

INNOVATIVE ENDOSCOPIC SOLUTION FOR CSF LEAK REPAIR USING MIDDLE TURBinate AND HADAD-BASSAGASTEGUY FLAP

Otorhinolaryngology

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ABSTRACT

Background: This case series documents a new method of CSF leak repair done at a tertiary ENT centre in South India. In the study period of 2 years, 200 FESS cases were done. In sinus surgery, if the skull base is extensively eroded due to the disease process, this may often lead to a leak of cerebrospinal fluid from the skull base defects during the surgery process, and there are also several cases of idiopathic CSF leaks. Thus, an effective management issue arises with leaks. These CSF leaks may be challenging to repair, and therefore techniques are indispensable to prevent all forms of harm to patients, resulting in long-term good outcomes. **Study Design:** Prospective case series over two years involving 200 patients undergoing functional endoscopic sinus surgery (FESS). Four cases with CSF leaks (three intraoperative, one idiopathic) were repaired using an endoscopic technique combining resected middle turbinate bone with a Hadad-Bassagasteguy flap and resected middle turbinate. Patients were followed for two years to assess outcomes. **Study Setting:** Single tertiary care otorhinolaryngology center in southern India, serving as a regional referral hospital with advanced endoscopic surgical capabilities. Participants- 200 patients undergoing functional endoscopic sinus surgery (FESS). Four cases with CSF leaks. Method- In 200 total procedures, CSF leaks were identified in three patients intraoperatively. The Hadad-Bassagasteguy flap with resected bone from the middle turbinate of the patient obliterated each leak. One idiopathic CSF rhinorrhoea with a meningocele was treated by the same technique, sealing the defect by placing resected and reshaped part of the middle turbinate bone and overlapping it entirely with the Hadad flap. No synthetic materials or free grafts were needed. All repairs were done in the least invasive manner using endoscopy. **Results:** All CSF leaks in this series healed without recurrence (0% recurrence), with a two-year follow-up period. This technique of closing CSF leak is safe and minimally invasive, with successful outcomes and no complications. There were no complications for the patients regarding the partial resection of the middle turbinate; therefore, they had an excellent recovery, without any signs of infection or worries of the graft's displacement. **Conclusion:** This case series highlights the simplicity and effectiveness of the Hadad-Bassagasteguy flap combined with resected middle turbinate bone in the treatment of CSF leak repair. The resected middle turbinate will provide additional support to the Hadad flap. This is a minimally invasive procedure that can avoid the use of additional grafts for patients, thereby reducing the morbidities associated with additional grafts and minimizing possible complications. More importantly, this method provides more reinforcement to the Hadad-Bassagasteguy flap in cases with high intracranial pressure. This newer method has resulted in sustained strong outcomes even after two years of follow-up.

KEYWORDS

Cerebrospinal Fluid Leak, Endoscopic Skull Base Repair, Hadad-Bassagasteguy Flap, Middle Turbinate Bone Graft, Minimally Invasive Surgery

INTRODUCTION

With the invention and more practical application of the Endoscope in Rhinology, Cerebrospinal fluid repair has advanced from open-invasive approaches to trans nasal endoscopic approaches. That circumvents the traditional side effects of frontal craniotomy methods, including anosmia, intracranial hemorrhage or edema, seizures, memory impairments, and behavioral disorders. This has reduced morbidity, shortened hospital stays, and sped up return to work, which has reduced indirect costs.(1)

Cerebrospinal fluid leak can result from congenital and acquired causes. Acquired causes are again classified into Idiopathic, traumatic, inflammatory, and neoplastic causes. It requires prompt methods of repair to prevent further complications like meningitis and pneumocephalus. Accidental skull base injuries are the typical reason behind CSF leaks during functional endoscopic sinus surgery.

The principle of Functional endoscopic sinus surgery is to restore the Paranasal sinus function by re-establishing the physiological pattern of ventilation and mucociliary clearance. From traditional external approaches and direct headlight-assisted sinus procedures to functional endoscopic sinus surgery have happened over the past three decades. The innovative concept of preferential mucociliary drainage pathways where secretion is drained towards the natural ostium despite any surgical openings further created has a great impact. The complication rate has been studied thoroughly and found that CSF leak after SCS trials is around 0.2-3%, although it appears rare, it is significant when put against any minor risk of major complication as well (2). Despite this, the procedure is still considered to be relatively safe due to its low rate of complications.

There are various techniques described for repairing CSF leaks, including free grafts, synthetic materials, and fibrin glue. Recently

Hadad-Bassagasteguy flap which was originally developed as a vascularized naso-septal flap for skull base reconstruction, has gained preference because of its ability to achieve reliable outcomes and healing through vascularization. Hadad-Bassagasteguy flap is a neuro-vascular pedicled flap derived from the mucoperiosteum and mucoperichondrium of nasal septum, which is supplied by the naso-septal artery, which is a branch of the posterior septal artery, which is in turn a terminal branch of internal maxillary artery (3). Nevertheless, in cases of CSF leaks with significant bony defects, this flap alone may be insufficient. Hence, it is essential to make reinforcements in the form of grafts- (natural or synthetic), middle turbinate flap, and free dural grafts. In this study, we replace these conventional graft materials by partially resected middle turbinate bone.

In this current case series, we present our experience with 200 cases of functional endoscopic sinus surgery in which three of which were found CSF leaks intraoperatively and one another case of idiopathic CSF leak with meningocele. These leaks were repaired using the Hadad-Bassagasteguy flap along with resected bone from the middle turbinate, thereby eliminating the need for additional graft materials. This technique ensures a successful reinforcement to the Hadad-Bassagasteguy flap by endoscopic method and minimizes the complications and recovery time.

RATIONALE

There is a vast variety of grafting materials and techniques used to get the best results in skull-based reconstructive surgeries. Available natural grafts include fascia latae, adipose tissue, and septal mucosa (4) while the synthetic options are DuraGen, Teflon, and collagen matrix(5) these synthetic materials are reported to be viable alternatives. In certain cases, middle turbinate flaps may prove beneficial, and even more complex reconstructions may benefit from adding free dural grafts(6). However, there are some drawbacks

associated with these alternative methods. The biggest problem is graft rejection and donor site morbidity as additional wounds increase the risk of scarring, infection, or other complications. Furthermore, these techniques require considerably more time, often lack adequate structural reinforcement, and carry a higher risk of infection.

This new enhancement of the Hadad flap eliminates the need for synthetic or free grafts. An excised portion of the middle turbinate bone along with its periosteum and mucosa is utilized to reconstruct this tissue to match the defect, thus effectively sealing it with a more cohesive and biologically integrated alternative. The combined method offers the best result compared to using the Hadad flap alone or the Hadad flap with other free grafts. Being applied directly at this defect site reduces the requirements for secondary grafts and also minimizes donor-site morbidity. Also, the presence of the perichondrium and mucosal layer in the resected middle turbinate bone will speed up the biological integration to the skull base. In addition to that, it avoids the use of synthetic materials and free grafts, so the chances of infection, rejection, and displacement are less. As an endoscopic technique, it is a minimally invasive procedure, thus avoiding the need for further incisions, hence offering a more efficient and patient-centered methodology.

OBJECTIVES

1. To assess the effectiveness of a minimally invasive endoscopic technique combining the Hadad-Bassagasteguy flap with resected middle turbinate bone for the repair of cerebrospinal fluid (CSF) leaks.
2. To evaluate the clinical outcomes and safety profile of this method, including recurrence rates and postoperative complications over a two-year follow-up period.

MATERIALS AND METHODS

The accurate identification of the size and characteristics of bony defects is of utmost importance for the effective treatment of CSF leaks. Its long-term successful outcome requires a proper understanding of the dimensions and locations of the defect, as this helps tailor the grafting procedures and flap placement to suit every individual's anatomy. A preoperative CT cisternogram using iohexol makes this step easier. We can also use T2 weighted MRI, though it's less specific. In addition to that, High resolution computed tomography of paranasal sinuses can identify the defect, but cannot identify active leaks (7). Hence, it's not recommended. Furthermore, under general anesthesia, intraoperatively endoscopic visualization is used to assess the defect and extent of the CSF leak. It guides the subsequent steps and ensures our restorative structures are placed correctly. After identifying the defect, the middle turbinate needs to be harvested, we have to resect the anterior end of the middle turbinate bone and reshape the resected bone to fit the bony defect. This is done after infiltration of 1% 1 in 100,000 lignocaine with adrenaline solution into the anterior end of the middle turbinate, then a vertical incision put on the anterior end, elevate the mucous flap and resect anterior end of the middle turbinate bone, ensuring both the periosteum and part of mucosal layer taken along with the middle turbinate. Then reposition the mucosal flap of the middle turbinate to its original position. This method provides a significant advantage as it offers a graft that is biologically compatible as well as structurally robust.

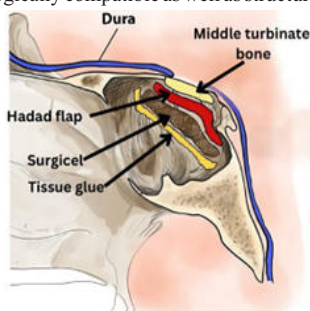


Figure i- Diagrammatic Representation Of Post Operative State

Part of the middle turbinate bone is used as a local source of grafting to eliminate the need for any additional grafts from distant areas. It also reduces the complications associated with harvesting from alternative donor sites. Following this technique, reduces patient morbidity, minimizes the risk of infection, as well as maximizes the success rate of the surgery. After taking the piece of middle turbinate bone, the next focus of attention should be on shaping and positioning it over the

defect. This is then carefully trimmed and contoured to ensure precise fit so that there is maximum stability and coverage. This is an overlay technique where the reshaped bone is placed caudally to the defect within the nasal cavity and its edges overlap the defect to provide optimal structural coverage. This method has many advantages, mainly in enhancing the mechanical strength of the repair, as it distributes structural load associated with elevated intracranial pressure and minimizes the chance of graft displacement.(fig. 1)

More than that, the periosteal layer foster stability by enhancing the addition of tissue to the adjacent mucosa so that it facilitates the natural healing and integration of graft. As Next step, Hadad flap is advanced over the middle turbinate bone graft. Hadad flap is highly vascularized and it reinforces the bone graft with additional support, hence this becomes a combined layered repair mechanism which is double strengthened, maximizing stability and aiding the healing process. The vascularization of the Hadad flap reduces the chances of infection as well as promotes the long-term success of graft integration.

Then Surgicel is palced below to the Hadad flap layer. Surgicel is a hemostatic agent which helps control any minor bleeding and also reinforces the graft by inducing fibrosis. We used this to ensure the integrity of the repair. Surgicel's absorptive properties also aid in stabilizing the graft during the early postoperative period. More than that, a layer of fibrin glue can be applied over the grafted region which firmly secures both the bone graft and Hadad flap placed. It enhances the stability of the repair. Fibrin glue is particularly useful for supporting hemostasis as well as encouraging adhesion, reduces the likelihood of displacement due to motion or pressure change. B/L nasal cavity is packe for 48 hours, And the patient is discharged after 24 hours of pack removal.



Figure ii Post Operative Picture Of Remanent Of Middle Turbinate

SUMMARY

This method leverages the benefits of using the patient's resected middle turbinate bone with the Hadad flap to ensure a stable and biologically coherent repair. The addition of Surgicel and fibrin glue enhances closure, making a strong, secure seal, providing the structural and biological demands that are required for CSF leak repair. This method enhances the success rate, reducing the risk of infection, and giving a minimally invasive solution which is both effective and safe.

Case Study

Case 1

A patient in their 40s with chronic rhinosinusitis underwent functional endoscopic sinus surgery for nasal polyposis. A CSF leak was identified at the ethmoid roof near medial lamella intraoperatively. The middle turbinate bone was harvested, and placed in the defect, and the Hadad flap was placed over the middle turbinate bone. Tissue glue was applied on top of surgicel to ensure the repair. The patient had an uneventful postoperative recovery without any recurrence of CSF rhinorrhea during follow-up.

Case 2

An adult patient presented with a history of watery nasal discharge. CT imaging was done, which showed a skull-based defect associated with a meningocele(fig.iii). The defect was covered with the bone graft harvested from middle turbinate and the Hadad flap. The surgicel and tissue glue were used to reinforce the repair. There were no signs of CSF leak after surgery.

Case 3

An adult patient with a history of chronic rhinosinusitis and nasal polyps underwent functional endoscopic sinus surgery. During the surgery, a skull-based defect was identified in the posterior ethmoid

roof. This defect was partially covered with a bone graft obtained from middle turbinate and a Hadad flap. The flap was placed superiorly. To seal the closure, surgical glue and medicated gel foam were used. The patient made an excellent recovery and remained asymptomatic on follow-up.



Figure iii skull base defect in anterior cranial fossa

★ - Skull base defect

Case 4

A patient in their 20s with a deviated nasal septum and bilateral nasal polyposis underwent functional endoscopic sinus surgery. During the procedure, skull-based dehiscence was noted, and the CSF leak was repaired by placing the middle turbinate over the defect. The Hadad flap was then applied, and surgical and tissue glue were used to reinforce the closure. The patient remained symptom free during follow-up.

RESULT

In this study, Cerebrospinal Fluid leaks were treated successfully using part of resected reshaped middle turbinate and Hadad flap without the use of any additional graft material. No post-operative complications were noted in those cases and there was no recurrence of CSF rhinorrhoea in the two-year follow-up period.

In three cases of intraoperative CSF leaks, that were identified during functional endoscopic sinus surgery. Those were repaired using middle turbinate bone overlay method, followed by the Hadad flap. One case involved idiopathic CSF rhinorrhea with a meningocele was also treated successfully using the same approach. This combination of middle turbinate bone and the Hadad flap demonstrated high reliability and effectiveness in the repair of CSF leaks, yielding excellent long-term outcomes.

DISCUSSION

The aetiology of CSF leaks can broadly be divided into congenital and acquired causes. Congenital causes can include meningocele, meningoencephalocele, congenital skull base defects, and congenital hydrocephalus. Acquired causes can be idiopathic, traumatic, inflammatory, or neoplasm. The most common traumatic causes are Road traffic accidents and iatrogenic injury, commonly during FESS and trans nasal intracranial approaches. The incidence of CSF leaks in our case series during functional endoscopic sinus surgery was 1.5%. This incidence aligns with rates reported in the literature (3).

Intra operative CSF leak should be closed in the same sitting itself, provided the leak is significant. In case of small skull base dehiscence with no active CSF leak, we can try conservative methods such as medical management to reduce intracranial pressure, reduce CSF production, stool looseners, meningococcal vaccines, and lifestyle modifications.

In idiopathic CSF leak, the diagnosis can be made by proper history, beta-2 transferrin assay of nasal discharge, and radiological studies including CT Cisternography and/or gadolinium-enhanced MRI and for small inactive leaks isotope study using Indium can be used.

Surgical interventions for CSF leaks are indicated in cases of

- chronic CSF leak
- Recurrence of CSF leak
- Persistent CSF leak after 10-14 days, not responding to medical therapy.

The approaches for CSF leak repair can be intracranial and extracranial(transnasal). In the new era of endoscopes, and high-definition camera equipment, the transnasal approaches have a significant role in CSF leak repair,

In case of a CSF leak, it's critical to have prompt techniques to avoid serious complications such as meningitis and pneumocephalus. Various methods like free grafts and synthetic materials have been described to repair these skull base defects. Many of these materials are often associated with complications such as graft rejection, meningitis, the need for secondary incision hence increasing morbidity.

For the large skull base defects and cases with high intracranial pressure, the use of hadad flap alone may be structurally inadequate which causes surgical failure. However, the combination of Hadad flap and resected middle turbinate bone is more effective and efficient than using the Hadad flap and other artificial grafts alone. Part of middle turbinate bone with periosteum and mucosal layer can induce more quicker biological adhesion to skull base and more fibrosis. Middle turbinate bone is located adjacent to the surgical site hence a minimally invasive endoscopic approach can be used, eliminating the need for secondary open surgical exposure for grafts. Also, the Hadad flap involves healing capabilities, which are quite useful for its application in the skull base.

Another important feature is that no synthetic grafts were used in any of our cases. Instead, the middle turbinate bone was used in an overlay technique. Then, along with the Hadad flap, Surgicel and tissue adhesives, are used for reinforcement. This simplified approach presents several benefits:

The necessity for procuring supplementary grafts is eliminated, thereby preventing additional scars.

The middle turbinate is nearby and so is accessible, with reducing the operative time. The entire procedure is conducted via endoscopy, thereby minimizing patient morbidity.

The CSF leaks were adequately sealed, even with non-payable grafts.

This study shows that the combined method involving resected middle turbinate bone with the Hadad flap is a very effective, minimally invasive approach for treating CSF leaks and skull base defects. It also avoids the use of synthetic or free grafts, which in the patients would have fewer complications thereby improving recovery.

CONCLUSION

All the Cerebrospinal fluid leaks are closed by combining the reshaped resected middle turbinate bone with the Hadad-Bassagasteguy flap. The whole procedure does not involve any use of artificial grafts, which helps for speedy recovery and reduce morbidity. The entire procedure was done noninvasively using an endoscopic approach. There were no reports of recurrence of CSF rhinorrhea or postoperative complications during the follow up period of two year. This method simplifies the repair process and provides durable, effective results using the combination of middle turbinate bone with a vascularized Hadad flap. It is a reliable, minimally invasive procedure for the effective repair of CSF leaks while also eliminating the need for synthetic or free grafts and minimizing surgical trauma and associated complications.

This method is recommended for adoption in similar clinical settings as it offers safe and effective solutions for managing CSF leaks and skull base defects.

Compliance With Ethical Standards

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This paper not included any Research involving Human Participants and/or Animals.

Informed Consent form is attached with the documents.

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