

Nasoseptal flap for anterior skull base reconstruction

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The [nasoseptal flap](#) is a commonly used [surgical technique](#) in [anterior skull base reconstruction](#), particularly in the context of [endoscopic endonasal skull base surgery](#). This [flap](#) utilizes [tissue](#) from the [nasal septum](#) to provide [support](#), seal defects, and promote healing after the removal of lesions or tumors in the [anterior skull base](#).

Before the description of the nasoseptal flap in 2006, other local vascularized flaps such as the pericranial or temporoparietal fascia flaps were utilized and conveyed potentially unnecessary morbidity to patients. Reconstruction of the anterior skull base does not always require a vascularized tissue flap and can often be achieved with non-vascularized autologous or synthetic grafts. However, large skull base defects involving high-flow cerebrospinal fluid (CSF) leaks require vascularized tissue reconstruction to avoid post-operative CSF leaks and resultant complications. The nasoseptal flap utilizes mucosa based on a vascular pedicle within the nasal cavity that minimizes morbidity and maximizes success for anterior skull base surgical procedures ¹⁾.

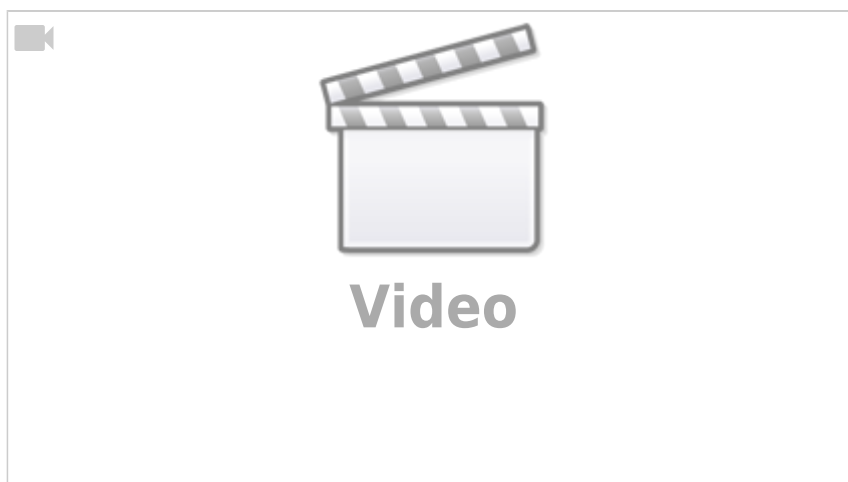
The nasoseptal flap, also known as the Hadad-Bassagasteguy flap (HB flap), was developed at the University of Rosario, [Argentina](#), and the University of Pittsburgh and was first described in 2006 ²⁾

East Asians and females had a shorter NSF length and a lower ratio of expected NSF to surgical defect lengths after anterior skull base reconstruction compared with the other races and with males, respectively. Anatomical differences should be considered when long NSF lengths are required, such as for anterior skull base reconstruction ³⁾

The management of patients with [diabetes mellitus](#), cardiovascular problems, advanced age, postoperative nasal infection, and radiation therapy may require more attention to improve NSF survival ⁴⁾.

Technique

The surgical procedure involves carefully harvesting the [nasoseptal flap](#) while preserving its blood supply. The flap is then transferred to the surgical site on the [anterior skull base](#) to reconstruct and seal defects.



Reuter et al. describe a detailed method for endoscopic harvesting and placing a [nasoseptal flap](#) (NSF). They also describe the indications and the decision process leading to the use of NSF ⁵⁾.

Protocols

A standardized surgical technique with pericranial flap as part of a multilayered reconstruction for large anterior skull base defects following resection of sinonasal malignancies is proposed, which appears to be a safe choice when endonasal flaps are not available ⁶⁾

McCoul et al. describe the effect of postoperative cerebrospinal fluid (CSF) leak after anterior skull base (ASB) surgery and complications associated with the addition of the vascularized nasoseptal flap (NSF) to an existing reconstruction protocol.

A prospective database of all patients undergoing endoscopic ASB approaches was reviewed. Patients were divided into three groups based on the date the use of the NSF was adopted. Group A included patients with high-volume CSF leak closed using the NSF in addition to a multilayer closure. Group B included patients operated on during the same time period with no high-volume leak and no NSF.

Group C included patients operated on before the adoption of the NSF with all types of CSF leak. Rates of intraoperative and postoperative CSF leak were analyzed for statistical significance.

Of 415 consecutive patients undergoing endoscopic ASB surgery, there were 96 in group A, 114 in group B, and 205 in group C. CSF leak rates in group A (3.1%) and group B (2.6%) were significantly lower than in group C (5.9%; $P < 0.05$). Lumbar drains and the gasket seal closure were performed more frequently in group A (75% and 32%) compared with group B (21% and 12%) and group C (28% and 11%). NSF carried a 2% risk of postoperative mucocele.

The addition of NSF to an algorithm for multilayer closure can decrease the rate of postoperative CSF leak ⁷⁾.

Rescue Flaps

Several traumatic and non-traumatic defects in the anterior base of the skull require incessant reconstruction to stop the leakage of cerebrospinal fluid (CSF). Reconstruction of these defects at the earliest is essential to achieve an uncomplicated recovery. Various innovations in surgical procedures are seen contemporarily in reconstructing the weaknesses in the anterior part of the skull base. Multilayer grafting techniques successfully repair minor dural defects, while significant dural defects require pedicled vascularized grafts for reconstruction. Using nasoseptal flaps (NSFs) has drastically lowered the instances of CSF leaks in significant dural defects. The rescue flap is an advancement in the approach of the NSF, which was discovered in 2011. This flap is made in a downward direction with the formation of a posterior superior incision so that it does not interfere with the mucosal flap. A small incision is made at the ostium of the sphenoid bone, which is brought into the anterior aspect of the superior nasal septum. The mucosa is elevated inferiorly through the ostium of the sphenoid bone, so some septal branch of the sphenopalatine artery is preserved. In this way, the vascular supply is protected. However, in cases of CSF leak during operations, this rescue flap is reverted into an atypical and standard NSF for reconstructing the base of the skull. This rescue flap technique gives a binaural approach to sella in a way that does not compromise the pedicle during tumor removal. This rescue flap significantly decreases the duration of care in the post-operative phase and improves the cost efficiency of the surgery by avoiding donor site morbidity ⁸⁾.

Reuse

The reuse of the nasoseptal flap represents a favorable option for skull base reconstruction in revision endoscopic anterior skull base surgery. Lee et al. demonstrated that a detached nasoseptal flap can remain viable for several days even if not immediately reattached ⁹⁾.

Reviews

Sigler et al. reviewed the available technologies and techniques, including vascularized and nonvascularized [flaps](#), synthetic [grafts](#), [sealants](#) and [glues](#), and multilayer reconstruction. Understanding which of these repair methods is appropriate and under what circumstances is paramount to achieving success in this challenging but rewarding field. A graduated approach to [skull base reconstruction](#) is presented to provide a systematic framework to guide the selection of repair

techniques to ensure a successful outcome while minimizing morbidity for the patient ¹⁰⁾

After providing a brief historical perspective, Werner et al. in a review focus on the relevant primary literature published in the last ten years. They touch upon new applications of the flap, how the flap has been modified to expand its reach and robustness, and some of the current limitations. They conclude by discussing what the future holds for improving upon the design and use of the nasoseptal flap in anterior skull base reconstruction ¹¹⁾.

Cadaveric Studies

In a cadaveric study, ASB dissection without sphenoidotomy was performed using 10 formalin-fixed and 5 fresh adult cadaver specimens, and the sufficiency of the PNSF to cover the ASB was assessed. After the sphenoidotomy, the length by which the PNSF fell short in providing coverage at the posterior wall of the frontal sinus (CPFS), and the extent of the anterior coverage from the limbus (CL) of the sphenoid bone was measured.

Results: Without sphenoidotomy, the mean length of the remaining PNSF after the coverage of the posterior wall of the frontal sinus was 0.67 cm. After sphenoidotomy, the PNSF fell short by a mean length of 2.10 cm, in providing CPFS. The CL was 1.86 cm. Based on these findings, defects resulting from an endoscopic resection of ASB tumors were reconstructed using PNSF without total sphenoidotomy in 3 patients. There were no postoperative CSF leaks or complications.

Conclusions: The use of PNSF for ASB reconstruction may be insufficient to cover the entire ASB defect after removal of large lesions which need total sphenoidotomy. When possible, by leaving some portion of the anterior sphenoid wall for supporting the PNSF, successful ASB reconstruction could be achieved in endoscopic resection of ASB tumors. Additional methods might be needed in some cases of large ASB lesions wherein the anterior sphenoid wall should be removed totally and the ASB defect is too large ¹²⁾.

Releasing the [nasoseptal flap](#) (NSF) pedicle from the [sphenopalatine foramen](#) may considerably improve flap reach and surface area.

The objectives of Shastri et al. were to quantify increases in pedicle length and NSF reach through extended pedicle dissection into the [pterygopalatine fossa](#) (PPF) through cadaveric dissections and present clinical applications.

Twelve cadaveric dissections were performed. Following standard NSF harvest, the distance from the anterior edge of the flap to the [anterior nasal spine](#) while pulling the flap anteriorly was measured. As dissection into the SPA foramen and PPF continued, similar interval measurements were completed in four stages after release from the SPA foramen, release of the internal maxillary artery (IMAX), and transection of the descending palatine artery (DPA). The extended pedicle dissection technique was performed in seven consecutive patients for a variety of different pathologies.

The mean length of the NSF from the anterior nasal spine and maximum flap reach were 1.91 ± 0.40

cm/ 9.3 ± 0.39 cm following standard harvest, 2.52 ± 0.61 cm/ 9.75 ± 1.06 cm following SPA foramen release, 4.93 ± 0.89 cm/ 12.16 ± 0.54 cm following full IMAX dissection, and 6.18 ± 0.68 cm/ 13.41 ± 0.75 cm following DPA transection. No flap dehiscence or necrosis was observed in all seven surgical patients.

Extended pedicle dissection of the NSF to the SPA/IMAX markedly improves the potential length and reach of the flap. This technique may provide a feasible option for the reconstruction of large anterior skull base and craniocervical junction defects. Seven successful cases are presented here, but further studies with larger series are warranted to validate findings in a clinical setting ¹³⁾.

Janus flap

[Janus flap](#).

Case series

Adult patients undergoing endoscopic endonasal approach (EEA) surgery of the skull base (transsellar/transplanum/transclival approaches) with NSF reconstruction were identified. Data from 2 separate cohorts, one retrospective and one prospective, were collected. Follow-up was at least 6 months. Patients were photographed preoperatively and postoperatively using standard rhinoplastic nasal views. Patients completed the University of Pennsylvania Smell Identification Test (UPSIT) and the 22-item Sino-Nasal Outcome Test (SNOT-22) preoperatively and postoperatively and were also queried regarding subjective changes in nasal appearance and plans for cosmetic surgery following EEA.

Results: There were no statistically significant differences in the change in UPSIT and SNOT-22 scores between patients receiving RSF and other reconstructive groups (either NSF without RSF or no NSF). One of 25 patients who were reconstructed with an NSF with RSF reported a change in nasal appearance; none were considering reconstructive surgery. The proportion of patients reporting changes in appearance was significantly lower in the NSF with RSF group as compared to the NSF without RSF group ($P = .012$).

Conclusion: The use of an RSF to limit donor site morbidity of the NSF was shown to significantly decrease the proportion of patients who reported nasal deformities and did not show a significant difference in patient-reported sinonasal outcomes. Given these findings, RSF should be considered whenever an NSF is used for reconstruction ¹⁴⁾.

retrospectively analyzed 703 patients with pituitary adenoma who underwent EES in our center from January 2020 to August 2022. Clinical, imaging, operative, and pathologic data were recorded from the medical records and analyzed. Skull base reconstruction was performed to achieve the following three goals: seal the original leak, eliminate dead space, provide blood supply, and early ambulation. Reconstruction was tailored to individual patients based on grade of CSF leakage encountered during surgery.

Results: The number of patients with a grade 0, 1, 2, and 3 intraoperative CSF leak was 487, 101, 86, and 29, respectively. Overall incidence of postoperative CSF leakage was 0.14% (1/703). Fascia

sutured and vascularized nasoseptal flap were selected for all grade 3 CSF leaks. One patient who experienced postoperative CSF leakage developed intracranial infection and were treated with lumbar CSF drainage that failed; eventually re-exploration surgery for repair was required. Other patients did not have complications such as CSF leak and infection. 29 patients with grade 3 CSF leakage did not complain of severe nasal complications after operation. No perioperative complications related to the strategy (overpacking, infections, or hematomas) occurred. Incidence of postoperative CSF leak according to intraoperative leak grade was as follows: grade 0, zero; grade 1, zero; grade 2, 1.16% (1/86); and grade 3, zero.

Conclusion: The principles of sealing the original leak, eliminating dead space, providing blood supply, and early ambulation are key in skull base reconstruction after EES. Individualization of these principles can significantly reduce the incidence of postoperative CSF leakage and intracranial infection and reduce the use of lumbar CSF drainage. Skull base suture technique is safe and effective in patients with high-flow cerebrospinal fluid leaks ¹⁵⁾.

Nasoseptal flap reconstruction is a widely accepted method for reducing cerebrospinal fluid (CSF) leakage following endoscopic transnasal surgeries (ETSs). However, this method is associated with nasal complications and has difficulty in repeatedly applying for recurrent cases. Therefore, alternative methods are needed.

METHODS: Layers of autologous fascia lata were placed on the inside and outside of the dural defect to sufficiently cover it, and the grafts were compressed with an inflated balloon. A lumbar drainage system with a pressure-control valve was used for 72 hours postoperatively. We retrospectively analyzed data on patients with skull base lesions showing intracranial extensions that required wide opening of the ventral dura in ETS. Fifty cases (47 skull base tumors and 3 others) were included, in which 28 were recurrent cases.

RESULTS: In 21 cases (42%), the nasal septum was not intact because of the previous ETS. Seventeen patients (34%) had a history of radiotherapy and 9 (18%) had undergone multi-session radiotherapies. None of the 50 patients required additional surgery for postoperative CSF rhinorrhea, while 2 had intermittent CSF leakage that resolved with prolonged lumbar drainage placement for a week. Prior multi-session radiotherapy was the only significant risk factor for the need of prolonged drainage ($p = 0.029$).

The multi-layer closure method with pressure control spinal drainage system is a simple, safe, and effective method for preventing postoperative CSF leakage, which can be readily applied for the dural defects in any parts of the skull base regions and for patients with various conditions ¹⁶⁾.

2017

A retrospective radioanatomic analysis was conducted in 100 Korean adult patients. Septal and skull-base dimensions were measured and the feasibility of the NSF in reconstructing a full anterior skull-base defect was evaluated. Scans of 49 white patients were analyzed for a comparative study.

Among various septal dimensions, the length of the septum was significantly different in Koreans when compared to whites. Skull-base dimensions such as anterior skull-base length and width at the

level of the anterior ethmoidal artery were different between the 2 ethnic groups. Individual differences between the anterior width of the hypothetical NSF and the anterior margin of the skull-base defect (2.8 ± 3.1 vs 6.4 ± 4.8) and the difference between the hypothetical NSF length and the length of the flap needed for full coverage of the defect were significantly smaller in Korean patients (7.2 ± 3.8 vs 13.1 ± 5.6), leading to a statistically higher chance of flap insufficiency. The insufficiency was more often found in female patients.

The risk of NSF insufficiency for covering the anterior skull-base defect in Koreans is higher relative to whites, and is accentuated in female patients. Efforts to increase the size of the NSF as well as efforts to avoid intraoperative shrinkage of the NSF should be considered to compensate for the relatively small NSF in Asians ¹⁷⁾.

A prospective study of 13 patients was done, who underwent endoscopic skull base surgery with reconstruction using the Hadad-Bassagasteguy flap. Pre-operative MRI was done to assess the size, extent and location of the lesion and a postoperative MRI was done to evaluate flap configuration, enhancement patterns, location, flap thickness and signal intensity characteristics.

The postoperative MRI of all patients showed a detectable flap covering over the skull base defects forming an "open cup" appearance. They were uniformly isointense on T1-weighted/ fat suppressed images to the adjacent nasal mucosa and hyperintense on T2-weighted images. On the MRI scans done after four weeks, all 13 of our patients had enhancing flaps. One flap migrated slightly to the left side; however, there was no Cerebrospinal Fluid (CSF) leak.

Vascular pedicle nasoseptal (Hadad) flaps are being widely used. MRI is a very useful tool in assessing the viability of the flap postoperatively and to evaluate for variations that may suggest potential flap failure ¹⁸⁾.

2014

In four cases in which the HBF was successfully used to repair recurrent CSF leaks despite prior posterior septectomy and transsphenoidal surgery.

Two were men and two were women with a mean age of 37 years (range, 24-48 years). All had previously undergone resection of a pituitary macroadenoma via a transsphenoidal approach, with intraoperative CSF leaks repaired using multilayered free grafts. Recurrent CSF rhinorrhea arose 0.37-12 months (mean, 2.98 months) after the initial pituitary surgery. Active CSF drainage could be visualized intraoperatively with posterior septal perforations present. The HBF was successfully used in all cases, with no evidence of recurrent CSF leak after a mean follow-up of 2.35 years. The HBF may be salvaged for repair of recurrent CSF leaks even in the context of prior posterior septectomy and transsphenoidal surgery. However, longer follow-up is necessary to determine the long-term efficacy of this procedure in such revision cases ¹⁹⁾.

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