Cerebrospinal fluid rhinorrhea: endoscopic repair based on a combined diagnostic approach

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Abstract

Background The treatment of cerebrospinal fluid rhinorrhea has evolved since the first recorded instance of this condition by Willis in 1676. The advancements in radiology and endoscopic nasal surgery have provided ways to solve this potentially dangerous condition. But even now quite a few questions remain unanswered while tackling this difficult clinical situation. Laboratory tests for confirming the presence of cerebrospinal fluid in nasal fluid can yield false positive results and radiological evaluation has never been foolproof when it comes to small leaks and multiple leaks. Also the postoperative recurrence needs to be brought within acceptable limits.

Objectives We have tried to evaluate endoscopic repair of CSF rhinorrhea based on a combined diagnostic approach. The methods for diagnosis of CSF rhinorrhea have been reevaluated based on our experience with a view to prevent recurrences and complications.

Materials and methods The study group included twenty patients of CSF rhinorrhea who have been treated by endoscopic repair and spans over a period of five years from January 2001 to December 2005. A combination of retrospective and prospective methods of study has been used. Patients have been subjected to laboratory, radiological and dye studies for confirmation and localization of leak. Endoscopic repair of CSF fistula with composite graft and

fibrin glue has been performed. Postoperative management included intracranial pressure reducing measures and control of primary condition in cases of spontaneous leak.

Results Endoscopic repair of CSF rhinorrhea produced a first time success rate of 92%. CT/MR Cisternogram could localize the defect in 85% cases while intrathecal fluorescein aided localization whenever it was used. The use of fibrin glue with composite graft and postoperative intracranial pressure reducing measures could improve the success rate.

Conclusion Management of a suspected CSF leak requires a combined diagnostic approach. Endoscopic repair with composite graft and fibrin glue should be the first line of management in cases of CSF rhinorrhea requiring surgical closure. Intracranial pressure reducing measures play an important role in preventing postoperative recurrence.

Keywords Cerebrospinal fluid rhinorrhea · Endoscopic skull base surgery · Fluorescein dye · Endoscopic repair of CSF leak · Mondini's dysplasia · CSF otorhinorrhea

Introduction

Cerebrospinal fluid rhinorrhea (CSF), 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. Evaluation of CSF rhinorrhea often poses diagnostic and therapeutic challenges. Laboratory tests for confirming the presence of CSF in nasal fluid yield false positive results and radiological evaluation has never been foolproof when it comes to small leaks and multiple leaks. This has been the reason behind unnecessary surgical intervention or inadequate treatment in CSF rhinorrhea.

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The first recorded instance of CSF rhinorrhea is thought to be described by Willis in 1676 [1, 2] (Mac Donald, 1945) [1]. Miller in 1826 described a fistula between nasal cavity and subarachnoid space in a hydrocephalic child who had history of intermittent clear nasal discharge which was an incidental finding at necropsy. He is credited with the first comprehensive description of a CSF leak. St. Clair Thompson (1899) [2, 3] described that in addition to traumatic CSF rhinorrhea, there is a subgroup of spontaneous CSF rhinorrhea. Ommoya et al. (1968) [4] classified CSF rhinorrhea into traumatic and non-traumatic, subdividing the latter into non-traumatic with normal CSF pressure and non-traumatic with CSF hypertension.

The origin of CSF may be from the anterior, middle or posterior cranial fossa. Cerebrospinal fluid from the anterior, middle or posterior cranial fossa may enter the nose directly through the cribriform plate or through the frontal, sphenoid or ethmoidal sinuses. Middle cranial fossa leaks can occur through the sphenoid sinus or indirectly from the mastoid air cells or middle ear through the eustachian tube. CSF can reach the nose from the posterior cranial fossa via the mastoid air cells or middle ear through the eustachian tube. Rarely CSF leak can occur from the posterior cranial fossa into the nose via the sphenoid.

The factors responsible for CSF fistulae, regardless of the etiology, are the same [2]. This includes disruption of the arachnoid and dura mater coupled with an osseous defect and a CSF pressure gradient that is either continuously or intermittently greater than the tensile strength required for healing of the disrupted tissue.

In this study we try to reevaluate CSF rhinorrhea through a combination of prospective and retrospective methods. Our objectives included:

1. Endoscopic repair of CSF rhinorrhea based on a combined diagnostic approach and evaluation of the results.
2. To reevaluate the methods for diagnosis of CSF rhinorrhea, especially in cases of small and multiple leaks.
3. To prevent recurrence and complications in patients with CSF rhinorrhea.

Fig. 1 CECT scan of the PNS showing encephalocele coming through a defect in rt cribriform and fovea ethmoidalis

Fig. 2 CECT scan of PNS showing sagittal view of a large defect in skull base causing encephalocele

Fig. 3 Postoperative CT scan of PNS showing the reduction of encephalocele and closure of defect using multiple layers of bone, muscle and fascia graft

Materials and methods

We have used a combination of retrospective and prospective methods in this study which spans from January 2000 to December 2005. The study group included 20 patients of whom 13 had history of trauma which included iatrogenic causes also, the rest being non-traumatic. Twelve patients (60%) were male and eight (40%) female. Age group of patients varied from 6 years to 65 years. One patient had bilateral CSF leak and another had multiple unilateral leaks, the rest having unilateral leaks.

Diagnosis

A proper history is very important in the diagnosis of CSF rhinorrhea. A complaint of clear watery nasal discharge following [5] trauma within the past few months or years was the presenting complaint in 12 patients which included accidental, iatrogenic and assault injuries. History of recurrent meningitis was the presenting complaint in three patients. Five patients presented with clear watery nasal discharge without any previous history of trauma. Postoperative patients with CSF fistula included a case of angiofibroma. Any other condition which can cause raised intracranial pressure was looked for, like chronic obstructive pulmonary disease, hypertension, chronic constipation etc. Three of our patients were hypertensives, another three were having allergic rhinitis. Importance was given to rule out related congenital anomalies during examination. A possibility of paradoxical rhinorrhea was kept in mind, i.e., CSF coming through the nostril contralateral to the side of leak, which occurs when midline structures that act as separating barriers (eg. crista galli, vomer) are dislocated or a meningocele obstructing the nostril on the affected side. The clinical diagnosis was further helped by increased flow with change of posture like leaning forward and straining

especially against a closed glottis, headache associated with cessation of flow.

Laboratory investigations

Nasal fluid was evaluated for the presence of CSF. The presence of [6] glucose in nasal fluid >30 mg% was taken as a positive evidence for the presence of CSF. This was very sensitive (100%) but highly unreliable due to false positive reports, which could be due to the presence of blood in the sample, active meningitis, subjective laboratory variations etc. $\beta 2$ transferrin assay is much more specific for CSF, but in cases of associated orbital injuries even this is unreliable due to the presence of $\beta 2$ transferrin in vitreous humor [7]. $\beta 2$ transferrin may yield false positive reports in patients with liver diseases. It is also found in new born serum. Since $\beta 2$ transferrin assay was not cost effective we have not used this in our patients.

Radiology

CT/MR cisternography was done in all patients which could demonstrate the fracture site and leak in 17 patients. Failure in demonstrating inactive fistulae was a drawback. Also, there were quite a few false negative reports in patients with multiple leaks and/or small leaks.

Intrathecal dye study

Intrathecal injection of sodium fluorescein 0.2–0.7 ml of 5% solution mixed with 10 ml of CSF or distilled water was used in localizing the site of leak. This method was use-

Fig. 4 CT scan of the PNS showing defect in the lateral wall of sphenoid which caused cerebrospinal fluid leak

Fig. 5 CECT scan of PNS showing defect at the roof of ethmoid with CSF collection in the left side roof of ethmoid

ful in preoperative and transoperative localization of CSF leak. Fluorescein stained CSF was seen coming out of the defect as bright yellowish green fluid. The fluorescein we used for injection was injection sodium fluorescein at 20%

which was previously diluted for a 5% solution. This was administered intrathecally before the anesthesia except in children and very anxious patients between L3/L4 or L4/L5 intervertebral disc space. CSF pressure was measured

Table 1 Details of patients and their treatment

No.	Age/sex	Clinical presentation and diagnosis	Treatment and follow-up
1.	4/M	Lt. cribriform area leak through a 4 mm defect	Endoscopic repair, composite graft as underlay with layered fibrin glue
2.	6/F	5 mm defect in rt. cribriform plate with dural prolapse into nose	Endoscopic repair, composite graft as underlay with layered fibrin glue
3.	35/M	Posttraumatic bilateral cribriform leak with 2 cm defect on rt. side	Endoscopic repair, composite graft as underlay with layered fibrin glue
4.	40/F	Hypertensive patient, spontaneous onset CSF leak from rt. cribriform area	Endoscopic repair, composite graft as underlay with layered fibrin glue recurrence after 8 months treated with multilayer packing of fistula
5.	4/M	h/o head injury with Lt. dacrocystitis, CT scan showing 4 mm defect at the jn of cribriform plate and roof of ethmoid and lamina papyracea	Endoscopic repair, composite graft as underlay with layered fibrin glue
6.	40/F	Hypertensive patient, spontaneous CSF leak, defect at the lateral wall of rt. sphenoid sinus	Endoscopic repair, composite graft as underlay with layered fibrin glue; recurrence after 6 months, revision surgery done
7.	30/M	Rt. CSF leak, CT scan revealed pituitary tumor with downward extension into sphenoid sinus, prolactinoma	Endoscopic hypophysectomy with repair of fistula
8.	35/F	Posttraumatic CSF leak from lateral wall of rt. sphenoid sinus	Endoscopic repair, composite graft as underlay with layered fibrin glue
9.	40/F	Iatrogenic CSF leak following FESS, rt. cribriform plate injury	Endoscopic repair, composite graft as underlay with layered fibrin glue
10.	6/M	Recurrent meningitis, CSF rhinorrhea, CT/MR with intrathecal fluorescein study confirming Mondini's defect with multiple leaks- Lt. oval window and Lt. cribriform plate	Endoscopic/microscopic repair of both cribriform plate and oval window leaks, composite graft as underlay with layered fibrin glue
11.	35/F	Bronchial asthma, allergic rhinitis, constipation with CSF leak from the rt. cribriform plate	Endoscopic repair, composite graft as underlay with layered fibrin glue
12.	14/M	Recurrent meningitis, CT/MR + intrathecal fluorescein study confirming leak from Lt. fovea ethmoidalis	Endoscopic repair, composite graft as underlay with layered fibrin glue
13.	35/F	Spontaneous CSF rhinorrhoea, rt. cribriform area leak with allergic rhinitis	Endoscopic repair, composite graft as underlay with layered fibrin glue
14.	17/F	Pulmonary tuberculosis, CSF fistula from rt. cribriform plate	Endoscopic repair, composite graft as underlay with layered fibrin glue, antituberculosis therapy
15.	35/M	h/o meningitis, CSF leak through Lt. cribriform plate	Endoscopic repair, composite graft as underlay with layered fibrin glue
16.	42/F	Posttraumatic CSF leak from rt. cribriform plate	Endoscopic repair, composite graft as underlay with layered fibrin glue
17.	14/M	Iatrogenic CSF leak from Lt. sphenoid sinus following removal of angiofibroma	Endoscopic repair, composite graft as underlay with layered fibrin glue
18.	65/M	Posttraumatic CSF leak through Lt. cribriform plate, hypertensive	Endoscopic repair, composite graft as underlay with layered fibrin glue
19.	26/M	Posttraumatic CSF leak through posterior wall of frontal sinus on right side.	Endoscopic repair, composite graft as underlay with layered fibrin glue
20.	38/M	Posttraumatic CSF leak through Lt. cribriform plate	Endoscopic repair, composite graft as underlay with layered fibrin glue

whenever possible and 5 cm³ of CSF was removed for lab analysis. Children and very anxious elderly patients were submitted to general anesthesia with orotracheal intubation and immediately placed in surgical position with head and trunk elevated by approximately 30 degrees. 0, 30 and 45 degree endoscopes were used for the visualization of fluorescein and exact localization of fistula drainage after 30 min.

Fig. 6 MR cisternogram showing CSF leak through the defect in the roof of ethmoid

Fig. 7 Postoperative CT scan showing complete closure of defect in the above patient

Treatment

Knowledge of the etiology and topography of the leak plays an important role in the management of CSF rhinorrhea.

Conservative management

Conservative management in CSF rhinorrhea consists of measures to reduce high intracranial pressure. These include – bed rest, head end elevation, avoiding heavy lifting. In our patients we used acetazolamide with the intention of reducing intracranial pressure. Stool softeners or laxatives were used to decrease the strain and increase in intracranial pressure associated with bowel movements.

Fig. 8 Six-year-old female with rt. cribriform plate defect and dural prolapse

Fig. 9 Postoperative CT scan of the same patient showing complete closure of the defect

Fig. 10 Posttraumatic CSF leak patient presenting as left dacryocystitis

Surgical treatment

This study includes only those patients in whom we have used endoscopic approach as a method to repair CSF leak.

A proper exposure of the site of leak was given utmost importance. A deviated nasal septum was corrected using a septoplasty and submucous resection. Once the site of leak is identified endoscopically, the mucosa is elevated from the surrounding bone and the musculofascial graft is tucked in above the bony skull base where possible, i.e., the intracranial side is supported. In the positioning of the graft we have used underlay or overlay techniques based on the size of leak. In case of a small dural defects less than 3 mm free mucoperichondrial graft was placed in an overlay fashion. In larger dural defects or bony defects we have used composite graft. Cartilage or bone was placed in underlay fashion and covered with local flap. Muscle or mucoperiosteum from nasal septum is then placed over the defect and the edges are tucked under the mucosal edges around the defect. Fibrin glue was used to secure it and further support was provided by the use of gel foam packing.

Postoperative care

In the postoperative period all patients were subjected to strict bed rest, head end elevation, cough suppressants and stool softeners apart from broad spectrum antibiotic coverage. Acetazolamide and/or lumbar drainage was tried with the intention of preventing recurrence and ensuring faster healing. Nasal pack was removed after 3–5 days.

Follow-up

The patients were advised monthly follow-up for the first 6 months, six monthly thereafter. Measures like avoiding straining/heavy work, laxatives, cough suppressants were

continued for a period of 6 months postoperatively to prevent a probable recurrence. Acetazolamide therapy was stopped after a period of 3 months. During the follow-up all predisposing factors to CSF rhinorrhea were reassessed and treated when found necessary. All patients were followed-up for a period of 6 months to 5 years, mean being 2 years. Recurrence was noted in 3 patients (15%). Of the three recurrences, one patient was treated by fascia lata graft and muscle and two patients by layering fascia, muscle and fibrin glue. Intrathecal fluorescein was not used for preoperative localization of these cases, initially. Exact localization of defect using intrathecal fluorescein coupled with an effective closure using fascia, muscle and fibrin glue went a long way in reducing recurrence

Results

Of the patients who completed follow-up 60% were male and 40% female. 70% of these were traumatic CSF leaks and 30% non-traumatic. Revision surgery was done in (15%) patients. Endoscopic repair of CSF rhinorrhea produced a first time success rate of 85%. Over all recurrence rate was 15% for the first time and 5% for the second time. CT/MR cisternogram could localize the defect precisely in 85% cases. Intrathecal fluorescein could show the site of CSF leak in all patients in whom this was used (100%). Complications of surgery included anosmia in 20% patients, recurrence in 5%.

Discussion

The use of endoscopes for repair of CSF rhinorrhea has several advantages over the other approaches, including better field of vision with enhanced illumination and magnified angle of visualization. Other advantages include the ability to clean the mucosa off the adjacent bone without increasing the size of the defect and accurate positioning of the graft under direct visualization. It requires a shortened operating time and is associated with lesser morbidity. This should be considered as the first method of closure in all cases except those associated with obvious intracranial pathology like a space occupying lesion. Laboratory analysis of nasal fluid for the presence of CSF is associated with high rate of false positive results. Also radiological evaluation is not foolproof in the localization of fistula as shown by the cases where CT/MRI failed to localize the exact site of leak (15%). Johnson et al. [8] admitted that ideal radiological technique for accurate localization of preoperative CSF fistulae is controversial. The use of intrathecal fluorescein stands as an excellent means to diagnose the site of CSF leak though the invasive nature of this procedure prevents its use as a first line investigation. So this should bring us to the conclusion that the diagnosis of CSF rhinorrhea should

be based on a combination of laboratory and radiological evaluation with the use of intrathecal fluorescein providing the final proof of diagnosis and serving as an effective transoperative guide to closure of the leak. Upon reviewing the literature, we came across a few reports of reversible complications when using intrathecal fluorescein [9–11] though most of the studies show that fluorescein can be safely used [12–14]. No undesirable side-effect was detected in any of our patients after the use of intrathecal fluorescein. Duration of conservative treatment in a case of CSF rhinorrhea should be case dependent and based on etiology. Traumatic and postoperative CSF leaks show better response to conservative treatment. CSF otorhinorrhea in children should be worked up for the presence of underlying pathology like [15, 16] inner ear dysplasias and other systemic involvement. This can be a great mimicker which can present as recurrent pyogenic meningitis or protein energy malnutrition. Diagnosis of such cases require good clinical acumen and can be life saving. The layering of graft material with fibrin glue can reduce the rate of postoperative recurrence of CSF rhinorrhea. Intracranial pressure reducing measures like lumbar drainage of CSF and the use of drugs like [17] acetazolamide have been useful in faster and effective healing of CSF fistulae. Causes of recurrence of CSF leak include failure to localize the exact site of leak, difficulty in controlling the underlying cause of leak like a chronic obstructive pulmonary disease or hypertension, failure on the part of the patient to follow the postoperative advice completely etc.

Conclusion

Endoscopic repair of CSF rhinorrhea provides a better field of vision with enhanced illumination, magnified angle of visualization and accurate positioning of the graft under direct visualization. The high success rate attached with this should make it the preferred approach in traumatic and non traumatic CSF leaks, not associated with intracranial space occupying lesions. Duration of conservative treatment in a case of CSF rhinorrhea should be case dependent and based on etiology. A diagnosis of CSF rhinorrhea should always be based on a combined diagnostic approach which should include laboratory investigations as well as investigations to localize the site of leak. The use of intrathecal fluorescein provides an excellent means to localize the site of leak. The layering of graft material with fibrin glue can reduce the rate of postoperative recurrence of CSF rhinorrhea. Intracranial pressure reducing measures like lumbar drainage of CSF and the use of drugs like acetazolamide are useful in faster and effective healing of CSF fistulae. CSF otorhinorrhea in children should receive utmost priority in clinical work-up

since this may be the sign of some underlying pathology and can produce life threatening complications.

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