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Endoscopic endonasal repair of sphenoid cerebrospinal fluid leak, review and institutional experience

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ABSTRACT

Background: Rhinogenic CSF leaks are not an uncommon presentation. Considering the possibility of drastic intracranial complications if left untreated, makes the management of such cases of outmost importance. Most of the non-traumatic CSF leaks will need a surgical repair. And since the introduction of the endoscopic nasal surgeries, these repairs are done almost always through the endoscopic endonasal approach.
Methods: Retrospective review of cases with endoscopic repair of sphenoid CSF leak, who presented to King Fahad Specialist Hospital in Dammam (KFSH-D), from November 2003 to December 2017. And the U.S. National Library of Medicine (Pubmed) database was searched for "Sphenoid CSF Leak".
Results: We had a total of 12 cases. The demographic data, diagnostic investigations and operative data were retrieved and reviewed.
Conclusions: We advise using high resolution CT and intra-operative fluroscein for a reliable localization. And we found no complications with use of correct concentration of fluroscein. Endoscopic endonasal approach for repair of sphenoid CSF leak was found to be both effective and safe.

Keywords: Endoscopic sinus surgery, Sphenoid CSF leak, CSF rhinorrhea, CSF leak repair, Endoscopic endonasal approach

INTRODUCTION

Cerebrospinal fluid leak happens because of communication between the sterile subarachnoid space and the outer environment.

Repair of CSF leaks earns its importance due to the possibility of being complicated with intracranial infections and become life threatening if left untreated.

Initially trans-cranial approach to the skull base was used, however this approach is very aggressive and associated with high morbidity and mortality. Thus, since the introduction of endoscopic sinus surgery this method has become the standard of care in surgical management for the rhinogenic CSF leaks with a success rate of 90% in first attempt and up to 97% in the second attempts.[1,2]

It must be mentioned that managing CFS leaks originating from the Sphenoid sinus poses unique difficulties in approach and visualization due to their anatomical location. And they should be handled in great delicacy because of the anatomic proximity to vital structures, namely the carotid artery and the optic nerve.

Another difficulty is the placement of underlay graft in this area, which might be endangering the adjacent neuromuscular structures.

In this study we aim to present the cases with symptomatic sphenoid CSF leak and our institutional

experience in managing such cases. Also to give a summery of the current knowledge, focusing on diagnostic strategies and management details, from the review of the literatures.

METHODS

A retrospective study was performed for all cases of sphenoid sinus CSF leak, that have been presented to KFSH-D between November 2003 to December 2017.

(This hospital is a tertiary and referring hospital covering the eastern provision with a population of more than 4 million.)

Inclusion criteria: All cases with symptomatic sphenoid CSF leak presented to KFSH-D, from November 2003 to December 2017. Both genders and all ages were included.

Exclusion criteria: CSF leaks from sinuses other than sphenoid, and cases with iatrogenic leak during skull base and pituitary surgeries that were repaired immediately in the same surgery were not included. Also cases of traumatic CSF leaks that were successfully managed with conservative methods were excluded.

A total of 12 cases were found to fulfill inclusion and exclusion criteria.

Chart review done with data point collection for the age, sex, presentation and aetiology, localization methods including HRCT, CT and MRI cysternography and intra-operative cysternography.

The operative notes were reviewed and the post-operative records and clinic visits were recorded and analyzed using SPSS software.

And the U.S. National Library of Medicine (PubMed) database was searched for "Sphenoid CSF Leak". And the citations of the retrieved manuscripts were searched to identify additional relevant articles.

RESULTS

We had a total of 12 cases, out of them 11 cases sought the help of otolaryngologist after an episode of meningitis. And the one that didn't developed meningitis was refereed by neurosurgery department because of typical history of unilateral clear and spontaneous rhinorrhea with a brain tumour invading the bony sphenoid.

4 cases had a history of trauma. Road traffic accident in 3 of them and a gunshot injury in one of them was the traumatic mechanism (Table 1).

In our study all cases underwent plain high resolution CT (Figure 1) and intraoperative cysternography as the main localisation method. We had 4 cases with questionable sites of bony dehiscence on plain CT so they underwent CT cisternography for further evaluation. One of the cases had multiple leak sites, therefor navigation assisted CT (Figure 2) was used intraoperatively to detect all the sites of leakage.

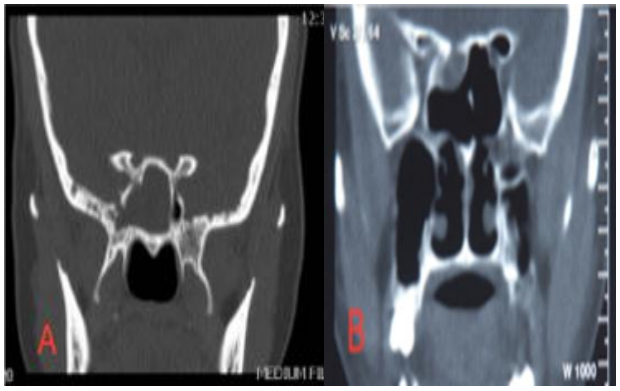

Figure 1: Showing high resolution CT images in coronal views; (A) defect in the right lateral wall of sphenoid sinus, (B) defect in the right roof of sphenoid sinus.

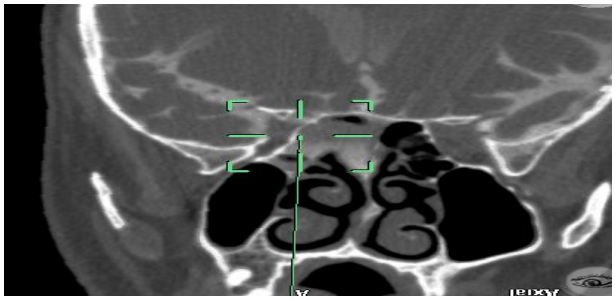

Figure 2: Use of intraoperative CT guided endoscopic tools for real time localisation feedback.

MRI was used in 5 cases with suspected meningocele on the CT, and 4 of them had meningoceles (Figure 3).

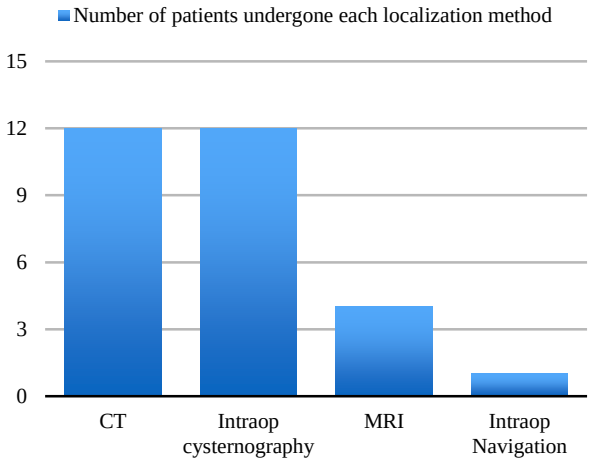

Figure 3: Summery of the localization methods used for the patients.

The operative notes were reviewed and the post-operative records and clinic visits were recorded and analysed.

After induction of general anaesthesia, nasal cavity was decongested using xylometazoline soaked packing. By the help of neurosurgeons lumbar drain is placed and 0.2 mL fluorescein 10% is diluted in 10 ml CSF and slowly injected intrathecally (Figure 4).

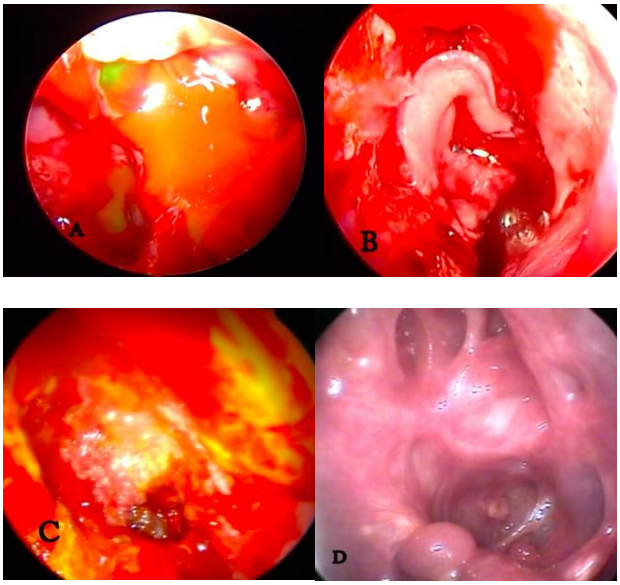

Figure 4: (A) intra-operative intrathecal fluorescein dye showing right sphenoid supero-lateral defect, (B) Haddah flap covering the defect, (C) second layer of the repair with fat graft, (D) one year post repair healed sphenoid.

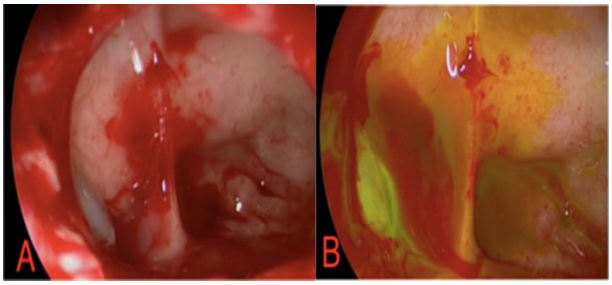

Figure 5: Before (A) and after (B) use of topical fluorescein dye showing a defect in the inferior part of lateral wall of right sphenoid sinus.

Intraoperative fluorescein not only helps with localisation, but also helps insuring a watertight closure. Another method to use flurocein is by topical application and in this method there is no risk for central nervous system complications (Figure 5).

After that the patient is handed back to the otolaryngologist for the endoscopic repair. Starting with examination and identification of sphenoid osteum. The surgeon then proceeds to a wide sphenoidotomy.

For the sake of a better visualisation, it might be necessary to remove the supreme and superior turbinates or the posterior part of the middle turbinate. And in some cases we needed an ethmoidectomy to get better access for instrumentation.

If leak is located in the lateral recess the surgical field should be extended through transpterygopalatine or transmaxillary approaches.

Once the skull base defect is optimally exposed, herniated meningocele or meningoencephaloceles should be reduced into the intracranial cavity. That is easily achieved using a bipolar diathermy.

It should be mentioned that in the setting of an encephalocele, brain tissue that has herniated into the nasal cavity is rarely functional and is considered a potential intracranial source of infection if not resected.

A crucial step is that the sinonasal mucosa around the bony defect must be carefully removed to allow the graft to adhere securely to the bony skull base and prevent future mucocele formation at the surgical site.

We used mucoperiosteal flap, harvested from the nasal septum as the primary layer for all closures. It was secured in place using glue.

After applying the coverage flap, surgi-cell was used to avoid adherence of the flap to the nasal cavity walls. By using the sponge self-absorbable packing, we avoided the risk of removing the flap postoperatively during pack removal, that could happen due to adherence of the the pack to the flap by blood clot or glue.

The importance of cooperative anesthesiologists is not to be forgotten, to achieve a bloodless field and a smooth recovery from anesthesia. And cases been reported in which main cause of failure was suspected to be a stressful extubation.

We had two cases with recurrence. Both had increased ICP plus one had a large defect due to a gun shot wound. Both were managed in first time with a single on-lay method and after recurrence a more secure multilayer method plus a VP shunt was used, which was found successful after 2 and 5 years of follow up (Table 1).

Out of 6 cases of spontaneous CSF leak, half had increased ICP ant the other half had normal ICP.

The 3 cases that had an increased ICP needed more than simple one layer on-lay method. And when we used that method for one of them, the CSF leak recurred. Eventually, 2 of them ended up with VP shunt and the last one needed multilayer closure.

Table 1: The summery of the collected data regarding initial presentation and the age at presentation , the method used for closure , the recurrence and how they were managed after recurrence .

Presentation	Number of patients (%)	Mean age (years)	Closure	Recurrence	Recurrence after secondary management
Spontaneous meningitis (with increased ICP)	3 (25)	36	Single layer 1 Multilayer 2	1 case within 6 months (managed with multilayer closer with VP shunt)	None in 2 years
Spontaneous meningitis (without increased ICP)	3 (25)	36	Single layer only 2 Multilayer 1	None in 2 years follow up	
Post traumatic meningitis	5 (42)	33	Single layer only 5	1 case within 2 months (managed with multilayer closer with VP shunt)	None in 5 years
Clear rhinorrhea	1 (8)	60	Multilayer	None in 2 years follow up	
Total	12 (100)	37		2 (16%)	

The 3 cases of traumatic RTA leaks and 2 out of 3 cases of spontaneous leaks without increased ICP were managed successfully with simple one layer unlay closure. The last case of spontaneous leak without increased ICP had a large defect and needed multilayer closure to insure no recurrence. In cases where mucoperiosteal and Haddad flaps were taken from the nasal septum, we found no donor site complications. Re-epithelization happened after around 2 weeks. There were no cases of nasal perforation.

Majority of our cases stopped follow up clinic visits after 2 or 3 years of improvement. There were no significant complications with the cases other than recurrence in 2 cases (Table 1).

DISCUSSION

Cerebrospinal fluid leak can only occur when all the layers separating the CSF-containing subarachnoid space from the nasal cavity are breached. This includes the arachnoid and dura matters plus a bony defect and nasal mucosa. However this is only a prerequisite and for the active flow to happen there must be a pressure gradient exceeding the tensile strength of the mucosal surface.[3]

The management of rhinogenic CSF leak has developed tremendously since the first published successful repair done by Dandy in 1926.[4] Dandy described a transcranial reconstruction with placement of a facia lata graft. With the heavy burden of a full craniotomy and its morbidity, plus the high recurrence rate reaching up to 27%, this approach was soon out of favour.

In 1948 Dohlman described a naso-orbital incision, which was the beginning of the extra cranial approaches.[5]

As all the other rhinologic surgeries the CSF leak repair underwent a revolution with the introduction of endoscopic techniques. Papay et al was the first to describe the rigid endoscopic repair in 1989.[6] This minimally invasive method reported to have a success rate of up to 90% in first attempt and 97% in the second attempt.[7] Due to its safety and the great success rate this approach has become the mainstay of treatment nowadays.[8]

To begin the management of a patient with CSF leak, we should be able to recognise the clinical presentation of such cases. The patient will typically complain of a unilateral, clear watery nasal discharge that is flowing spontaneously with a salty or metallic taste. Some other characteristic complaints may include a headache that improves with rhinorrhea, or a rhinorrhea that is increasing with leaning forwards or straining. The CSF leak should be also suspected with unexplained recurrent history of meningitis with or without such nasal discharges.

The workup of a patient with CSF leak should include; first the confirmation of the presence of CSF and second the localization of the lesion to guide the surgical repair in case needed.

Glucose oxidase strips can be used to test for the presence of CSF, due to its higher glucose level than the usual nasal secretions. However this test is a very rough estimate with a high rate of false positives, because of reducing substances in tears and nasal secretions in addition to the false negatives that may happen with bacterial meningitis. [9-11]

The more reliable chemical markers are beta-2 transferrin which is far more specific and Beta trace protein that is both specific and sensitive.[12,13]

CSF tracers can be used with imaging studies to detect an active flow to the nasal cavity, which both helps in the confirmation of the leak and can help in localization. These studies include radionuclide cisternography, CT cisternography and MRI cisternography. The radionuclide cisternography needs an intrathecal injection of radioactive dye and has a very poor spatial localization.[14] CT cisternography also needs an intrathecal injection of the dye but gives a much better localization specially for the bony defect that is important in surgical planning.[15] MRI cisternography has the advantage of not needing intrathecal injection, but a relatively poor localization in compared to CT cisternography.[16]

In a review by Zapalac et al, beta 2 transferrin was suggested for the confirmation of presence of CSF while high resolution CT without cisternography was suggested as the diagnostic strategy.[17] In this case MRI can be used for a better assessment of soft tissue structures including possible concurrent meningoencephalocele, or soft tissue masses.

One of the most used localization techniques is intraoperative intrathecal fluorescein injection while doing endoscopic examination. Although concerns have been made regarding its safety, the latest studies announced that low-dose fluorescein (50 mg or less) is unlikely to be associated with adverse events, because most complications seem to be dose related.[18]

After the proper diagnostic evaluation we can proceed to treatment strategies for the leak, which may be conservative or surgical.

The surgical approach to the sphenoid sinus can be challenging due to its location, and even with the use of angled endoscopes it might be difficult to visualize the lateral wall of the sinus.[19] That is why if leak is located in the lateral recess the surgical field should be extended through transpterygopalatine approach.[20]

The other challenge is the proximity of the sphenoid sinus to some neuromuscular structures, which may render the placement of an underlay graft impossible. In such instances, obliteration of the sinus is advised.[21,22]

CONCLUSION

Endoscopic endonasal approach for repair of sphenoid CSF leak was found to be both effective and safe. We advise using high resolution CT and intraoperative fluroscein for a reliable localization. And we found no complications with use of correct concentration of fluroscein.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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