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Endoscopic Endonasal Repair of Cerebrospinal Fluid Rhinorrhea by The Combined Overlay and Underlay Techniques

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Objective: This study is aimed to describe the efficacy of endoscopic transnasal repair of cerebrospinal fluid (CSF) rhinorrhea and anterior skull base defect using a combined overlay and underlay techniques.

Methods: The authors have performed 5 endoscopic procedures in the 3 patients with CSF rhinorrhea. The etiologies of the CSF leaks were 2 traumatic brain injuries and 1 iatrogenic one. All patients underwent preoperatively magnetic resonance imaging (MRI) scan with intrathecal infusion of Gadolinium. The repair using the overlay or combination technique was done with fibrin glue, strips of fat, and septal cartilage or porous polyethylene implant (Medpor).

Results: All CSF leaks were found out during endoscopic procedures. One patient underwent an overlay technique using a rotated middle turbinate flap had recurrent CSF leakage, which was successfully treated with the combination technique. Other two patients exhibiting 3 CSF leakages were successfully treated with the combination techniques. Any major complication was not seen.

Conclusion: The endoscopic transnasal repair with free grafts by the combined overlay and underlay techniques is a safe and successful method for the treatment of CSF leaks.

Key Words: Cerebrospinal fluid rhinorrhea · Endoscopic surgery · Endonasal

INTRODUCTION

Cerebrospinal fluid (CSF) rhinorrhea involves a breakdown of all barriers that separate the subarachnoid space from the upper aerodigestive tract, namely, the mucosa of the nasal cavity or paranasal sinus, skull base, dura mater, and arachnoid membrane. CSF rhinorrhea expressed as meningitis, subdural empyema or brain abscess, when inadequately treated[3,19]. CSF fistulas can be classified into traumatic and non-traumatic: the traumatic group can be classified in accidental and iatrogenic[16]. The non-traumatic group is related with brain tumors, congenital skull base defect and meningoceles or meningoencephaloceles.

Conservative treatment is based on bed rest, lumbar punctures and permanent spinal fluid diversion. The surgical treatment of a CSF fistula is controversial as it depends on the etiology of leak and the location of the fistula[15]. Surgical repair consists of transcranial approaches or nasal approaches with the use of an endoscope[1,3,19]. The success rate of transcranial approaches ranged from 60~90%. In recent years, endoscopic methods for the repair of CSF fistula are considered to be the treatment of choice for CSF rhinorrhea repair[9,15]. The advantages associated with the use of an endoscope - better lighting, magnification of the image and best angle visualization - give the surgeon a more precise diagnosis and a less invasive method of treatment[11,14,17,23].

The aim of this study is to determine the efficacy of endoscopic transnasal repair of cerebrospinal fluid rhinorrhea and skull base defect by the combined overlay and underlay techniques.

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PATIENTS AND METHODS

This procedure was conducted between 2001 and 2005. Three patients with CSF rhinorrhea were treated in our institute. The

etiologies of the leaks were iatrogenic in 1 case and traumatic in 2 cases. In three patients, five procedures were done. Before the surgery, all the patients undertook computed tomography (CT) scan of the brain and paranasal sinus including thin section of coronal acquisition. Magnetic resonance (MR) cisternography was performed for all three patients to localize the exact portion of CSF leak. In one patient, CT and MR cisternography hardly showed the defect site. To localize the defect area, fluorescein was injected by way of a lumbar puncture intraoperatively and a small defect on ethmoidal sinus could be detected.

Postoperatively, we did not use continuous lumbar drainage. Patients were nursed 30° head up and administered intravenous antibiotics for 3 days and then oral antibiotics for 7 days more.

1. Surgical technique

The patients were placed in supine position under the general anesthesia and the nasal cavities were infiltrated with a solution of 2% lidocaine and 1:50,000 epinephrine. After the CSF leak was identified, the surrounding bony edges and mucosa were freed from soft tissues. The surgical graft was composed of strips of fat harvested from the abdomen, adjacent soft tissue such as middle turbinate, septal cartilage and Medpor. Fibrin glue was used in all procedures after graft positioning. So-called 'underlay' reconstruction was performed with a piece of adjacent mucosal graft from the middle turbinate or Medpor between the bone of the skull base and the dura. Then the site was fixed with fibrin glue. Over the bony edges, 'overlay' reconstruction using a free graft of fat was accomplished and the fibrin glue was sprayed on it.

RESULTS

The causes of CSF rhinorrhea were traumatic (2 cases) and postsurgical (1 cases). Complete closure was obtained for all three patients; however, additional endoscopic procedures were needed for two patients. There was no wound infection after the surgery. The combined underlay and overlay technique was performed in four procedures and an overlay reconstruction was performed in only one procedure (illustrated case 1) (Table 1).

2. Case illustration 1

This 36-year-old male patient complained of anterior nasal drip after the superior orbital rim craniotomy using an eyebrow incision for the treatment of a ruptured paraclinoid aneurysm. He underwent an intradural clinoidectomy to get satisfactory clipping of an aneurysmal neck. Under the impression of CSF rhinorrhea, we reviewed his operative video and perioperative images of skull basal bony structures. It was verified of prominent pneumatization of sphenoid sinus toward the anterior clinoid process. Paranasal CT and MR cisternography were followed and the defect site was thought to be the site of clinoidectomy. Through the endoscopic endonasal approach, the defect was sealed up with an overlay technique using a rotated middle turbinate flap, free abdominal fat and fibrin glue.

After a month, CSF leak developed again and the same site leak was confirmed. The combined reconstruction of underlay and overlay technique with a piece of septal cartilage, strips of fat, and fibrin glue was carried out. Thereafter he showed no more CSF leak until 36-month follow-up (Fig. 1).

3. Case illustration 2

A 17-year-old boy who had suffered a motor cycle accident presented CSF rhinorrhea. His CT scan showed an anterior skull basal fracture. The exact site of CSF leak was identified with a fluorescein dye during endoscopic exploration intraoperatively. It was sealed by the combined underlay and overlay reconstruction with a Medpor, a free abdominal fat and fibrin glue. One month later CSF leakage developed again from another nostril. Another defect was detected during a revision endoscopic surgery, and it was treated by the same procedure of combined underlay and

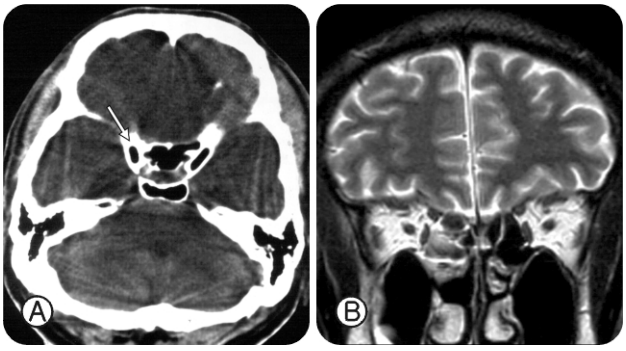

Fig. 1, A. Paranasal CT showing profuse pneumatization of sphenoid sinus toward the anterior clinoid process. B. T2-weighted MRI showing signal change at the same site.

Table 1. Summary of illustrated cases

No.	Age (years)	Sex	Cause	Size (mm)	Locations	Technique of operation	Complications	Follow-up (months)
1	36	male	Post-surgical	6	sphenoid	Overlay	recurrent	36
						Combined underlay and overlay	none	
2	17	male	trauma	7	ethmoid	Combined underlay and overlay	none	18
						Combined underlay and overlay	none	
3	24	male	trauma	5	sphenoid	Combined underlay and overlay	none	20

overlay technique with a Medpor, a free abdominal fat and fibrin glue. After the second procedure, he is being followed-up for 18 months and there is no more CSF leak (Fig. 2).

4. Case illustration 3

This 24-year-old male patient was operated on the epidural hematoma, frontal sinus fracture, and multiple facial bone fractures. He developed deteriorated consciousness and CSF rhinorrhea, and his CT scan showed a tension pneumocephalus and CSF leakage. Pneumocephalus was drained out promptly and the basal defect of sphenoid sinus was sealed up with a Medpor, several pieces of free abdominal fats and fibrin glue (Fig 3). He recovered uneventfully.

DISCUSSION

Trauma is the most common cause of CSF rhinorrhea[22]. Lewin reported that approximately two thirds of posttraumatic CSF leakage would become clinically evident within 48 hours of injury, whereas nearly all would present within 3 months of the injury[12]. Idiopathic leaks have been associated with hydrocephalus and empty sella syndrome[20].

Recognition of the exact site of the CSF fistula is a fundamental condition for performing an adequate treatment. A CT scan detects skull base defects and fracture. A CT scan after metrizamide injection is a valuable tool for localizing the CSF fistula sites, but a CSF leak must be present at the moments of the examination and metrizamide has side effects and was replaced with low-osmolarity nonionic substances such as iohexol and iopamidol[13]. T2-weighted MR image is a precise method for identifying the CSF fistula site even when there is no CSF leak,

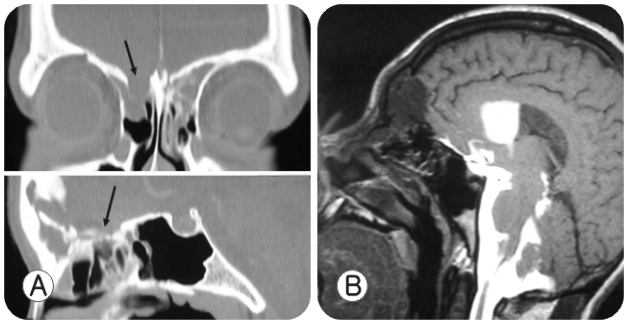

Fig. 2. A. Plain CT scan showing opacification of the ethmoid sinus due to trapped CSF with bony dehiscence at the roof of the ethmoid sinus. **B**. Gd-DTPA MR cisternography did not delineate the exact defect site.

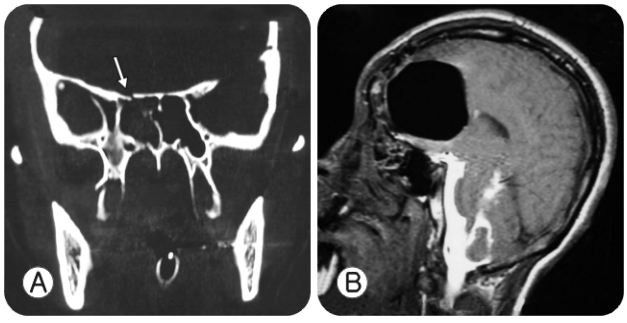

Fig. 3. A. Plain CT scan showing opacification of the sphenoid sinus due to trapped CSF with bony dehiscence at the roof of the sphenoid sinus. **B**. Gd-DTPA MR cisternography showing contrast accumulation at the same site and pneumocephalus.

and for diagnosing associated lesion such as pseudomeningoceles and pseudomeningoencephaloceles[6,8]. MR cisternography is a method that does not require intrathecal injection of contrast and may become the method of choice for evaluation of the CSF fistula. However Intrathecal gadolinium enhanced magnetic resonance cister-

nography (Gd-DTPA MR cisternography) is more safe and feasible method in confirming bony change and determining the forcus of active CSF leaks than T2-weighted MR image[2,10]. Intrathecal injection of fluorescein is a widespread method utilized to localize the CSF fistula during the operation.

In this study, all patients were checked by paranasal sinus CT scan in coronal and axial acquisitions and Gd-DTPA MR cisternography, revealing fracture area. In 1 patient, defect site was verified with the aid of intraoperative fluorescein localization.

The operative management of CSF rhinorrhea consists of intracranial and extracranial approaches. Intracranial approach has the disadvantage of anosmia, brain swelling and a high recurrence rate18). Extracranial approach has the advantages of decreased morbidity, decreased incidence of anosmia, and superior exposure of the ethmoid and sphenoid regions[5]. The endonasal endoscopic approach for the treatment of CSF fistula has great support since Wigand introduced it. Burns et al. operated 42 patients with CSF fistula[4]. Their success rate was 85.3% after one procedure, with only 3 patients requiring a second surgical approach. Lanza et al. treated 36 patients and the success rate was 94.4%[11]. More recent studies insist on using of the endoscopic repair of CSF fistula. In this study, endoscopic endonasal approach was applied to all cases. The graft can be positioned in an underlay form (between the dura and the skull base) or in an overlay form (on the nasal side of the leak). On size of the bony skull-base defect, larger bony defects (generally >6 mm) were reconstructed using septal or turbinate bone shaped to the defect and placed in an underlay fashion, and smaller bony defects (generally < 6 mm) using fat, mucosa in an overlay fashion. Before graft, the graft site was prepared by removing a cuff of normal mucosa for at least 3～4 mm surrounding the defect. In this study, 1 patient treated with only overlay method had a recurrent CSF leakage, but 4 combination procedures were successful to treat the defects.

Several types of grafting material have been used with good results in treatment of CSF rhinorrhea. The relative advantage of pedicle flaps versus free grafts has been much discussed. The merits of the pedicle flap have intrinsic blood supply, which is thought to increase likelihood of take and closure and to increase apposition between layers[7]. Zeitouni et al. prefer free grafts because of less perceived interference with nasal function[24]. In this study, 4 procedures using free grafts have performed the satisfactory closure of the defects. Hegazy et al. found no statistically significant difference among different grafting techniques and materials[9]. They report a 90% of success rate after a first attempt at repair and a 97% success rate overall.

All the sites of the CSF leaks were found out during endoscopic procedures. One patient underwent an overlay technique using a rotated middle turbinate flap had recurrent CSF leakage, which was successfully treated with an additional combination technique. Other two patients exhibiting 3 CSF leakages were also successfully treated with the combination techniques. Therefore, the combination technique could be recommended to use for the satisfactory treatment of CSF leakage if possible. This mode of treatment using endoscopic endonasal procedure is becoming the method of choice for surgical repair of CSF fistula for its excellent rate of success and the lower morbidity.

CONCLUSION

The endoscopic endonasal repair with free grafts by the combined overlay and underlay techniques is a safe and successful method of treating CSF leaks. Also repeat endoscopic endonasal approach is available for the treatment of recurrent CSF leaks without any morbidity.

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