Endoscopic Endonasal Repair of Sphenoid Sinus Cerebrospinal Fluid Leaks: Our Experience

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Abstract Endoscopic endonasal approaches are becoming increasingly popular over transcranial approaches for repair of cerebrospinal leak defects. Sphenoid sinus CSF leaks pose a significant challenge and carry the risk of life-threatening intracranial complications. Their management depends upon identifying the leak using imaging techniques followed by intraoperative endoscopic localization. Our experience in the endoscopic endonasal management of sphenoid sinus CSF leaks is reported in this paper.

Keywords Sphenoid sinus · Cerebrospinal fluid · Sternberg canal · Endoscopic

Introduction

An abnormal communication between the subarachnoid space and nasal cavity results in Cerebrospinal fluid rhinorrhoea. Nearly 80 % of CSF leaks occur as a result of accidental trauma. About 16 % are iatrogenic and attributable to intracranial or sinonasal surgeries. Only 4 % of leaks are spontaneous (non-traumatic) leaks. These may occur due to intracranial tumours, congenital or acquired hydrocephalus. Meningoceles and meningoencephaloceles may occur with both traumatic and non-traumatic causes. Idiopathic CSF leaks are the rarest of CSF leaks and are

often a diagnosis of exclusion. The defects may be located anywhere in the ventral skull base which includes the cribriform plate, fovea ethmoidalis, sphenoid bone, temporal bone or posterior table of frontal sinus [1].

Patients usually present with intermittent leakage of clear, watery fluid from the nose that is classically associated with change in position. Laboratory analysis of the nasal discharge for CSF markers confirms the diagnosis [2]. Most traumatic cases resolve with conservative measures such as bed rest, head end elevation, avoidance of strenuous activities such as coughing, sneezing, nose blowing or straining at stools and reducing CSF pressure by spinal tap/drain within 7–10 days. Leaks which persist despite conservative measures, extensive intracranial injury and leaks identified intra-operatively (during endoscopic sinus surgery or skull base surgery) require to be managed surgically [3].

The surgical repair of CSF leaks has progressed drastically with the advent of endoscopes and improved understanding of skull base anatomy. Endoscopes permit direct visualisation, accurate localisation and precise repair of leak and hence reduce failures and morbidity associated with transcranial approaches.

CSF leaks involving the sphenoid sinus are challenging. Transcranial approaches to the sphenoid sinus are particularly extensive and even using microscopic trans-septal approaches, it may not be possible to visualise the lateral walls. Due to the presence of adjacent neurovascular structures, it may not be possible to cover defect using underlay graft and extended sphenoidotomy approach through pterygopalatine fossa may be needed. Hence, obliteration of sinus or lateral recess has been recommended [4].

This paper reports our experience with the endoscopic endonasal management of sphenoid sinus CSF leaks.

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Methodology

A retrospective review of case records of patients who underwent endoscopic endonasal repair of sphenoid sinus CSF leaks at Royal Pearl Hospital, Trichy, Tamilnadu from 2009 to 2013 was done. All cases of congenital, traumatic and idiopathic sphenoid sinus CSF leaks were included. Clinical details of patients including history, diagnostic work up which included Computerised Tomography (CT) and Magnetic Resonance Imaging (MRI) studies, operative notes, post-operative management and course of stay were recorded and analysed. A total of 21 patients were included in the study.

Results

A total of 21 patients underwent endoscopic repair of sphenoid sinus CSF leaks during the study period of which 15 were males and 6 were females. Three of these patients had traumatic leaks while seventeen had idiopathic leak and one had congenital leak. Complications associated with CSF leak included meningitis in three patients and pneumocephalus in one. All patients underwent detailed neuro-ophthalmological evaluation. Glucose in nasal discharge was estimated to confirm CSF. Site of leak was confirmed using CT or MR Cisternography (Figs. 1, 2, 3). Separate informed consent was taken from patients for injection of intrathecal fluorescein. Intrathecal fluorescein (0.5 ml of 5 % fluorescein mixed with 10 ml of CSF injected over 10 min) was further used to endoscopically confirm and localize the site of leak. A CSF leak filter (blue filter) was used to detect green birefringence during surgery. Patient was put in head down position for 1 h after injecting intrathecal fluorescein and then taken up for surgery (Fig. 4). Table 1 shows the site of leak in patients included in the present study.

Fig. 1 Coronal CT image showing Sternberg canal leak

Fig. 2 CT scan showing CSF leak in region of tuberculum sphenoidale

Fig. 3 CT scan showing CSF leak in region of planum sphenoidale

Operative Technique

Endoscopic endonasal repair of CSF leak was performed in all patients using the bi-nostril, two-surgeon, four handed dissection technique. All surgeries were performed under general anesthesia (normotensive). The posterior two thirds of the ipsilateral inferior turbinate was resected. The inferior part of ipsilateral middle turbinate was resected in all cases to create a wide surgical corridor. Transpterygoid approach was employed for Sternberg canal leaks. Posterior septectomy was done and the Hadad–Bassagasteguy flap (pedicled naso-septal flap) was raised on the opposite side of leak. After performing a middle meatal antrostomy on the side of leak, the medial 1/3 of the posterior wall of the maxillary sinus was chiselled out. The sphenopalatine artery was ligated and the descending palatine artery was

Fig. 4 Green birefringence seen on administration of intrathecal fluorescein in a case of Sternberg canal leak

Table 1 Site of leak

Site of leak	Number of cases
Planum	2
Tuberculum	1
Mid-clivus	1
Petro-clival	1
Sternberg canal	16
Total	21

cauterised at the junction of the vertical process of palatine bone with the medial pterygoid plate. Sphenoidotomy was performed and the sphenoid ostium was widened. The pterygoid wedge which is situated at the trifurcation of the medial pterygoid plate with its attachment to the body of the sphenoid was drilled. Anterior wall of the sphenoid sinus was drilled. Opposite side sphenoidotomy was performed. Intersinus septum and rostrum were drilled to combine both the sphenoids into a single cavity. Sphenoid sinus mucosa was stripped and its floor was drilled to expose the lateral recess. The encephalocoele, when present was identified and cauterised using an angulated bipolar diathermy till it was reduced to the level of the neck. The bony margins of the leak were delineated and the leak was closed using dumb-bell fat over which surgicel was placed and then Hadad flap was positioned (Fig. 5). In our initial cases of Sternberg canal leak, dumbbell fat, onlay fascia lata with fat and fibrin glue was used in 3 cases. Tuberculum, mid-clival and petro-clival leaks were sealed using dumbbell fat, surgicel, Hadad flap and fibrin

glue (Fig. 6). Planum leaks were closed using Hadad flap with inlay septal cartilage (Fig. 7).

Nose was packed with nasopore. Thigh sutures were removed on the 10th post-operative day in cases where fascia lata was harvested. No lumbar drains/lumbar punctures were used post-operatively and patients were kept on antibiotics with bed rest, head-end elevation and advised to avoid any strenuous activity such as coughing, sneezing or nose blowing for 2 weeks. Stool softeners were prescribed. Patients were followed up weekly for 4 weeks. This was followed by clinical and endoscopic examination every 3 months for a period of 2 years. The mean follow-up period of patients included in this study was 1.5 years. Post-operatively, only 1 patient developed meningitis which turned out to be fatal. Three of the patients reported transient headache which resolved spontaneously in 2 months.

Discussion

The sphenoid sinus is a rare site of CSF leak in comparison to other locations. Ten percent of all CSF leaks have been reported to be from the sphenoid sinus of which 7 % are reported to be spontaneous [5]. Iatrogenic trauma is reported as the commonest cause for sphenoid sinus CSF leak by some authors [6, 7]. The complicated ontogenesis of the sphenoid bone has been attributed to be the cause of bony defects. It is suggested that during embryonal development, independent cartilaginous precursors are formed separately which form particular parts of the sphenoid bone after ossification. The fusion of the central sphenoid bone and lateral sphenoid bone occurs only after birth by a weak cartilaginous connection. During ossification, which progresses from anterior to posterior, a small canal is created which connects the middle cranial fossa with the nasopharynx. This is the lateral craniopharyngeal canal which was first described by Cruveilhier and later by Sternberg. The Sternberg canal is considered to be a potential source of spontaneous CSF leak from the middle cranial fossa [8, 9]. Most of the leaks in the present study were from the Sternberg canal.

Leakage of CSF from sphenoid sinus is to be suspected whenever fluid gushes with forward tilt of the head (Teapot sign).

Diagnosis, localization and surgical management of sphenoid sinus CSF leaks is challenging. A number of methods have been described for the diagnosis of CSF leak [2, 10, 11]. In this case series, estimation of glucose in nasal fluid with CT/MR cisternography and endoscopic confirmation intra-operatively using intrathecal fluorescein was done. CT/MR Cisternography are non-invasive imaging techniques which help accurate identification of site of

Fig. 5 Endoscopic picture showing Sternberg canal leak and repair of defect using Hadad flap

Fig. 6 Endoscopic intraoperative image showing leak from tuberculum sphenoidale

Fig. 7 Endoscopic picture showing leak from planum sphenoidale

leak. Pre-operative endoscopic localization using intrathecal fluorescein helps co-relation of HRCT/MR imaging findings with endoscopic findings and aids precise surgical planning.

Endoscopic endonasal approaches have largely replaced transcranial approaches in the management of CSF leaks ever since Wigand's first documentation of endoscopic endonasal CSF leak repair in 1991 [12, 13, 14]. A number of autologous materials are reported to be used for sealing CSF leaks in literature which include septal cartilage, bone of middle turbinate, vomer, perpendicular plate of ethmoid and mucosal tissues like temporalis fascia, fascia lata, free mucosal or free mucoperichondrial flaps. Heterologous materials recommended include equine collagen matrix, fibrin glue and polytetrafluoroethylene foam. Multi-layered techniques are reported to have better results [1, 3, 15]. Hadad–Bassagasteguy flap (vascular pedicled nasoseptal flap) is a robust reconstructive option for skull base defects with near 100 % survival rate [16, 17]. The survival rate of Hadad flap in this series was 100 %. Some authors use the lumbar spinal drain post-operatively [4, 11]. Observations of this study show that a lumbar spinal drain is not necessary. A number of complications such as meningitis, pneumocephalus, intracranial hematomas, chronic headaches, anosmia and frontal lobe abnormalities have been reported. Transient headache was experienced only by two patients in this series which resolved spontaneously in 2 months. However, one patient succumbed to meningitis.

Conclusion

Endonasal endoscopic approaches constitute a safe and effective approach for management of CSF leaks of the sphenoid sinus. Endoscopes permit improved visualization

of the site of leak. Morbidity and complications are significantly lesser with endoscopic approaches as compared to open approaches. The endoscopic endonasal transpterygoid approach provides a wide corridor for access to leaks in the lateral recess area. The Hadad–Bassagasteguy flap is the work-horse for sealing sphenoid CSF leaks. Multi-layered closure is associated with better surgical outcome.

Compliance with Ethical Standards

Conflict of interest None.

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