Management of Spontaneous CSF Rhinorrhea

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Abstract: Background: Cerebrospinal fluid (**CSF**) is a clear watery nutrient-rich fluid that circulates around the brain and spinal cord. Cerebrospinal fluid rhinorrhea is the leakage of that fluid into nose. It is a symptom of failed containment of Cerebrospinal fluid in its subarachnoid space. Treatment of CSF rhinorrhea includes medical treatment and surgical. **Aim of work**: evaluate and compare the outcome of endonasal endoscopic versus transcranial in repair of anterior cranial fossa dural tear in Spontaneous CSF rhinorrhea. **Material & Methods**: This study was conducted on 20 patients. C.T cisternography using Omnipaque or metrizimide were done for all patients. **Results**: Nine from ten patients of endoscopic cases and eight from ten patients of transcranial were completely cured from the CSF leak. The success rate was (85 %) on the first trial and the only failed three cases had a revision closure with cessation of the leak with same minor complications after the repair three endoscopic and two transcranial. Three transcranial cases and one endoscopic case had major complications. **Conclusion**: CT with intra-thecal injection of Omnipaque or metrizimide is reliable for diagnosis and determinations of the site of the leak. Pre-operative intra-thecal injection of Fluorescein offer the advantage of clear exact identification of the site of the CSF leak. We concluded that the technique of trans-nasal endoscopic repair of CSF rhinorrhea offer the advantage of clear identification of the source of the leak and satisfactory closure with a low morbidity.

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1. Introduction

The cerebrospinal fluid is produced from arterial blood by the choroid plexuses of the lateral and fourth ventricles. A small amount is also produced by ependymal cells. The total volume of CSF in the adult ranges from140 to 270 ml. CSF is produced at a rate of 0.2 - 0.7 ml per minute or 600-700 ml per day. (1)

Cerebrospinal fluid (CSF) rhinorrhea is the leakage of a clear watery nutrient-rich fluid that circulates around the brain and spinal cord into nose. (2)

Anterior cranial fossa cerebrospinal fluid rhinorrhea presents complex challenges for management and repair because of the diverse etiologies, including accidental trauma, surgical trauma (iatrogenic), spontaneous, congenital, and tumors. It is estimated that 70 to 80% of CSF leaks are due to closed head injury from accidental trauma and most commonly after motor vehicle accidents. (3)

Most of the non-traumatic cases occur in adults in the fourth decade of life with females outnumbering males 2:1. It may present after an episode of sneezing, coughing or a minor upper respiratory tract infection. The initial onset is insidious, often mistaken for a feature of rhinitis. (4)

It is not difficult to appreciate how this may happen after trauma, but it is more difficult to account for this in non-traumatic cases of CSF rhinorrhea. Postulated mechanisms of CSF escape generally begin with increased intra cranial pressure (ICP). Raised ICP even if transient could start a leak if the potential pathway is present. This may be the case even if there is no evidence of raised ICP because the leak may act as a safety valve. However, raised ICP may not be necessary for the development of spontaneous CSF rhinorrhea. It has been noted that the onset of non-traumatic CSF rhinorrhea usually occurs in adults, which coincides with the attainment of the highest levels of normal CSF pressure, an increase from 40 mm in infants to approximately 140 mm in the adult. In addition, the normal CSF pressure is high in many positions of the head and is subject to recurring fluctuations, averaging 80 mm CSF fluid every few seconds. Another factor also affects CSF pressure is the arterial and respiratory pulse waves. It is believed that the deep excavations of the cranial vault occupied by arachnoid granulations produce the normal CSF pressure pulse. (5)

Diagnosis

Various combinations of planar tomography and CT, contrast enhanced CT cisternography, and radionuclide cisternography, and, more recently, MR Cisternography have been used in the diagnosis of CSF leak. Radionuclide cisternography and contrast-enhanced CT cisternography techniques require injections into the intra-thecal space, most often via lumbar puncture. Although cisternography has minimal inherent risks, such as infection and lumbar CSF leak, it significantly increases expense and adds patient discomfort. Radionuclide studies do not

provide precise anatomic localization of CSF leaks suggest that high-resolution CT is a useful screening examination for the initial workup of CSF rhinorrhea or otorrhea. [6]

Laboratory tests of the fluid can be conducted. In some cases, there is contamination of the material with blood or other secretions, so the test with β_2 transferrin becomes mandatory. β_2 transferrin is a carbohydrate-free isoform of transferrin, which is almost exclusively found in the CSF and blood or nasal secretion does not disturb the test. β_2 transferrin is not present in blood, nasal mucus, tears or mucosal discharge. [7]

Detection of glucose in the sample fluid using Glucostix test strips has been a traditional method for detection of the presence of CSF in nasal and ear discharge. It not recommended as a confirmatory test due to its lack of specificity and sensitivity. [8]

The "Reservoir sign" is a well-known physical finding used to elicit rhinorrhea. This test is ideally performed immediately on rising from the bed. The patient is asked to place the chin over their chest. The patient must stay in that position for one full minute. Clear fluid dripping from the nose is CSF. A sudden rush of clear fluid is indicative of CSF fistulae. It is a useful method for collecting fluid for biochemical analysis. [9]

The handkerchief test: Discharge from the nose is blown into a handkerchief and is allowed to dry. If the discharge is CSF, the handkerchief will not stiffen, if the discharge is secretions from the nose the handkerchief stiffens due to the presence of mucin in the nasal secretions. [10]

Treatment

Conservative management in CSF rhinorrhea consist of measures to reduce high intracranial pressure.

These include bed rest, head end elevation, avoiding lifting of heavy weights and acetazolamide. Stool softener or laxatives can be used to decrease the strain and increase in intracranial pressure associated with bowel movements. [11]

A subarachnoid lumbar drain may be placed to drain approximately 5-10 mL of CSF per hour. Continuous drainage is recommended over intermittent drainage to avoid spikes in CSF pressure. The utility of a lumbar drain is limited in cases of a large skull base defect or iatrogenic CSF leaks. The long-term consequences of a persistent defect in the anterior cranial fossa dissuade many physicians from using this method of treatment. [12]

If non-operative treatment has failed after 10-14 days, or if the leak recurs or is chronic, the problem of localization and surgical treatment must be addressed as the other treatment option. [13]

Transcranial Approach:

Intracranial repair was frequently used for the routine repair of anterior cranial fossa CSF leaks. These leaks were typically approached via a frontal craniotomy. In rare situations, a middle fossa or posterior fossa craniotomy was required. Leaks arising from the sphenoid sinus are difficult to reach by means of an intracranial approach. [14]

Once the subarachnoid dehiscence has been identified, its intradural repair with sutures permits a watertight seal. It is described as having the advantages of direct visualization of the dural tear, inspection and treatment of adjacent cortex, and a better chance at tamponading a leak in the face of increased ICP. However this approach has many drawbacks including greater morbidity, brain retraction and frequent loss of olfaction (in surgery of the anterior cranial fossa), extended operative time, prolonged hospitalization, poor view of communicating fistulas from the sphenoid sinus, and increased risk of anosmia. Incidence of persistent leak. Series report from 20% to 40% failure rate. 10% have persistent leaks despite multiple repair attempts. [15]

Extracranial Approach:

External approaches to the skull base can also be obtained through various incisions or through nasal approaches for access to the ethmoid sinuses and sphenoid sinus. These include external ethmoidectomy, transethmoidal sphenoidotomy, transseptal sphenoidotomy, and the transantral approach to the skull base. These procedures are infrequently chosen in current practice, given the high success rates and low morbidity associated with the endoscopic approach. [16]

Endoscopic Surgery:

The endoscopic approach is asubset of the extracranial, extradural approach to CSF fistula. Since 1981 when Wigand first used endoscopic treatment to treat CSF rhinorrhea, the technique has become popular worldwide due to its advantages of excellent visualization, precise graft placement, and shortened operating time. Trasnasal endoscopic surgery minimizes intranasal trauma and preserves the bony framework supporting the frontal recess and other critical areas. [17]

Endoscopic repair of CSF rhinorrhea essentially follows the same principle as that of microscope. It however has added advantage of panoramic view of the skull base and has more accuratelocalizing value than the other methods of repair. The transnasal repair with endoscope involves, packing the nose with xylocaine with adrenaline (1:100,000) tofacilitate shrinkage of mucosa and turbinates and minimizing operative blood loss. Zero and 30 degree telescope are often used for the repair. The procedure can be done with or without the use of nasal speculum. Similarly, one can be guided at the site of leak by the use of intra

operative fluoroscopy. There are group of surgeons who believe that the middle turbinate should be excised whereas others do it by lateralizing middle turbinate. The site of leak requires definite confirmation before repair. The site of leak can be confirmed with Valsalva maneuver or by the use of fluorescent dye, whichis seen as yellowish stain CSF within the endoscope. [18]

CSF fistula in the sphenoid sinus is nicely controlled with fibrin glue and Gel foam. Fibrin glue is injected through standard angiocatheters and under direct vision into the sphenoid sinus. Once gelatinized, the sphenoidotomy opening is plugged with Gel foam to hold the fibrin glue in place. Within 2 weeks, the Gel foam dissolves and the fibrin glue is absorbed or disappears. [19]

Familiarity with the nose and paranasal sinuses is an essential step in doing endoscopic repair. It is to be noted that the visible site of CSF leak in the nose may not be the actual site of dural rent at the base of skull. Many times, the leak at floor of sinus is mistaken as leak at the base of skull. Therefore, dura or the herniating brain should be identified at the base of skull before the repair is started. Whenever there is herniation of any brain substance into the sinuses it should be removed till the margins of dura are clearly defined. For most of the neurosurgeons the site of leak at the sphenoid sinus is easily identified because of the familiarity of this area to the neurosurgeons. [20]

Major complications associated with endoscopic endonasal approaches are similar in nature to those encountered during traditional skull base approaches. These include CSFleaks, bleeding, pneumocephalus, diplopia, traumatic or compressive optic neuropathy, hemorrhage, and cerebrovascular accidents. Other infections, such as meningitis, intracranial abscesses, and osteomyelitis, are possible, although they occur rarely. [21]

2. Patients and Methods

This is a retrospective and prospective study of patients with CSF rhinorrhea whom underwent surgical treatment via endonasal endoscopic and transcranial approach operated by between 2009 and 2018 for evaluating the clinical state, laboratory investigation, radiological findings and different ways of management in cases of CSF rhinorrhea and its results.

The patients having post endonasal endoscopic or transcranial CSF rhinorrhea repair who were operated in Neurosurgery Department, Al-Hussien Hospital, Al-Azhar University, Cairo, Egypt, Dar Al-Shiffa Hospital, Cairo, Egypt, Kasr El-Eni University Hospitals, Cairo, Egypt and Al Doaa Hospital, Cairo, Egypt.

All patients were subjected to the following scheme of work:

I. History taking:

A) Personal history including age and sex.

B) Past medical history, any operation history, allergy, chronic diseases.

C) Onset, course and duration of the patient's complaint.

D) Present history including complete ENT symptoms: with stress on rhinologic symptoms and inquiring about:

- ***Nasal obstruction*:** unilateral or bilateral and its severity.
- ***Nasal discharge*:** unilateral clear watery which may be persistent or intermittent, its duration, its character (does not dry on handkerchief), its color and odor, if the discharge had a salty taste, its relation to position (increases on leaning forward), effect of coughing or straining on the discharge).
- ***Headache*:** It is caused by either high or low CSF pressure, its relation to the nasal discharge; if it is relieved by the watery discharge, it indicates that it is mostly a high-pressure leak.
- ***Smell disorder*:** Anosmia may suggest a cribriform plate defect or fracture traumatizing the olfactory tract.
- ***Epistaxis*:** In elderly patients, this raises the suspension of hypertension.

E) History of previous nasal surgery: (surgical trauma) and its relation to the onset of the discharge to exclude this case.

F) History of head trauma: CSF rhinorrhea may occur due to fracture skull base especially in the region of anterior cranial fossa to exclude this case.

II. Complete Neurological examinations:

A) General Appearance, including posture, motor activity, vital signs and perhaps meningeal signs if indicated.

B) Mini Mental Status Exam, including speech observation.

C) Cranial Nerves, I through XII.

D) Motor System, including muscle atrophy, tone and power.

E) Sensory System, including vibration, position, pin prick, temperature, light touch and higher sensory functions.

F) Reflexes, including deep tendon reflexes, clonus, Hoffman's response and plantar reflex.

G) Coordination, gait and Rhomberg's Test

III. Confirm CSF leak:

A) Positional change test: the patient is put in prone position for 5 minutes then observing if there is leak.

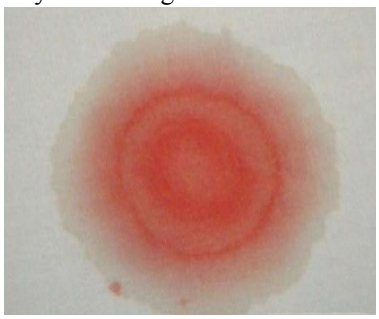
B) Jugular compression test: to confirm diagnosis (manual compression of internal jugular

vein provokes or increases the leak due to raised intracranial tension).

C) Reservoir sign: after being supine for some time, the patient is brought to an upright position with the neck flexed. A sudden rush of clear fluid is indicative of CSF fistula.

D) Handkerchief test: the fluid associated with rhinitis contains mucous that stiffens on the handkerchief, while CSF do not as it does not contain mucous.

E) Halo/Target sign: When the CSF leak is blood stained it dries out with a central blood stain surrounded by a clear ring.



Laboratory investigations:

A) Glucose content in CSF.

B)β_2 transferrin: its detection can clearly demonstrate whether CSF leakage exists or not as it has been demonstrated only in CSF, perilymph, and aqueous humor.

Radiological investigations:

A) CT cisternography: CT scan with intra-thecal injection of contrast (Omnipaque or metrizamide):

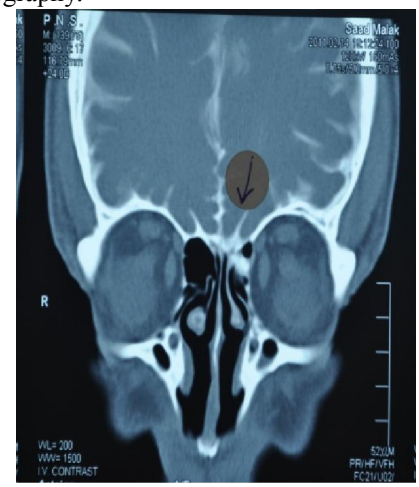
1. pre-contrast CT is performed with thin slices.

2.3-10 mL of contrast agent is installed into thecal sac after lumbar puncture.

3. The patient is tilted with foot-end elevation and a CT scan is performed with thin slices; manoeuvres that provoke an active leak, such as head hanging or sneezing, are performed to visualize intermittent or occult leaks.

4. post-contrast images are then compared with the pre-contrast image to see where the CSF and the contrast are leaking out.

5. radionuclide cisternography is more sensitive but has poor anatomic resolution compared to CT cisternography.



B) Coronal MRI cisternography scan.

V. Exclusion of any other causes of watery nasal discharge:

A) Nasal allergy

B) Organic causes such as intracranial neoplasms such as meningioma, glioma and pituitary gland tumors.

C) Skull base neoplasms e.g.: nasopharyngeal carcinoma, angiofibroma.

D) Sino-nasal malignancy.

VI. Trial of Conservative treatment:

All patients in this study go to a trial of conservative medical treatment for 3 month at least, in the form of:

- Bed rest in semi-sitting position with the head elevated 45 degree from the supine position.
- Patients were advised to avoid sneezing, coughing, straining, lifting heavy objects.
- Systemic antibiotics for 10 days, 3rd generation Cephalosporin were chosen as they cross the blood brain barrier.

Results

This study included 20 cases of spontaneous CSF rhinorrhea. They were selected to be managed surgically. Patients were followed up clinically for six months after treatment.

Age of the patients ranged from 12-65 years. The mean age was 46.35 years old with SD ±13.377; most patients' age was ranging between 41 – 50. There were 5 males (25%) and 15 females (75%). pseudotumor cerebri was present in 9 patients, congenital bone defect was seen in 5, Infected bone erosion was seen in 4 and empty sella was observed in 2 patients.

In the present study patients presented with variety of symptoms concerning spontaneous CSF rhinorrhea as headache, unilateral watery discharge, vertigo, facial numbness or weakness, unusually blurry or double vision, neuralgia, fatigue, or a salty taste in the mouth.

Table 1: Distribution of expecting pathology, the total patient watery discharge is 19.

positive examinations	Number	Percentage
positional change	13	68.5%
Jugular compression	14	73.6%
Reservoir sign	17	89.5%
Halo sign	17	89.5%
Glucose concentration	19	100%
β2 Transferrin	19	100%

Forty percent of cases had excellent outcome without any complications or recurrence, twenty-five percent of cases had minor complications improved with short time (Good outcome), twenty percent of cases had major complications (anosmia, Tension Pneumocepahlus, Perioperative Bleeding, Cerebrovascular Accidents, Osteoradionecrosis, orbital hemorrhage, exophthalmos, orbital emphysema, lipogranuloma formation, and intraorbital foreign body reaction) and (3/20) fifteen percent of cases is require second attempt.

Table 2: The outcome of patients in relation to age distribution.

Gender		Outcome			
Age	Number	Excellent	Good	Fair	poor
< 20	2	2			
20 - 40	2	1	1		
41 - 60	13	5	4	3	2
>60	2			1	1
total	20	8	5	4	3

Percentage of excellent outcome in Endoscopic patients 62.5% (5/8) of all excellent outcome, In comparison with Transcranial Patient is 37.5%. Percentage of Fair and poor outcome in Endoscopic patients 28.6% (2/7) of all poor and fair outcome, and in Transcranial patients is 71.4%.

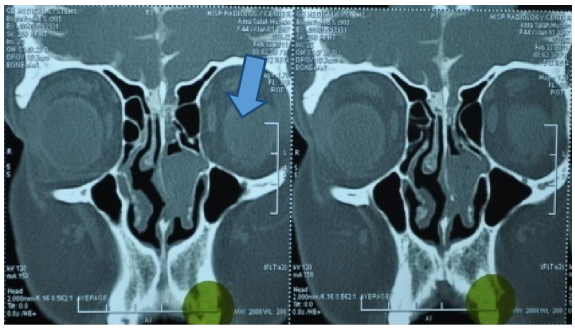
Table 3: Percentage of site of leakage.

Site of the leakage	Number	Percentage
Fovea ethmoidalis	3	15%
Cribriform plate	7	35%
Sphenoid sinus	2	10%
Frontal recess	1	5%
Lateral lamella	1	5%
Roof of the posterior ethmoid	6	30%

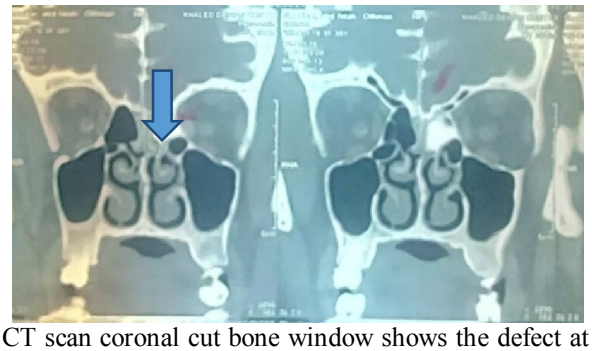
Cribriform plate is most site of CSF leakage in cases of spontaneous rhinorrhea, and the less site is frontal recess and lateral lamella.

Table 4: correlation between site of the leakage and expecting pathology.

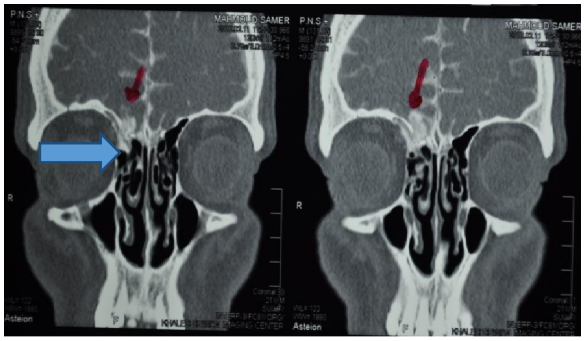
Site of the leakage	Number	expecting pathology			
		congenital	bone erosion	pseudotumor cerebri	empty sella
Fovea ethmoidalis	3	2 (66%)		1 (34%)	
Cribriform plate	7	2 (28.5%)		5 (71.5%)	
Sphenoid sinus	2				2 (100%)
Frontal recess	1		1 (100%)		
Lateral lamella	1			1 (100%)	
Roof of the ethmoid	6	1 (16.5%)	3 (50%)	2 (83.5%)	



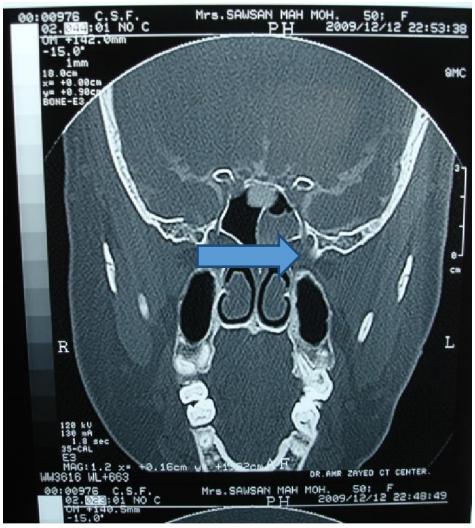
CT cisternography coronal cut shows the recurrent defect at anterior cribriform plate on the left side with slipped flap (arrow).



CT scan coronal cut bone window shows the defect at the posterior ethmoid roof on the left side (arrow).



CT cisternography coronal cut bone window shows the defect at the frontal recess on the right side (arrow).



CT cisternography axial cut bone window shows the defect at the sphenoid sinus (planumsphenoidale) on left side (arrow).

Cribriform plate is most site of CSF leakage and pseudotumor cerebri is most expecting pathology of spontaneous CSF rhinorrhea.

Conclusion

CSF rhinorrhoea is a symptom of failed containment of the CSF to its subarachnoid space. It indicates a communication with the subarachnoid space and therefore dura and bone to permit exit of CSF to the nose.

The causes can be divided into traumatic and non-traumatic (spontaneous). Further, the traumatic group is divided into acute and delayed, while the non-traumatic group is includes two subdivisions according to the intracranial pressure (ICP), those with high pressure and a normal pressure group.

Management of CSF rhinorrhea is controversial but can be divided into a conservative and surgical treatment. Should the conservative treatment fail, the surgical decision must be considered to avoid the most

dangerous complication, which is the risk of meningitis, in this present study, one patient suffer recurrent meningitis due to patient will to latency of surgery.

The surgical treatment for closure of CSF leak is divided into intra-cranial approach and extra-cranial one. Recently the trans-nasal endoscopic technique is introduced in the management of CSF leak.

The aim of this work was to study to evaluate and compare the outcome of endonasal endoscopic versus transcranial in repair of anterior cranial fossa dural tear in Spontaneous CSF rhinorrhea.

The study was conducted on 20 patients suffering from CSF rhinorrhea. Their leaks were spontaneously.

The patients were subjected to thorough history taking, general examination, and full ENT examination including nasal endoscopy in the outpatient clinic. CT cisternography using Omnipaque or metrizamide injected intra-thecally.

In our work, 17 patients had a complete cessation of CSF rhinorrhea. 3 patients had recurrence of the leak. 10 our patients had a non-complicated follow up and other 10 patient had minor or major complication.

In endoscopic cases, the main graft material used was obtained from mucoperichondrium of the same side of the nasal septum or fascia lata and subcutaneous fat. At the end, sergicell or gelfoam was used to support the grafting material.

In transcranial cases, the main graft material used was obtained is dural graft and we used fibrin glue to support our graft material.

Our study showed that the use of CT scan with intra-thecal injection of Omnipaque or metrizamide of great help in diagnosis and localization of the defect. Moreover, the use of Fluorescein dye pre-operative is very helpful in tracing the colored CSF and repairing the defect.

In our study, we did in same cases use spinal taps or lumber drains postoperatively and brain-dehydrating agents used to decrease the intracranial pressure.

We concluded that the technique of trans-nasal endoscopic repair of CSF rhinorrhea offer the advantage of clear identification of the source of the leak and satisfactory closure with a low morbidity.

This technique has proven to be a safe and successful approach for management of CSF rhinorrhea.

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