidal arteries superiorly, the greater palatine artery inferiorly, and the anterior facial

artery anteriorly, adding more feasibility and reliability over other techniques.^{26–30} However, this was at the cost of increasing postoperative nasal morbidities (i.e., prolonged crusting of the donor site, septal cartilage necrosis, synechiae, and decreased olfaction).²⁵ Moreover, it has to be anticipated in advance before performing a posterior septectomy as it would destroy the vascular pedicle.

In our institution, the Hemi-T approach was adopted since 2012 and became our preferred method of reconstruction. Our long term follow-up data support our previous claims on the advantages of the Hemi-T technique that we described previously,⁵ including obtaining a binasal access to the sella for bimanual dissection without injuring the right or left vascular pedicle. Unlike the HBF, the Hemi-T does not need to be anticipated in advance; therefore, the patient is preserved from the nasal morbidity of a full-flap harvest if the decision is made not to do so. Moreover, most patients have normal-appearing nasal mucosa in early and late postoperative period.⁵ Having said that, we maintained a relatively short operative time, avoided autologous fascia lata or fat harvest in many occasions, and rarely used a lumbar drain postoperatively.

This technique is not without its limitation. For example, it is associated with slightly restricted corridor that may require more experienced team. However, this limitation can be avoided by holding the NSF with a horizontal mattress suture as mentioned earlier. Recall bias is a potential limitation to this study as well.

Conclusion

In this long-term follow-up study, we found that the Hemi-T approach is safe and effective reconstructive technique that allows for bilateral preservation of the NSF vascular pedicle and permits selective reconstruction of the sella. Moreover, by working on avascular plane, minimal bleeding is encountered; therefore, shorter operative time can be achieved.

Note

Presented at the 26th Annual Meeting North American Skull Base Society, Princess Scottsdale, Arizona, February 12 to 14, 2016.

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