

# Novel repair of high-flow skull base defects after endoscopic endonasal tumor resection using a fat-fascia lata “sandwich” graft

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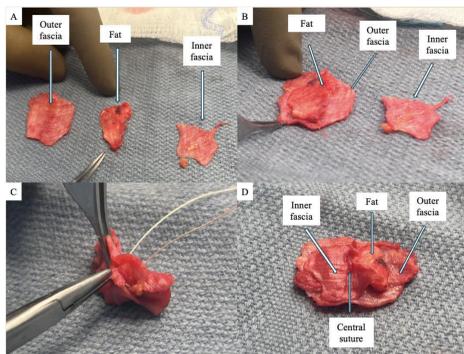
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## Background

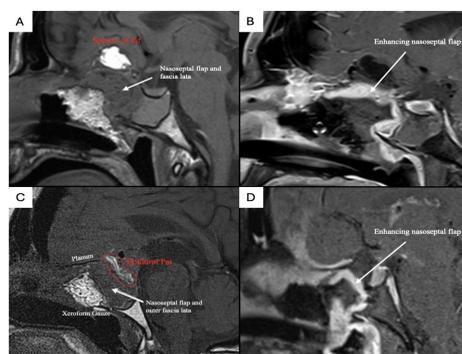
- Endoscopic skull base surgery has undergone significant advancements with respect to understanding anatomical relationships, surgical approaches, and skull base reconstruction. Surgically-created defects are increasingly challenging to reconstruct due to larger dural resections, exposure of critical neurovascular structures, communication with cisterns or ventricles, and a lack of bony edges for inlay placement.<sup>1,2</sup>
- Post-operative CSF leak rates are variable, decreasing over time, and may range from 1% to over 10% depending on defect size and location, use of a lumbar drain, surgeon experience, availability of vascularized onlay options, and various patient risk factors such as elevated body mass index (BMI).<sup>3-5</sup>
- For high-flow defects, a multilayered closure with a vascularized onlay is often necessary for proper reconstruction.<sup>6</sup> However, inlay reconstruction is highly heterogeneous, with a lack of consensus on the number of layers necessary or utility of autologous tissues versus allografts.<sup>7</sup>
- Fat is commonly used for the inlay given its ability to obliterate large dead spaces. However, there is a risk of migration and compression of neurovascular structures.
- In the present study, we report our center’s successful experience with a novel inlay reconstruction method for high flow defects, coined the “sandwich graft.”

## Methods

- This is a single-institution retrospective study comparing a change in intervention for adult and pediatric patients who underwent endoscopic repair of high-flow leaks after tumor resection using fat and fascia lata. All patients then had a vascularized flap onlay, namely the nasoseptal flap.
- Patients prior to 2020 had reconstruction with fat and fascia lata as separate free layers in the subdural and/or epidural plane. In 2020, inlay reconstruction changed to a composite “sandwich” graft of fat sutured between two pieces of fascia lata (see Figure 1 below).
- The primary outcome was the rate of post-operative CSF leak in both groups.
- Retrospective chart review performed to obtain patient demographics, medical comorbidities, surgical and skull base defect details, tumor pathology, reconstruction details, post-operative course, and information on drain, extraventricular drain (EVD), or shunt usage.
- As an evolution of the “button graft” described by Luginbuhl et al. in 2010<sup>8</sup>, a sandwich graft involves rolled compressed fat graft between two pieces of fascia lata. Fat is compressed and rolled vigorously within gauze to remove all water content. Fascia lata is cut into two pieces; the inner layer is the size of the dural defect while the outer layer is 25-30% larger than the bony defect on all sides. The 1-3 mm thick sheet of fat should be slightly larger than the dural defect. A 3-0 vicryl suture secures the fat between the fascia lata pieces in their center. (Figure 1). The inner fascia layer and fat are tucked into the subdural or epidural space depending on the defect. The outer fascia layer is then draped over bone, anchoring the graft to prevent migration or movement in the coronal plane (Figure 2).



**Figure 1**  
A). The three layers comprising the graft: larger outer fascia layer, smaller inner fascia layer, and rolled compressed fat.  
B). Fat placed between the two fascia layers.  
C). A 3-0 vicryl suture runs through each layer and back such that the knot is tied on the larger fascia side.  
D). Composite graft with all layers seen.



**Figure 2**  
A. T1 pre-contrast sagittal MRI: traditional fat sphere and fascia reconstruction used before 2020 in a patient with a planum meningioma.  
B. T1 post-contrast sagittal MRI: enhancing nasoseptal flap with traditional reconstruction in the same patient mentioned in part A.  
C. T1 pre-contrast sagittal MRI: compressed fat used in the sandwich graft after tuberculum meningioma resection.  
D. T1 post-contrast sagittal MRI: enhancing nasoseptal flap in the same patient discussed in part C.

## Results

Patient Factor	Sandwich (n = 75)	Pre-Sandwich (n = 55)	p <sup>§</sup>
Age (mean)	36.8 y (14 mo-78 y)	47.5 y (5 y-87 y)	<b>0.019</b>
Gender (% male)	40 (53.3%)	25 (45.5%)	0.478
Race			0.174
White	41 (54.7%)	37 (67.3%)	
Black or African American	14 (18.7%)	10 (18.2%)	
Hispanic or Latino	7 (9.3%)	1 (1.8%)	
Asian	3 (4.0%)	4 (7.3%)	
Other/Not Disclosed	10 (13.3%)	3 (5.5%)	
BMI <sup>†</sup> (mean)	28.2	31.5	0.009

55 patients underwent sandwich graft repair and 75 patients underwent repair with fat and fascia as separate layers before 2020.

Demographic variables were similar between groups. BMI was slightly higher in the pre-sandwich cohort (31.5 vs. 28.2;  $p = 0.009$ ).

Surgical/Tumor Factor	Sandwich (n = 75)	Pre-Sandwich (n = 55)	p <sup>§</sup>
Revision (%)	22 (29.3%)	9 (16.4%)	0.086
Tumor Pathology (%)			0.113
Meningioma	16 (21.3%)	23 (41.8%)	
Craniopharyngioma	29 (38.7%)	14 (25.5%)	
Pituitary Adenoma	10 (13.3%)	4 (7.3%)	
Pontine Cavemoma	3 (4.0%)	1 (1.8%)	
Germinoma	1 (1.3%)	1 (1.8%)	
Esthesioneuroblastoma	2 (2.7%)	5 (9.1%)	
Sinonasal neuroendocrine carcinoma	3 (4.0%)	0 (0.0%)	
Sinonasal undifferentiated carcinoma	1 (1.3%)	1 (1.8%)	
Chordoma	0 (0.0%)	1 (1.8%)	
Other <sup>§</sup>	10 (13.3%)	5 (9.1%)	
Defect Type/Location (%)			0.850
Transcribriform/Anterior cranial fossa	13 (17.4%)	11 (20.0%)	
Sellar/Tuberculum/Planum	58 (77.3%)	42 (76.4%)	
Transclival/Posterior cranial fossa	4 (5.3%)	2 (3.6%)	
Onlay (%)			0.845
Unilateral nasoseptal flap	70 (93.3%)	53 (96.4%)	
Bilateral nasoseptal flap	4 (5.3%)	1 (1.8%)	
Inferior turbinate flap	0 (0.0%)	1 (1.8%)	
Pericranial flap	1 (1.3%)	0 (0.0%)	
Peri-op CSF drainage	<b>15 (20.0%)</b>	<b>7 (12.7%)</b>	<b>0.275</b>
Post-op CSF Leak	1 (1.3%)	6 (10.9%)	0.017

Transsellar, transtuberculum, or transplanum defects were the most common (77.3% for sandwich group and 76.4% for pre-sandwich group). The rate of post-operative CSF leak was significantly lower in the sandwich cohort (1.3% vs. 10.9%;  $p = 0.017$ ). This finding remained true when performing binary logistic regression while controlling for age, race, gender, BMI, revision surgery, defect location, tumor pathology, and peri-operative CSF drainage ( $p = 0.044$ ). Five out of 6 pre-sandwich era patients with a post-operative CSF leak were adults and had tuberculum or planum meningiomas. None of these patients had a peri-operative lumbar drain, EVD, or shunt.

## Conclusions

- We demonstrate the efficacy of the sandwich graft for high-flow defects. This technique reduced our post-operative CSF leak rate from 10.9% to 1.3% ( $p < 0.05$ ) with only one leak in the last five years.
- Sandwich graft patients had a lower mean age and BMI due to a higher percentage of pediatric patients (44% versus 23.6%;  $p = 0.001$ ); This was not identified as a confounder for the reduced CSF leak rate on logistic regression analysis.
- None of the 16 meningiomas in the sandwich graft cohort had a post-operative leak. Reconstructing large suprasellar defects with significant dural resection is challenging due to critical neurovascular structures in close proximity.<sup>9</sup> Peripheral edges of a free subdural fascia layer may pull away (even if fat is placed deep to it) due to a large dead space. This may lead to early postoperative CSF seepage.<sup>8</sup> The compressed fat in the sandwich graft adds formidable bulk and wound healing properties from mesenchymal cells and fibroblasts for preventing CSF seepage even if the inner fascia pulls away.
- Pediatric patients more often presented with acute hydrocephalus from tumor mass effect, so many patients had an EVD placed prior to transfer to our institution. Most EVDs were removed within the first 48 to 72 hours post-operatively.
- Limitations: retrospective, single institution, and non-blinded design. Multiple surgeons were involved and we could not control for subtle technical differences or the learning curve of implementing the new technique.

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