Spontaneous Medial Cribriform CSF Leak: Endoscopic Surgical Repair with Free Mucosal Graft—Our Experience

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Abstract Cribriform plate is the commonest site of spontaneous CSF leak, the fragility of the plate and juxtaposition of arachnoid's investment to the bone, where the olfactory nerve pierces the skull made this area, a vulnerable site for CSF leak. Transnasal endoscopic approach has gained popularity for CSF leak repair over the years. To describe the 5 year experience of spontaneous medial cribriform CSF leak repair with free mucosal graft in a tertiary medical centre. All patients who underwent transnasal endoscopic repair with free mucosal graft for spontaneous medial cribriform CSF leak in our institution between 2011 and 2016 were reviewed. Twelve patients were identified, all were women with a mean age of 44.5 years. The defect was localised by preoperative computed tomography scans with 1 mm cuts and MR cisternography. Via medial approach, the mucosa surrounding the entire defect was denuded and the defect was closed with free mucosal graft harvested either from the middle turbinate or from the nasal septum and middle turbinate was finally sutured with septum to stabilise the repair. The overall success rate was 100% with the first attempt with no recurrence or postoperative complications. Follow up ranged from 1 to 5 years. The endoscopic transnasal technique with free mucosal graft for the repair of spontaneous medial cribriform CSF rhinorrhoea is associated with a very high success rate and it should be considered for majority of cases.

Keywords Cerebrospinal fluid (CSF) rhinorrhoea · Medial cribriform spontaneous leak · Free mucosal graft

Introduction

CSF rhinorrhoea is leakage of cerebrospinal fluid from the nose due to communication with subarachnoid space with disruption of dura along with osseous defect [1]. Aetiology of CSF rhinorrhoea is classified as traumatic (80%) and spontaneous (20%) [2]. Traumatic include accidental and iatrogenic while nontraumatic (spontaneous) include high pressure and normal pressure CSF leak. Site of leak usually varies with aetiology.

Spontaneous CSF rhinorrhoeas are more common among obese females especially in 4th decade. Surgical management is the treatment of choice for spontaneous leak. Wigand in 1981 repaired the CSF leak by endonasal endoscope. Now minimally invasive endoscopic approach has become the standard treatment for CSF rhinorrhoea, with 90% success rate, with lower rate of morbidity and mortality as compared to the traditional intracranial techniques [3, 4].

Materials and Methods

We reviewed the patients who presented to our department with CSF rhinorrhoea. Patients with spontaneous medial cribriform CSF leaks were included in our retrospective study, while those with spontaneous leak from other site, history of trauma, previous nasal surgery, congenital skull base malformations, tumours eroding the skull base and patients with benign intracranial hypertension were excluded from the study. 12 patients (Table 1) were included in

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Table 1 Patient details

No.	Age and sex	Duration (months)	Symptom	Laterality	Diagnosis	Graft	Follow up
1	60 years, F	1	Watery discharge, anosmia	Left	MR cisternography	Septal mucosa	No recurrence
2	36 years, F	1	Headache, watery discharge	Left	HRCT	Middle turbinate mucosa	No recurrence
3	34 years, F	2	Headache, watery discharge	Left	MR cisternography	Septal mucosa	No recurrence
4	44 years, F	4	Watery discharge, meningitis	Right	HRCT	Septal mucosa	No recurrence
5	27 years, F	6	Recurrent meningitis, watery discharge	Left	HRCT	Septal mucosa	No recurrence
6	45 years, F	3	Watery discharge	Left	HRCT	Middle turbinate mucosa	No recurrence
7	36 years, F	6	Watery discharge, meningism	Right	HRCT	Septal mucosa	No recurrence
8	28 years, F	3	Watery discharge	Right	HRCT	Septal mucosa	No recurrence
9	40 years, F	2	Headache, watery discharge	Left	HRCT	Middle turbinate mucosa	No recurrence
10	33 years, F	4	Watery discharge	Left	HRCT	Septal mucosa	No recurrence
11	29 years, F	3	Watery discharge, meningitis	Left	HRCT	Septal mucosa	No recurrence
12	36 years, F	5	Watery discharge	Right	HRCT	Middle turbinate mucosa	No recurrence

the study. All were females with mean BMI of 24.5. Several parameters were evaluated including; age, sex, duration of the CSF leak laterality, accompanying complaint, diagnostic tests, types of graft, & follow up. The most common presenting complaint was continuous watery nasal discharge (Fig. 1). The diagnosis of CSF rhinorrhoea was based on clinical history and detailed nasal endoscopic examination. The presence and site of CSF leak was confirmed by CT scan coronal cuts (1 mm) of the paranasal sinuses and associated MR cisternography has to be done in two patients to confirm the site of defect as it was not clear on plain CT scan. CT cisternography was reserved for cases with multiple skull base defects or when conventional CT or MR cisternography fail to localise the site.

Fig. 1 Clinical presentations

MRI brain was routinely done in all patients to look out for radiological features of benign intracranial hypertension. All patients underwent Trans nasal endoscopic CSF leak repair with free mucosal graft.

Operative Technique

Under general anaesthesia, after proper decongestion of nasal cavity, middle turbinate and superior turbinate were lateralised to visualise the site of leak (Fig. 2). In cases where concha bullosa was evident on the side of defect, lateralisation of middle turbinate was done after lateral lamellectomy and the same mucosa was used for repair. After localising the defect, the mucosa surrounding the defect was cauterised with bipolar cautery (Fig. 3). If associated meningoencephalocele or meningocele were present, it was reduced with bipolar cautery. We also have MLW Coblation wand (Arthocare System). Free mucosal graft either from middle turbinate mucosa or from septum was placed by overlay technique. Graft stabilised with surgical and gelfoam after ensuring adequate contact between the graft and the defect site. Finally the middle turbinate was pushed back to normal position and sutured

Fig. 2 Raw area created around Right Cribriform area

Fig. 4 Surgical and gelfoam used to support the graft

Fig. 3 Graft spread out and should have adequate contact with the underlying bone

Fig. 5 Right middle turbinate sutured with the septum

with nasal septum to support the graft and also to stabilise the middle turbinate (Figs. 4, 5, 6). Merozel pack was removed on fifth postoperative day and patient ambulated.

Results

All the 12 patients were females, their ages ranged between 27 and 60 years with mean BMI of 24.5. All presented with watery nasal discharge, two patients with meningitis, two patients with headache and one patient with anosmia. Medial cribriform leak was confirmed by HRCT paranasal sinuses and associated MR cisternography has to be done in two patients to confirm the site of defect as it was not clear on plain CT. Although CT cisternography is the gold standard for evaluation of CSF leak, we usually resort to non invasive imaging like HRCT and MR cisternography. Endonasal endoscopic approach was used in all the patients with free mucosal graft of either middle turbinate or septum. In our series mean operating time was 20 min, no post operative morbidity, early mobilisation with 100% success rate and no recurrence on long follow up.

Fig. 6 Final view after repair

Discussion

Non traumatic CSF rhinorrhoea can be high pressure or normal pressure leak. Obesity is an important risk factor which increases intra abdominal and intra thoracic pressure. This may effect blood circulation in cranial venous collectors and lead to development of permanent benign intracranial hypertension [5, 6]. Spontaneous CSF leaks are idiopathic but recent studies revealed that spontaneous CSF rhinorrhoea is in secondary to an elevated intracranial

pressure (ICP) with co factors such as sneezing, coughing, or other causes of normal fluctuations in cerebrospinal fluid pressure [7]. The elevated pressure exerted on areas of the skull base result in remodelling and thinning of the bone. Ultimately, the bone is weakened and a defect is formed. If the defect is large, brain parenchyma may herniated as meningocele, encephalocele or meningoencephalocele. Since the communication between a sterile intracranial compartment and a non-sterile sinonasal cavity can lead to threatened complications (e.g., meningitis or brain abscess) [8–10].

CT/MR imaging features that support the diagnosis of benign intracranial hypertension include prominent sub-arachnoid space around the optic nerves, vertical tortuosity of the optic nerves, papilloedema with peripapillary C shaped halo, enhancement of the prelaminar (intra-ocular) optic nerves, enlarged arachnoid out-pouchings, partial empty sella, enlarged Meckel cave, prominent arachnoid pits or small meningoceles typically within the temporal bone and sphenoid wing and bilateral transverse sinus (lateral segments) stenosis [18]. Additional clinical finding include normal CSF composition with elevated opening pressure, with a mean pressure of less than 35 mmHg, with pressure waves as high as 80 mmHg which last 5–20 min. In cases with associated benign intracranial hypertension, shunting (ventriculoperitoneal or lumboperitoneal) has to be done before the repair.

Anterior skull base is formed by cribriform medially and fovea ethmoidalis laterally. Cribriform has a medial lamella [horizontal] and a lateral lamella [vertical]. Fovea extends from lateral lamella laterally to form the roof of ethmoidal sinuses. Lateral lamella is the part of cribriform plate lateral to middle turbinate attachment which lies lower than the level of fovea. Depth of olfactory fossa will depend on the height of lateral lamella [Keros]. Iatrogenic trauma are more common in lateral lamella Keros type 3. Medial lamella is the part of cribriform plate medial to middle turbinate attachment with an area of $< 0.5 \text{ cm}^2$ and thickness of 0.1–0.2 mm. The fragility of the plate and juxtaposition of the arachnoids' investment to the bone, where the first cranial nerve perforates the skull, prolongation of subarachnoid space which follows the olfactory filament, slow erosion of skull base owing to fluctuations in ICP leading to point erosion which finally leaks through the weakest area makes this area of the skull a vulnerable site for spontaneous CSF leak.

CT coronal 1 mm cuts of paranasal sinuses, MRI, CT cisternography and MR cisternography help in identifying the underlying aetiology of CSF rhinorrhoea and in detecting the site, side, and size of leaking fistula [11–13]. Surgical management of CSF rhinorrhoea can be by an intracranial or extracranial approach. Management by an intracranial approach carries morbidity and failure rates

between 20 and 40% [14–16]. Trans nasal endoscopic approach is less morbid and has a success rate of 90–100% [4].

During repair, mucosa surrounding the defect is removed and the edges made raw to promote osteogenesis, better placement and take up of the graft and to reduce the incidence of mucocele formation. Being the thinnest part of skull base, medial cribriform plate if subjected to too much manipulation can cause enlargement of the defect size and micro fractures which may extend to the lateral lamella of cribriform, disruption of olfactory filament resulting in hyposmia. Hence in our technique we created raw area at defect site and adjacent area which include upper part of septum and upper part of middle turbinate by bipolar cauterization or with MLW Coblation wand with no further manipulation or enlargement of defect size.

Number of grafting materials were used to close the defect such as abdominal fat, nasal septum mucosa, bone, fascia lata and muscle grafts [17]. Graft can be placed by different techniques like overlay, underlay, bath plug, sandwich multiple layer, blanket graft etc. Here we used simple overlay technique. Advantage of using the overlay technique in this region is, olfactory epithelium is non secretory, so even if the entire mucosa is not denuded, the chances of mucocele formation is nil. Middle turbinate Suturing has been highlighted in literature to prevent lateralization of middle turbinate. Advantage of middle turbinate suturing is that it supports the entire repair and enhances adhesion formation which helps to retain the graft in position. Advantage of free mucosal grafts of middle turbinate or septal grafts are obtaining from same site, less operative time (mean operating time – 20 min), less post operative morbidity and early mobilisation compared to other graft like fascia lata. Success rate is 100% with no recurrence on long term follow up. Reduced donor site morbidity as compared to fascia lata. Less crusting as compared to fascia lata.

Conclusion

Spontaneous CSF leaks are more common among middle aged obese females. Medial cribriform plate is the most common site in spontaneous leak because of its thin and fragile nature. With the aid of free mucosal graft, medial cribriform leak repair become easy with less operating time and very high success rate comparable to other graft materials.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval This article does not contain any studies with animals performed by any of the authors.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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