Endoscopic Endonasal Multilayer Repair Of CSF Rhinorrhea With Utilization Of The Middle Turbinate Rotational Flap

M A El-Ahl, I Elnashar, M W El-Anwar, M G Ammar, A Hessen

Citation

M A El-Ahl, I Elnashar, M W El-Anwar, M G Ammar, A Hessen. *Endoscopic Endonasal Multilayer Repair Of CSF Rhinorrhea With Utilization Of The Middle Turbinate Rotational Flap*. The Internet Journal of Neurosurgery. 2016 Volume 12 Number 1.

DOI: 10.5580/IJNS.36962

Abstract

Background: In recent years, many techniques for endoscopic closure of CSF leaks have been described and almost completely replaced the more traumatic transcranial and extracranial procedures.

Aim of work: To evaluate endoscopic endonasal multilayer repair of CSF rhinorrhea of anterior and middle cranial fossae utilizing the vascularized middle turbinate rotational flap.

Patients and methods: The study included 25 patients who were admitted to the Otorhinolaryngology and Neurosurgery Departments of Zagazig University Hospitals in the period from March 2008 to July 2011. All the patients suffered from CSF leaks of different etiologies with failure of conservative treatment. An endoscopic endonasal multilayer repair utilizing the middle turbinate rotational flap was used for repair of the CSF leak in all patients.

Results: This study included 25 patients; 11 females (44%) and 14 males (56%). The age of patients ranged from 17 to 65 years with a mean age of 41 years. The etiology of CSF rhinorrhea was traumatic in 18 patients (72%) and non traumatic in 7 patients (28%). The success rate of endoscopic multilayer repair of CSF rhinorrhea at the first attempt was 92% and with the second attempt increased to 100%.

Conclusion: Endoscopic repair of CSF rhinorrhea utilizing the middle turbinate rotational flab provides a better field of vision , accurate positioning of the graft, safe and effective technique with preservation of nasal and neurological function.

INTRODUCTION

Cerebrospinal fluid (CSF) rhinorrhea, classically described as the leakage of CSF from the nose, indicates an opening of arachnoid and dura with an osseous defect leading to a communication of subarachnoid space with the nose (1).

The etiology of CSF leaks can be categorized into 2 main groups: traumatic and nontraumatic. Traumatic leaks are subdivided into accidental (blunt or penetrating) or surgical. Trauma causes 70-80% of all cases of CSF rhinorrhea (26) and can lead to transient or permanent CSF leaks. The onset of non-surgical traumatic CSF rhinorrhea is variable. It can be classified as immediate (within 48 hours) or delayed. Most patients with CSF leaks secondary to non-surgical trauma present immediately. In contrast, only 50% of patients with iatrogenic CSF leaks present within the first week (19).

Non traumatic CSF rhinorrhoea causes include high-pressure and normal-pressure leaks. High-pressure CSF rhinorrhea is mainly caused by tumor obstruction, benign intracranial hypertension or hydrocephalus. Normal pressure leaks result from bony erosion by tumor, tumor treatment with radiation, meningoceles, etc…. Spontaneous CSF leaks are idiopathic or unknown in origin (26).

The site of skull-base defect ultimately determines the specific surgical approach. The preferential CSF leak sites are the roof of anterior or posterior ethmoid, the olfactory groove, the roof or the lateral wall of sphenoid sinus and the posterior wall of frontal sinus (13).

Treatment options can be conservative or surgical. The majority of acute post accidental CSF leaks heal spontaneously with conservative management; including bed rest, elevation of the head, avoidance of straining activities, fluid restriction, diuretics or with external CSF drainage (25).

Surgical repair is indicated for patients who do not respond to conservative measures, patients who have traumatic CSF leaks associated with extensive intracranial injury, patients whose CSF leaks are identified intraoperatively (e.g. during endoscopic sinus surgery or skull-base surgery) and with non-traumatic etiologies (tumor or congenital) (8).

Surgical repair may be achieved transcranially through a bifrontal craniotomy, extracranially through an external ethmoidectomy or osteoplastic flap, or transnasally with microscopic or endoscopic visualization (31,9).

In recent years, the popularity of endoscopic closure of CSF leak has continually increased and has almost completely replaced the more traumatic transcranial and extracranial procedures (14,9).

The endoscopic technique offers a direct access, good illumination, angled view, different magnification, exact identification of the site of the dural tear and precise placement of the graft. It permits preservation of the functional anatomy of the nose including smell (16, 9). In addition, it offers shortened operating time in conjunction with success rates of 90% after primary attempts and 97% after secondary repair (8, 9).

Almost all defects in the anterior skull base are amenable to endoscopic repair. However, external approaches are still mandatory in the presence of intracranial lesions, comminuted fractures of the cranium base, fractures of the posterior wall or lateral extensions of the frontal sinus (13).

Several grafting materials (autogenic orallogenic), and placement techniques (overlay, underlay, or multilayered) have been developed and discussed for management of CSF leaks (13).The aim of this work was to investigate the success of endoscopic multilayer repair utilizing the middle turbinate rotational flap in closure of CSF leaks that failed conservative measures.

PATIENTS AND METHODS

This study was carried on 25 patients suffering from cerebrospinal fluid rhinorrhea. They were managed at Departments of Otorhinolaryngology and neurosurgery at Zagazig University Hospitals between March 2008 and July 2011. The CSF leak was confirmed by history, nasal endoscopic examination, chemical analysis of the fluid and imaging including high resolution CT, MRI and in some cases CT metrizamide cisternography (7 cases).All patients underwent endoscopic repair of CSF rhinorrhea with multilayer technique utilizing a middle turbinate rotational flap.Intrathecal fluorescein injection was undertaken one hour prior to surgery in all patients. 0.1 ml of 10% fluorescein in 10 ml of the patient's own CSF was injected intrathecally and the patient was positioned 10 degrees head down to allow diffusion of the dye to reach the site of the defect.

Surgical technique:

All surgeries were performed under general anaesthesia. The patient was placed in the supine position with the head elevated and slightly turned towards the surgeon. The surgeries were performed by a team that consists of a neurosurgeon and a rhinologist. A combination of 0º and 30º and 45º rigid endoscopes were used throughout the procedure.

The extent of the operation was based on the site of the leak. For lesions of the ethmoid roof, a complete anterior and posterior ethmoidectomy was first performed with exposure of the skull base and frontal recess area. Sphenoidotomy was performed in cases where the suspected area of bony dehiscence was in the sphenoid sinus or diaphragmasella. A septoplasty and/or turbinoplasty were performed if surgical exposure was limited by a septal deviation or significant inferior and/or middle turbinate hypertrophy. All removed tissues were saved for subsequent use as graft material.

Great care was taken to precisely identify the site of the dural tear. In most cases, the dural defect was obvious on endoscopic examination and the CSF appeared as a yellowish-green fluid with the ordinary light source. However, if fluorescein could not be seen initially, certain intra-operative maneuvers, such as the Valsalva'smaneuver or lowering the head of the patient for few minutes were performed to increase the CSF pressure and allow further enhancement of CSF leakage.

Once the site of the leak was identified, the mucosa surrounding the edges of the defects was removed for a 3- to 5-mm margin of exposed bone with small-cupped forceps or diathermy (bipolar or low-watt monopolar) to facilitate the adhesion of the graft to the underlying bone. A piece of free graft (septal cartilage or bone) was prepared to be approximately 1 to 2 mm larger than the skull base defect.

The first layer was a piece of cellulose dressing (surgicel) or gelfoam placed through the defect and draped against the Dura. Next, harvested septal or ethmoidal bones or cartilages were fashioned to be slightly larger than the defect and placed intracranially against the first layer. The edges of the graft were tucked between the dura and the intracranial aspect of the bony defect margins forming a rigid scaffold for brain to rest on. The next layer was another piece of cellulose dressings (surgicel) or gelfoam, which was positioned over the bone/cartilage graft. Grafts were anchored to the skull base with administration of tissue adhesive (cyanoacrylates "histoacryl").The middle turbinate was pedicled over its posterior end by separating it from the skull base using sharp scissors, and the pedicled middle turbinate was rotated to cover the defect and the exposed surrounding skull base bone. The repair was reinforced with gelfoam and non-absorbable packing (Merocel tampon or antibiotic soaked gauze) to help apply pressure to the graft site.

Postoperative care:

After the procedure, the patients were kept on a regimen of complete bed rest with head of the bed elevated 45º for at least 3 days. Intravenous antibiotics were given for 7 to 10 days. The blood pressure of the patients was kept on the hypotensive side around 90/60 mmHg by giving the patients furosemide or cidamex as a diuretic to decrease CSF production and pressure.Stool softeners and anti-tussive medications were given as necessary in order to decrease pressure on the graft site.Non-absorbable packing was removed 5-7 days after the surgery.Patients were requested to avoid nose blowing for 8 weeks and strenuous exercise was forbidden for 6 months.Gradual endoscopic debridement of the nose was performed weekly over 4 weeks. All nasal donor sites were carefully cleaned to avoid crusting. The final position of the closure material was assessed endoscopically during the subsequent postoperative visits.

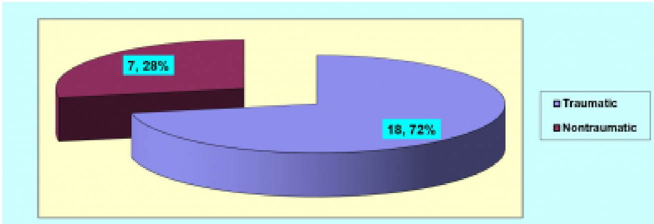
RESULTS

This study included 25 patients; 11 females (44%) and 14 males (56%). The age of patients ranged between 17 years to 65 years with a mean age of 41 years. The etiology of CSF rhinorrhea in our cases was traumatic in 18 patients (72%) and non-traumatic in 7 patients (28%).

In the traumatic group, 11 patients (61.1%) had accidental trauma and 7 patients (38.9%) developed the leak post surgically. In postsurgical cases, 3 patients underwent endoscopic trans-sphenoidal hypophysectomy for resection of pituitary adenomas, 2 patients underwent endoscopic resection of squamous cell carcinoma of the lateral nasal wall extending to the skull base, one case of fungal rhinosinusitis and one case of diffuse sinonasal polyposis.In the non-traumatic group (7 cases), the etiology in 6 cases (85.7%) was spontaneous and one case (14.3%) was ethmoidal meningocephalocele.

Chart 1

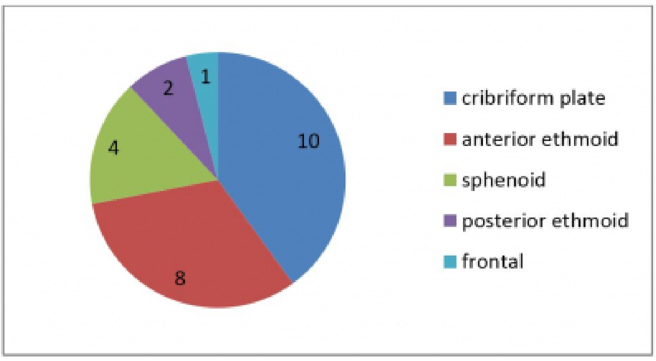
Etiology of CSF rhinorhoea



CSF leak was from right side in 15 cases (60%) and from left side in 10 cases (40%). The sites of the fistulas were the cribriform plate in 10 cases (40%), anterior ethmoid in 8 cases (32%), sphenoid in 4 cases (16%), posterior ethmoid in 2 cases (8%) and frontal sinus in one case (4%).

Chart 2

Sites of skull base defects in 25 patients of CSF rhinorrhea



Multilayer technique was performed in all cases either traumatic or non-traumatic,Septal bone from the vomer or perpendicular plate of ethmoid bone was used in 14 cases (56%), while septal cartilage was used in 11 cases (44%). Rotational middle turbinate flap was used and Histoacryl was added in all cases.

Postoperative follow up varied from 6 to 36 months (mean, 21 months). No patients developed any major complications (meningitis, pneumocephalus, intracranial bleeding or vision problems). Minor complications were recorded in 3 cases (12%); one case with nasal adhesions, one with hyposmia and one with septal perforation.

In this study, complete closure of the leak was achieved in 23 patients (92%) after the 1st attempt while, 2 patients (8%) required revision surgery to achieve closure. The first was a 25 years old female with spontaneous CSF leak. The actual site of the defect was difficult to be detected intraoperatively, the graft was placed over the suspected area and she was pregnant 3 months. The second case was a 56 years old hypertensive male with posttraumatic CSF leak and a large defect(about15 mm). There was difficulty in controlling the hypertension and the patient did not follow the postoperative advice completely. Both patients had a successful 2nd endoscopic closure with no further recurrence of the leak during the follow-up period.

Figure 1

Coronal CT scan showing left lateral lamella bony defect

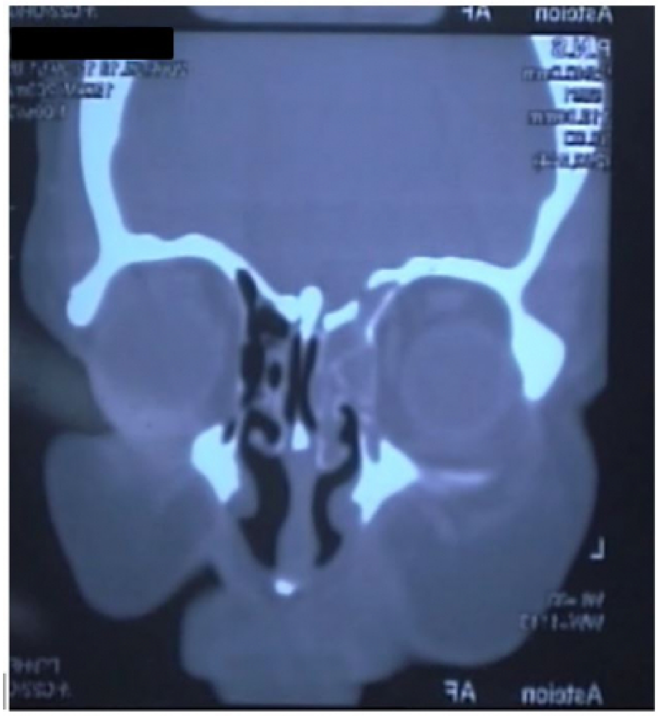


Figure 2

(A) Coronal CT scan showing soft tissue density in the right frontal sinus with CSF from right side as proved clinically (B) Axial CT scan showing posterior table defect with clear frontal sinus at the time of CT scan (intermittent type of CSF rhinorrhea)

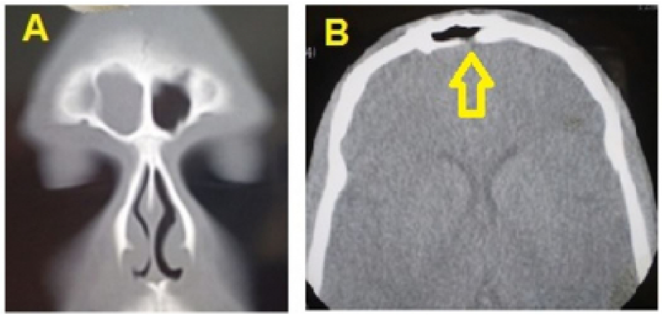


Figure 3

(A) MRI-T1-weighted image showing isointense signal at anterior ethmoid area through adefect in the roof. (B) MRI-T2 weighted image showing focal defect in the left cribriform plate with continuous high signal intensity into the left anterior ethmoid air cell.

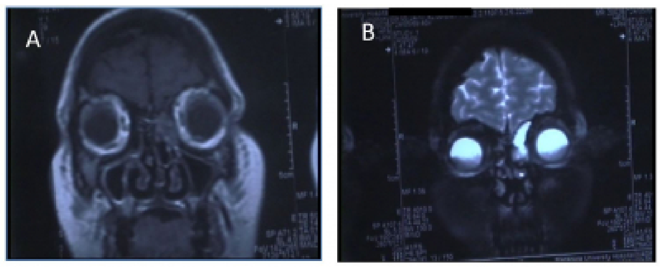


Figure 4

Endoscopic view showing bone graft reconstruction of sphenoid defect

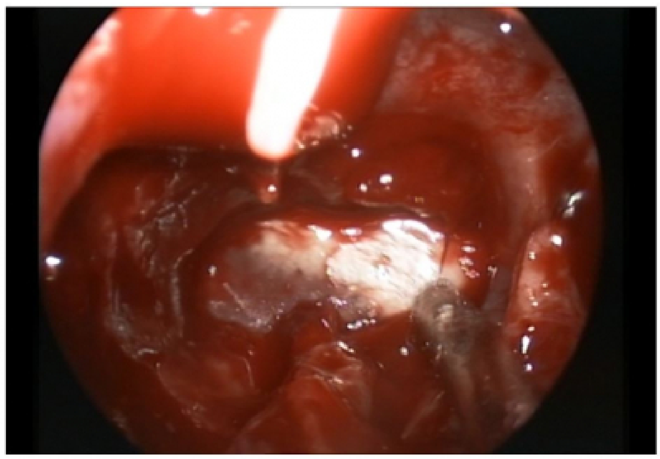
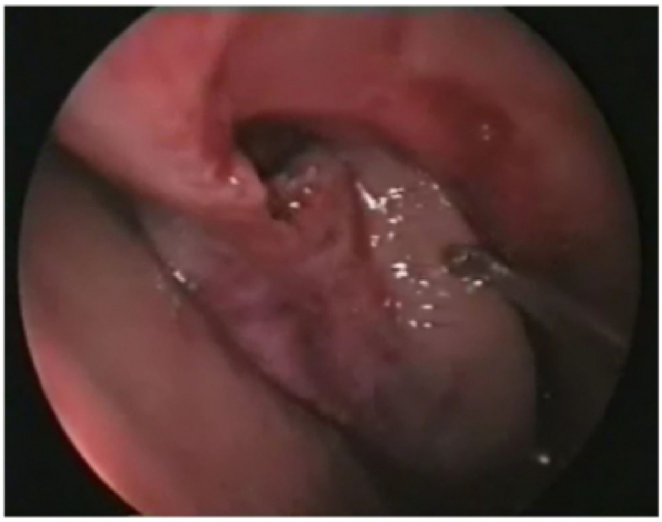


Figure 5

Endoscopic view showing middle turbinate rotational flap



DISCUSSION

Trauma either accidental or iatrogenic is the predominant cause of CSF rhinorrhea. With the increased number of endoscopic sinus and skull base surgeries, there has been an increase in the number of iatrogenic CSF leaks(29).

In this study, 18 (72%) cases were traumatic. Most authors agreed that accidental head trauma is the main cause of CSF rhinorrhea followed by iatrogenic fistula.(1,24,25)

In our series, the most common site of CSF rhinorrhea was in the cribriform plate in 10 cases (40%) followed by anterior ethmoid in 8 cases (32%), sphenoid in 4 cases (16%), posterior ethmoid in 2 cases (8%), and frontal in one case (4%). These findings are similar to study of Lopatin et al. (2003) and Kirtane et al. (2005) who reported the site of the leak in the cribriform area in 184 of 227 patients (81.25%).(11,14).On the other hand, Chowdhury et al. (2011) reported 6/13 cases in the cribriform area (7) while, Kamel et al. (2011) reported that the most common site was anterior ethmoid (40%) followed by cribriform plate (30%).(9)

In this study, the most common site of CSF leak was in the cribriform area in both traumatic as well as spontaneous leak. A belief that the cribriform plate is the thinnest and weakest area of the anterior skull base; it is the most likely area to be fractured was raised from the present results.In iatrogenic group, the cribriform area followed by posterior ethmoid area were the most common sites of CSF leak (28).

Iatrogenic posterior ethmoid fistula typically occurs in cases where the skull base is thin and the maxillary sinus is highly pneumatized which encroaches medially and superiorly, causing a corresponding relative decrease in posterior ethmoid pneumatization, The height of the posterior ethmoid is reduced. These factors work to result in a "shallow" or small posterior ethmoid cavity and also tend to deflect the angle of surgical approach more superiorly (23).Prevention of iatrogenic trauma usually starts with proper positioning of the patient during surgery. Once the upper part of the patient is in a slightly elevated position, the surgeon will safely work parallel to the skull base. In contrast, if the patient is positioned horizontally, the surgeon often works in a steep angle towards the base of skull, thus increasing the probability to injure this delicate structure.

Elevated Intracranial Pressure (ICP) is another contributing factor in development of CSF leaks, as elevated ICP forces the thin skull base at ethmoid and cribriform areas to cause a bony defect with herniation of the dura and the brain forming a meningo-encephalocele (23).

In our series, CT- metrizamide cysternography was required in 7 patients with non identified leakage site. It accurately localized the site of CSF leak in 6 patients with sensitivity of 85.7%. This result is similar to Mostafa and Khafagi(2004) who reported that the CT- metrizamide accurately localized the site of leak in 17 of 19 cases with sensitivity of 89.74% (18).

The initial management for CSF rhinorrhea is conservative, including measures to reduce high intracranial pressures(1,10,25). However, if these measures failed surgical intervention is indicated. Currently, there are three types of techniques used to repair CSF leaks: intracranial, extracranial and transnasal endoscopic repair (2,7,11,20). Intracranial approach with bifrontal craniotomy is today limited to those cases with large bony defects or when posterior frontal sinus wall is almost damaged. The success rate of this technique ranges from 50-70%. In this study, all cases with CSF rhinorrhea were repaired using multilayer endoscopic technique after failure of conservative measures.

A variety of graft materials and methods of applications have been described for endoscopic repair of CSF. These include the use of local flaps of which the middle turbinate osteo-mucoperiosteal flap or septal mucoperichondral flap that may be harvested from turbinate mucosa or septal cartilage are the most commonely used.

Free autologous grafts harvested from distant areas such as temporalis fascia, fascia lata, abdominal fat or calverial bone can also be used (8,17).Grafting techniques can be categorized into overlay, underlay and multilayered techniques (23).

In this study, multilayer technique utilizing middle turbinate rotational flap; together with free bone or cartilage grafts was performed in all cases of CSF rhinorrhea. This technique has several advantages over other techniques: First, this provides both structural support from the bone or cartilage in the epidural space and additional support of the vascularized rotated middle turbinate from the nasal side of the defect. Second, it reconstructs both the bone and the soft-tissue aspect of the defect, addressing the short-term goal of CSF leak cessation and the long-term goals of preventing encephalocele or CSF leak recurrence or ascending meningitis. An added benefit is the baffling effect of the bone or cartilage as without bone graft, the brain parenchyma and reduced encephalocele will tend to push back through the defect with cough or straining.

To overcome the difficulties described by petal et al, 2010 (21) in dissecting the middle turbinate mucosa, the authors of this work used composite middle turbinate rotational flap. This technique is relatively easy and provides a sufficient length of the rotated middle turbinate to cover the nearby defects.

The use of tissue adhesives like fibrin glue is controversial. Many authors (1,6,13,15,27) recommended its use, while others (3,7,10) didn't find additional benefits of its use. In this study, fibrin glue was not used, but another tissue adhesive (Histoacryl) was used in all cases. This provided more safety to the closure without causing any additional morbidity such as infection or granulations during the follow up period. In addition, the low cost and availability were other advantages that favored its use

Lumbar drain was not used in this work as many authors (4,5,6,26) also did not use lumbar drain, but lumbar drains were used by another group(1,12,15,31) ; In the study of Kirtane et al. (2005), lumbar drain was used in half of the patients and not used in the second half and no difference in success results was detected (10).

Fat packing was not utilized for support depending on gel-foam, surgicel and middle turbinate flap support. Although fat had been used by many surgeons (4,7,10). However, no fat was used by others (1,3,6,13,15) .Fat may provide more long-term support for the graft as compared with gel-foam, but this does not appear to be important in most of the defects (15). Also, it necessitates an additional incision with resultant scar. In addition, a second source of pain and possible infection is created (6).

Nasal packs were kept for 5-7 days postoperatively. This also was performed by many surgeons (1,11,15). On the other hand, no nasal packs were used by Chin and Rice (6).The authors of this work think that nasal packs are necessary to support the repair especially in large size defects.

In this study, no patients developed any major complications such as meningitis, pneumocephalus, intracranial bleeding, vision problems or death. Only minor complications recorded in 3 cases, one case with nasal adhesion. The second one with hyposmia and the last one was with septal perforation. This low incidence of complication is also reported by Kirtane et al. (10) who reported nasal adhesion and dehiscence of the thigh wound. Chowdhury et al. (7) reported foul smell within nose (2/13 cases), partial nasal obstruction in 1/13 cases and anosmia in 1/13 cases; On the other side, Paul and Upadhyay (22) reported major complications such as pneumocephalus, intracranial haematoma, frontal lobe abscess and meningitis.

In this study, multilayer endoscopic repair was performed in 25 cases with occlusion of the CSF fistula in 23 cases (92%). This success rate compares favorably with that reported in literature. Lorenz et al. (15) used a cellular dermal allograft and septal bone or cartilage graft and had 92% success rate on the first attempts and 96% on second attempts; Zein El-Abedin and El-Bosraty (30) used mucoperichondrium, fascia lata and fat and had 90% success rate on the first attempts and 100% on second attempts. Singh et al. (26) used septal cartilage, soft tissue graft, surgicel and gelfoam had success rate of 91% in first attempts and 97% in second attempts; Kamel et al. (9) reported success rate of 93.9% in first attempts and 100% in the second attempts.

CONCLUSION

Endoscopic multilayer repair utilizing the rotational middle turbinate flap is a safe and effective technique with low cost and complication. It provides both structural support from bone or cartilage in the epidural space and reconstructs both bone and mucosal aspect of the defect with preservation of nasal and neurological function.

References

1. Bhalaya NH and Joseph ST (2009): Cerebrospinal fluid rhinorrhea: Endoscopic repair based on a combined diagnostic approach. Indian J Otolaryngol Head Neck Surg; 61: 120-126.
2. Bibas AG, Skio B and Hickey SA (2000): Transnasal endoscopic repair of cerebrospinal fluid rhinorrhea. Br J Neurosurg; 14: 49-52.
3. Bolger WE, Tadros M, Ellenbogen RG, Judy K, Grady MS (2005): Endoscopic management of cerebrospinal fluid leak associated with the use of bone wax in skull-base surgery. Otolaryngol Head Neck Surg. 2005 Mar;132(3):418-20
4. Burns JA, Dadson EE and Gross CW (1996): Transnasal endoscopic repair of cranionasal fistula: A refined technique with long-term follow up. Laryngoscope; 106: 1080-3.
5. Casiano RR and Jassir D (1999): Endoscopic cerebrospinal fluid rhinorrhea repair: Is a lumbar drain necessary? Otolaryngol Head Neck Surg; 121: 745-50.
6. Chin GY and Rice DH (2003): Transnasal endoscopic closure of cerebrospinal fluid leaks. Laryngoscope; 113: 136-138.
7. Chowdhury FH, Haque R, Islam S, et al. (2011): Endoscopic transnasal repair of CSF rhinorrhea: Technique and outcome. Bangladesh J Otorhinolaryngol; 17(1): 14-20.
8. Hegazy HM, Carrau RL, Snyderman CH, et al. (2000): Transnasal endoscopic repair of cerebrospinal fluid rhinorrhea: A meta-analysis. Laryngoscope; 110: 1166-72.
9. Kamel RH, Elgohary EM, Kandil TM, et al. (2011): Cerebrospinal fluid rhinorrhea: Classification and guidelines for endoscopic repair. PAN Arab Journal of Rhinology; 1(1): 2-9.
10. Kirtane MV, Gautham K and Upadhyayor SR (2005): Endoscopic CSF rhinorrhea closure: Our experience in 267 cases. Otolaryngology Head and Neck Surgery; 137(2).
11. Kirtane MV, Gautham K and Upadhyayor SR (2005): Endoscopic CSF rhinorrhea closure: Our experience in 267 cases. Otolaryngology Head and Neck Surgery; 137(2).
12. Lanza DC, O'Brien DA and Kennedy DW (1996): Endoscopic repair of cerebrospinal fluid fistulae and encephaloceles. Laryngoscope; 106:1119-1125.
13. Locatelli D, Rampa F, Acchiardi I, et al. (2006): Endoscopic approaches for repair of cerebrospinal fluid leak: Nine-year experience. Neurosurgery; 58: 246-57.
14. Lopatin AS, Kapitanov DN and Potapov AA (2003): Endonasal endoscopic repair of spontaneous cerebrospinal fluid leaks. Arch Otolaryngol Head Neck Surg; 129: 859-863
15. Lorenz RR, Dean RL, Hurley DB, et al. (2003): Endoscopic reconstruction of anterior and middle cranial defects using a cellular dermal allograft. Laryngoscope; 113: 496-501.
16. Mattox DE and Loury M (2001): Endoscopic management of cerebrospinal fluid leaks and cephaloceles. In: Kennedy DW, Bolger WE, Zinreich SJ (eds). Diseases of the sinus diagnosis and management. BC Decker, Hamilton, London; 335-40.
17. McMahon SJ, Kingdom TT and Hudgins PA (2000): Management of cerebrospinal fluid leaks. Curr Opin Otolaryngol Head Neck Surg; 8: 32-36.
18. Mostafa B and Khafagi A (2004): Combined HRTC and MRI in detection of CSF rhinorrhea. Skull Base; 14(3): 157-162.
19. Ommaya AK (1996): Cerebrospinal fluid fistula and pneumocephalus. In: Wilkinas RH, Rengachary SS (eds): Neurosurgery. New York: McGraw-Hill; 2773-2782.
20. Paludetti G, Sorgi B, Rigante M, et al. (2004): New techniques and technology to repair cerebrospinal fluid rhinorrhea. Acta Otorhinolaryngol Otol; 24: 130-134.
21. Patel MR, Stadler ME, Patel MR, Stadler ME, Snyderman CH, Carrie, Hassam AB, Germanwala AV, Gardner P, Zanation AM. (2010): How to Choose? Endoscopic Skull Base Reconstructive Options and Limitations. Skull base; 20(6): 397-404.
22. Paul P and Upadhyay K (2010): Endoscopic endonasal repair of traumatic CSF rhinorrhea. Indian Journal Neurotrauma; 7(1): 67-70.
23. Schlosser RJ and Bolger WE (2004): Nasal cerebrospinal fluid leaks: Critical review and surgical considerations. Laryngoscope; 114: 255-65.
24. Schmerber S, Righini C, Lavieille JP, et al. (2001): Endonasal endoscopic closure of cerebrospinal fluid rhinorrhea: Skull base; 11(1): 47-58.
25. Sharma DP, Singh D, Sinha S, et al. (2010): CSF rhinorrhea: An overview of endoscopic repair. Indian Journal of Neurotrauma (IJNT); 7(2): 157-162.
26. Singh R, Hazarika P, Nayak DR, et al. (2009): Endoscopic repair of cerebrospinal fluid rhinorrhea: Manipal experience. Indian J Otolaryngol Head Neck Surg; 61: 14-18
27. Stamm AC and Pignatari SN (2005): Transnasal endoscopic-assisted surgery of the skull base. In: Cummings CW, Flint PW, Harker LA, et al. (eds). Cummings Otolaryngology Head and Neck Surgery, 4th ed. Elsevier Mosby, Philadelphia, Pennsylvania; 3855-75.
28. Stenkiewicz JA and Chow JM (2009): Two faces of orbital haematoma in intranasal (endoscopic) sinus surgery. Otolaryngol Head Neck Surg; 120: 841-849.
29. Wax MK, Ramadan HH, Ortiz O, et al. (1997): Contemporary management of cerebrospinal fluid rhinorrhea. Otolaryngol Head Neck Surg; 116: 442-449.
30. Zein El-Abedin MA and El-Bosraty H (2006): Endoscopic repair of CSF rhinorrhea. EJNS; 21(2): 49-56.
31. Zweig JL, Carrau RL, Celin SE, et al. (2000): Endoscopic repair of cerebrospinal fluid leaks to the sinonasal tract: Predictors of success. Otolaryngol Head Neck Surg; 123: 195-201.

Author Information

Magdy Abdalla Sayed El-Ahl
Professor of Otorhinolaryngology, Head and Neck Surgery, Otorhinolaryngology, Head and Neck Surgery Department, Faculty of Medicine, Zagazig University
Zagazig, Egypt

Ismail Elnashar
Professor of Otorhinolaryngology, Head and Neck Surgery, Otorhinolaryngology, Head and Neck Surgery Department, Faculty of Medicine, Zagazig University
Zagazig, Egypt

Mohammad Waheed El-Anwar
Assistant professor of Otorhinolaryngology, Head and Neck Surgery Otorhinolaryngology, Head and Neck Surgery Department, Faculty of Medicine, Zagazig University
Zagazig, Egypt

Mohamed Gouda Ammar
Lecturer of Neurosurgery, Neurosurgery department, faculty of medicine, Zagazig University
Zagazig, Egypt

Atef Hessen
Lecturer of Otorhinolaryngology, Head and Neck Surgery, Otorhinolaryngology, Head and Neck Surgery Department, Faculty of Medicine, Zagazig University
Zagazig, Egypt