Endoscopic Endonasal Approach for Cerebrospinal Fluid Fistulae

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Original Article

Abstract

Different techniques have been proposed to repair cerebrospinal fluid rhinorrhea. Advances in nasal surgery led to a high success rate and low morbidity for the endonasal approach. It has become the favorite route for treating cerebrospinal fluid leaks of the anterior skull base. Better results have been obtained with the improvement of rigid endoscopes and intrathecal sodium fluorescein. In a prospective study, twenty-four patients with cerebrospinal fluid rhinorrhea were evaluated and treated by endoscopic endonasal surgery. In all cases intrathecal sodium fluorescein enabled a precise localization of the bone defect. The most common causes of CSF rhinorrhea were traumatic (8 cases, 33%), spontaneous (6 cases, 25%), and iatrogenic (5 cases, 20.8%). Preoperative radiological evaluations (plane CT, CT cisternogram and MRI) showed the exact site and size of the defect in all patients. The most common site of leakage was the ethmoidal roof-cribriform plate. Primary closure was achieved in all patients. There were no major operative or postoperative complications. The endoscopic endonasal approach can be considered the first choice in the treatment of cerebrospinal fluid rhinorrhea.

Key words

Cerebrospinal fluid · fistulae · endoscopic endonasal approach · paranasal sinus

Introduction

Cerebrospinal fluid (CSF) rhinorrhea involves a breakdown of the barriers that separate the subarachnoid space from the upper aerodigestive tract, namely, the nasal cavity mucosa or paranasal sinus, skull base (i.e., bone), dura mater, and arachnoid membrane. The etiology of CSF leaks is diverse. Although the incidence of CSF fistula after endoscopy sinus surgery is less than 1%, it is still a common cause of iatrogenic CSF fistula. Blunt trauma to the head is another frequent cause which is diagnosed in 3% of all patients who have a closed head injury and in over 30% of patients who have skull base fractures. Although less common, conditions that increase the ventricular pressure, such as intracranial tumors and post-traumatic and post-infectious hydrocephalus are also frequent causes of CSF leaks [1]. Many of the CSF leaks that occur after blunt trauma or skull base surgery are solved by conservative measures, such as bed rest, elevation of the head, avoidance of straining activities, and/or decreasing the CSF pressure with spinal taps or drains.

The history of surgical repair of CSF leaks began with Walter Dandy who performed the first successful intracranial repair in 1926 [2]. In 1948, Dohlman described the first extracranial approach to repair CSF rhinorrhea using a nasoorbital incision [3]. In 1952, the Austrian Oskar Hirsch was the first to use the transseptal approach to repair a sphenoidal leak [4]. In 1981, Wigand was the first to introduce the usage of nasal endoscopes to repair CSF fistulas at the University of Erlangen, Germany. That technique was developed and diffused worldwide by Stammberger from the University of Graz, Austria [5].

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Minim Invas Neurosurg 2006; 49: 88–92 © Georg Thieme Verlag KG Stuttgart · New York
DOI 10.1055/s-2006-932188
ISSN 0946-7211

The surgical management of a CSF fistula remains controversial as it depends on the etiology of the leak, the location of the fistula and the temporal relationship of the leak with the inciting factor [6]. The open frontal craniotomy procedure has consistently been chosen as the neurosurgical procedure applied. Some authors reported excellent results in 90% [7] while other groups have seen lower success rates of approximately 60% [8]. The surgical repair of CSF leaks has improved as the result of technological advances and increased experience with transnasal endoscopic techniques. The purpose of this study is to ascertain the outcome of endoscopic repair of CSF leaks and whether the usage of specific techniques and materials offers significant advantages regarding outcome.

Patients and Methods

Between April 2001 and December 2004, twenty-four patients with CSF rhinorrhea were managed at Federal University of São Paulo. Patient's age ranged from 10 to 79 years (average: 39 years). There were 13 males and 11 females.

The etiologies of the leaks were traumatic in 8 cases, iatrogenic in 5 cases, spontaneous (normal pressure leak) in 5 cases, meningeo-encephalocele in 3 cases, treatment of prolactinoma (dopamine agonist bromocriptine) in 2 cases, and neoplasm invading the skull base in 1 case. Data regarding location and clinical features are summarized in Table **1**.

All patients presented unilateral CSF rhinorrhea (intermittent in 17 and continuous in 7 cases), 12 noticed headache, and 10 presented meningitis.

Preoperative high-resolution plane computed tomography (CT), CT with intrathecal non-ionic contrast (cisternogram) in axial and coronal cuts and magnetic resonance imaging (MRI) of the brain and paranasal sinuses using 2 mm slice thickness were done for patients who showed any causative intracranial lesions, to identify bony abnormalities within the sinuses or skull base, or to determine the site and size of the defect. A preoperative nasal endoscopic examination was performed in uncertain cases.

All patients had postoperative antibiotic cover, second-generation cephalosporins (Cefuroxime) for 24 hours. Postoperative lumbar CSF drainage was not necessary in any case.

All patients have undergone surgery under general anesthesia. Operations were performed with Karl Storz rigid endoscopes of 0 , 30 and 45 with a diameter of 4 mm.

Fluorescein was injected in all patients under general anesthesia after lumbar tap. With aspiration of 10 mL of water, adding 5% sodium fluorescein in a 0.1 mL/10 kg rate, with a limit rate of 1 mL. The head of the patient was placed slightly above the heart level [9].

The endoscopic approach was fairly standardized. The nasal cavity was prepared with topic pledgets dripped 1 : 1000 adrenaline. Intranasal endoscopy was performed. An anterior or posterior ethmoidectomy was performed when a fistula was located in the cribriform plate or in the superior border of the sphenoid sinus (Figs. **1** and **2**). In these cases, removal of the middle turbinate was performed in order to improve exposure of the region. In all cases, active leakage of a bright yellow-green fluid was demonstrated. All bleeding was carefully controlled with suction cautery. The leak site was identified by direct visualization. The sphenoid sinus ostium was carefully identified (medial to middle turbinate) and enlarged when a fistula was located in the sphenoid sinus (Figs. **3** and **4**).

Table **1** Age, sex, etiology, site and follow-up in patients treated surgically for CSF rhinorrhea

No.	*Age*	*Sex*	*Etiology*	*Site*	*Follow-up (months)*
1	25	m	trauma	ethmoid (right anterior)	44
2	16	m	trauma	ethmoid (cribriform plate)	42
3	79	m	during FESS for sinonasal polyposis	ethmoid (left posterior)	42
4	54	m	spontaneous	sphenoid (right roof)	42
5	48	f	meningeo-encephalocele	sphenoid (left roof)	40
6	53	f	after treatment for prolactinoma	sphenoid (right roof)	37
7	47	f	spontaneous	ethmoid (right anterior)	37
8	22	m	trauma	ethmoid (right anterior)	34
9	68	m	during FESS for sinonasal polyposis	ethmoid (left anterior)	34
10	35	f	spontaneous	sphenoid (left roof)	33
11	51	f	spontaneous	ethmoid (cribriform plate)	32
12	66	m	during FESS for chronic ethmoidal sinusitis	ethmoid (left anterior)	31
13	38	f	after sublabial-trans-septal-transsphenoid hypophysectomy	sphenoid (right roof)	29
14	38	m	during FESS for chronic ethmoidal sinusitis	ethmoid (left anterior and posterior)	29
15	47	f	after treatment for prolactinoma	sphenoid (right roof)	27
16	40	m	trauma	ethmoid (posterior)	22
17	16	f	trauma	frontal (posterior)	18
18	22	m	meningeo-encephalocele	ethmoid (cribriform plate)	16
19	20	m	trauma	ethmoid (right anterior)	15
20	27	m	trauma	ethmoid (anterior) and frontal	15
21	44	f	spontaneous	ethmoid (anterior and posterior)	14
22	31	f	trauma	ethmoid (left anterior)	11
23	42	m	meningeo-encephalocele	ethmoid (cribriform plate) and sphenoid (roof)	7
24	10	f	spontaneous	rhinopharynx	6

* FESS = functional endoscopic sinus surgery.

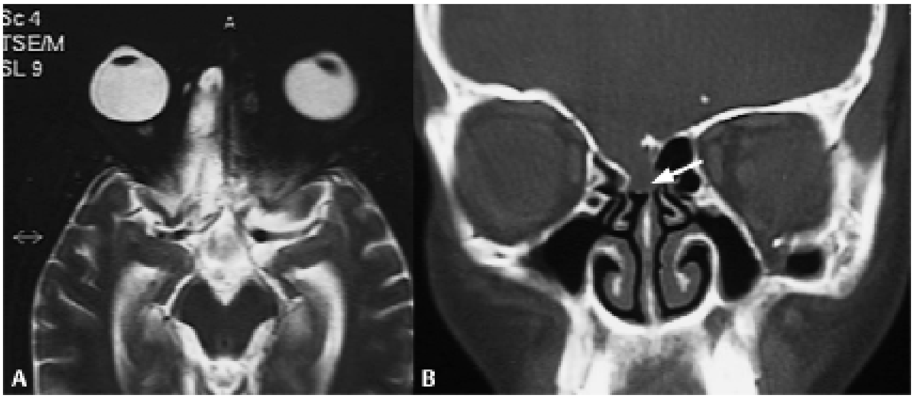

Fig. **1** **A** Axial T_2-weighted MRI. Bright signal from trapped CSF. **B** Coronal CT. CSF fistula (red arrow) at the cribriform plate.

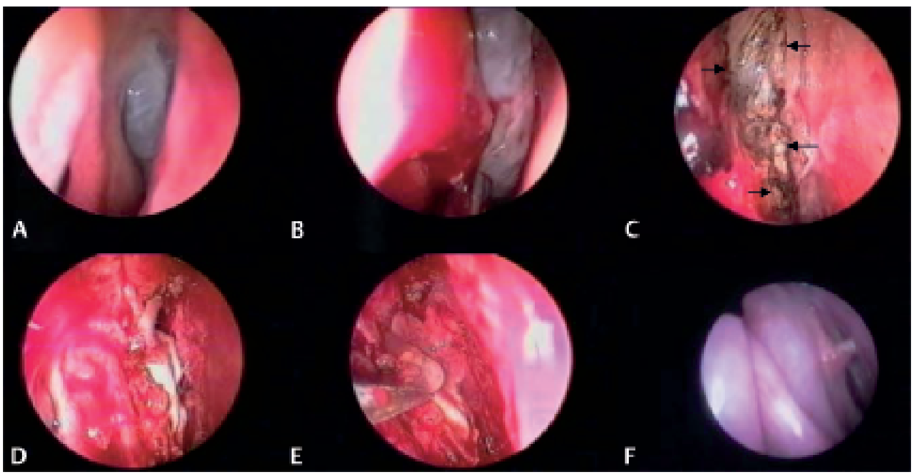

Fig. **2** Endoscopic image of the right nasal fossa (0 endoscope). **A** and **B** Meningeal protrusion, anatomically sited below the cribriform plate. **C** After cauterization of the meningoencephalocele. **D** Graft positioning. **E** Placing fibrin glue. **F** Postoperative image at 6 weeks.

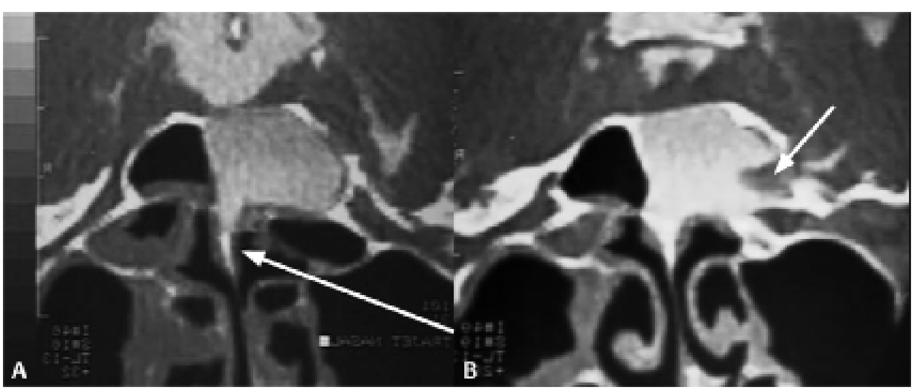

Fig. **3** Coronal CT cisternogram. **A** and **B** Meningeal protrusion occupying the left sphenoid sinus (red arrow).

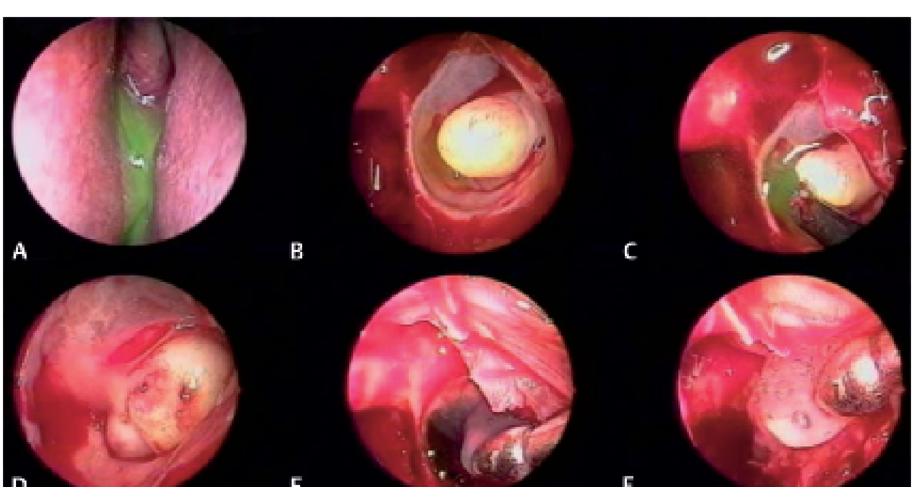

Fig. **4** Endoscopic image of the left nasal fossa. Green fluorescent dye. **B** Meningeal protrusion is highlighted with fluorescein. **C** Cauterization of the meningoencephalocele. **D** Graft positioning. **E** and **F** Placing Surgicel® and fibrin glue.

Once the defect was identified, the surrounding bony edges and mucosa around it were freed from soft tissues with small-cupped forceps in order to allow the graft to firmly adhere to the skull base. The underlay technique was used in all cases. The fistula was repaired by placing the grafting material as follows: Surgicel®, fibrin glue (rapidly polymerizing fibrin glue, Beriplast®), strips of mucoperiosteum from the middle turbinate and a piece of septal cartilage (obtained by septoplasty) and/or abdominal fat and finally another layer of fibrin glue.

The patient was subjected to the Valsalva maneuver by the anesthesiologist and its effect at the leakage site was observed. If further leakage was seen, the abdominal fat or mucoperiosteum plug was modified and replaced until no further leakage was visualized. Then, fibrin glue was dribbled over the mucoperiosteum creating a seal. After the operation patients were kept in bed rest from 3 to 5 days.

Patients were reviewed weekly as outpatients for the first two months. Follow-up ranged from 6 to 44 months (average: 27.4 months).

Results

The most common causes of CSF rhinorrhea in this work were traumatic (8 cases, 33%), spontaneous (6 cases, 25%), and iatrogenic (5 cases, 20.8%) (Table **1**).

Preoperative radiological evaluations (plane CT, CT cisternogram and MRI) showed the exact site and size of the defect in all patients. MRI showed a bright signal from trapped CSF or herniated arachnoid in the dural bone defect, T_2-weighted images showed the same finding as the CT cisternogram regarding the site of the CSF fistula.

The most common site of leakage was the ethmoidal roof-cribriform plate (Table **1**). Defects in the cribriform plate were mainly in the fovea ethmoidalis adjacent to the anterior ethmoidal artery. There were no major operative or postoperative complications.

Complete closure of the leaks was achieved in all patients. In one patient (case no. 23), the leak recurred postoperatively and was treated with a second endoscopic endonasal approach. In another patient (case no. 20), a craniotomy was performed to close the bone defect.

Discussion

The operative management of CSF rhinorrhea can be divided into intracranial and extracranial approaches. There are advantages and disadvantages for each of them [5–8,10–20]. Extracranial repairs are associated with decreased morbidity, decreased incidence of anosmia, and superior exposure of the ethmoid and sphenoid regions with success rates from 80 to 90% [18].

Considering less invasive procedures does not eliminate the option for craniotomy, if these are unsuccessful. The success of these approaches depends on the surgeon's experience. Acceptable closure rates can be obtained from any of these approaches [21].

With the advent of the surgical microscope and the rigid endoscope, the endonasal approach has become the most commonly used one for the initial closure of CSF leaks in this area. It allows excellent visualization of the leakage site, easy lifting of the surrounding mucosa and easy placement of the graft over the defect [14,19].

Initially, extracranial endonasal repairs of CSF leaks involved the use of a mucosal flap from the sinonasal tract, such as septal [22] and osteomucoperiosteal flaps from the middle turbinate [23]. In general, the advantage of a flap over a graft is its immediate viability which, in theory, increases the ability to heal. However, free tissue grafts are not much technically demanded and do not yield similar results. Furthermore, free grafts and flaps can be combined to reinforce the repair [1].

Throughout the literature, the choice of materials used during microscopic or endoscopic repair of CSF fistulas seems to depend on the experience and familiarity of the operating surgeons with the various techniques. Wigand [12] and Stankiewicz [13] described repairing CSF fistulas using a turbinate mucosa free graft with fibrin glue and post-auricular fat and temporalis facia, respectively. Papay et al. [24] described the endoscopic repair of spontaneous or traumatic CSF rhinorrhea using facia lata, muscle, and fat. Lanza et al. [14] repaired 42 skull base defects in 36 patients using mucoperichondrial and mucoperiosteal graft and septal cartilage.

It is also controversial whether the underlay or the overlay technique is superior. During the underlay technique, intact dura is detached from the edge of the bony defect to expose an adequate buttress for stable graft insertion. The graft is designed in such a way that it can be pushed a few millimeters between the bone and the raised intact dura on all sides of the defect as was indicated in our cases. The overlay (onlay) technique would be used if there was any risk that nerves or vessels could be damaged when raising dura from the surrounding bone or when the inlay technique was not technically possible. The graft was placed over the dural lesion and over exposed bony margins that had been denuded. Afterwards, the graft was supported in the place with layers of some types of fixators, such as Gelfoam®, Surgicel®, or fibrin glue [15–19,24]. Some studies reported that the form of graft positioning is not a critical factor in predicting the success of the procedure [12,16,24].

Fibrin glues have been widely used in neurosurgery. These glues are mainly used for preventing CSF leakage but they are also used for achieving homeostasis on the dura mater, for cranioplasty using resected autologous bone fragments, for anastomoses of nerves and vessels, and for the inclusion of antibiotics [25]. In the current study, fibrin glue was used as a sealant rather than an adhesive and also to form a tough fibrin clot plate that sufficiently sealed dural tears to prevent (CSF) leakage. It was used as an adjunct and not as a substitute for water-tight closure providing the most assured means of avoiding CSF leaks.

Failure to repair the defect by the endoscopic approach may be related to the inability to localize the defect successfully, to graft displacement, to insufficient graft size, to incomplete apposition of the graft to the skull base defect, and/or to patient non-compliance with postoperative instructions [19].

Contraindications to the endoscopic treatment of CSF fistulas include the presence of an intracranial lesion, a fracture of the posterior wall of the frontal sinus, lateral extensions of the frontal sinus and CSF rhinorrhea from a temporal bone defect [20].

Complications in repairing CSF fistulas include meningitis, chronic headache, pneumocephalus, intracranial hematomas, frontal lobe abscess, and anosmia which can all be consequences of transcranial or transendoscopic repair. Failure to repair the fistula or a recurrence of the CSF leak with associated neurological signs of meningeal irritation or both were also reported. On a meta-analysis, Hegazy [1] revealed a very low incidence of surgical complications such as meningitis (0.3 %), smell disorders (0.6 %), and headache (0.3 %). Whether endoscopic approaches improve this tendency remains to be analyzed. Our patients have not had the common complications to nasal surgery such as nasal obstruction, headaches, and chronic or recurrent sinusitis.

Conclusion

The transnasal endoscopic technique provides superior visualization, facilitates precise graft placement and repairs cranionasal fistulae with excellent results effectively.

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