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Sternberg's canal: a rare site of CSF leak—our experience and management of a series of cases at a tertiary care hospital in South India

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Abstract

Background: The lateral craniopharyngeal canal or Sternberg's canal is located in the postero-lateral part of the sphenoid sinus. It is the weakest area of the skull base, originating due to defective fusion during embryological development in a small proportion of individuals. Hence, it can give rise to CSF leaks from that region. Due to the proximity of this region to the internal carotid artery, optic nerve, and cavernous sinus, it proves to be challenging to repair these defects. The exact location, role in the causation of CSF leaks, and clinical presentation with arachnoid herniation are also subject to much controversy.

Results: In our case series, we describe 7 patients with the rare clinical entity of CSF leak from the Sternberg's canal, who had a mean age of 38.4 years, 4 of whom also had an arachnoid herniation through the canal. One patient already underwent prior endoscopic surgery for the CSF leak. We highlight a trans-nasal trans-sphenoid approach with multi-layer closure, i.e., fat plug, fascia, and a naso-septal flap with the use of an additional layer of muscle in one of the cases, following which all had good outcomes. Since the primary concern with this rare clinical scenario is correct identification and adequate exposure of the leak for repair, we additionally undertook a trans-pterygoid approach in 2 of our patients.

Conclusions: The key to the successful repair of the Sternberg's canal leak lies in its accurate identification and exposure. In our series, we achieved good exposure by drilling the pterygoids and lateral sphenoid walls along with the use of angled endoscopes for visualization. Our case series highlights the linear relation of elevated BMI with spontaneous CSF leaks in the absence of benign intracranial hypertension and the reinforcement of repair with the use of a harvested naso-septal flap. Our multi-layered closure ensured good results and no recurrence of a leak in any of our patients.

Keywords: Cerebrospinal fluid, Skull base, Sphenoid bone, Case report, Endoscopic

Background

The Sternberg's canal represents an embryological fusion defect between the posterior basisphenoid and lateral part of the greater wing of the sphenoid bone leading to abnormal communication between the cavity of the sphenoid sinus with the intracranial space. In 1888, Maximilian Sternberg described the existence of a lateral craniopharyngeal canal [1]. Its prevalence in adults ranges from 0.1 to 4% [2]. During the neonatal period, 2 ossification centers appear in the sphenoid sinus — anterior and posterior. In some cases, the posterior part fuses incompletely leaving a canal with bony dehiscence known as the lateral craniopharyngeal canal or Sternberg's canal [3, 4]. It is located in the postero-lateral part of the sphenoid sinus, lateral to the foramen rotundum. It is covered only by connective tissue, thus becoming

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the point of least resistance in the skull base [2]. It can be asymptomatic in a majority of individuals unless there is a predisposing factor like trauma or raised intra-cranial tension which can lead to a CSF leak. CSF rhinorrhoea with or without a meningoencephalocele from the lateral recess of the sphenoid sinus presents a unique challenge due to its proximity to the internal carotid artery, cavernous sinus and optic nerve, and extreme variations in the pneumatization of the sphenoid sinus [5].

There have been individual case reports and a few case series detailing the management of cases of CSF leak from the lateral recess of the sphenoid, all of which stress adequate access to the lateral recess via the nasal endoscopic route [5, 6]. In a study done by Ulu et al. in 2018, the use of an inflated Foley catheter balloon is also described to provide light compression in the reconstructed area [7]. Other methods such as packing the lateral recess have also been used to provide scaffolding to the site of repair [8].

This article aims to highlight the importance of identification and correct diagnosis of these rare cases with accurate localization of the defect and the advantage of using a trans-nasal transsphenoidal approach in their management. We present a series of 7 patients with Sternberg's canal leak with elevated BMI and without intracranial hypertension, who underwent trans-nasal trans-sphenoid endoscopic repair in our hospital and their outcomes with a 2-year follow-up period.

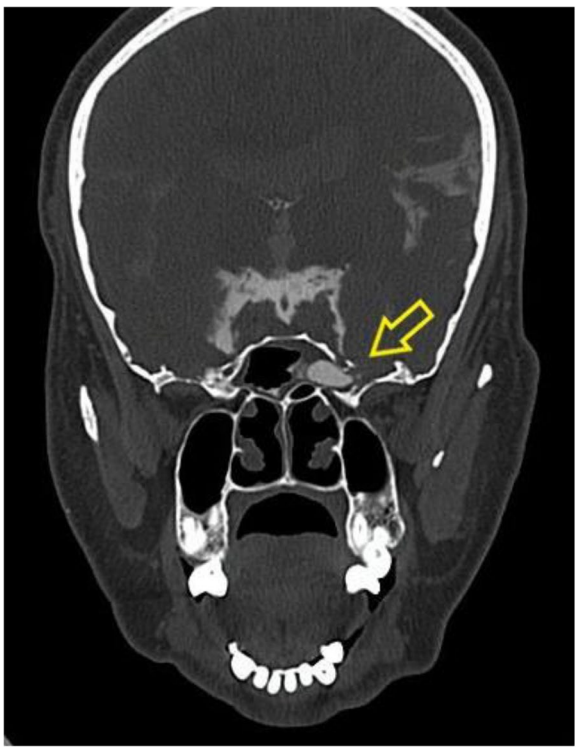

Fig. 1 The pre-operative CT cisternography of a patient with a left lateral recess of sphenoid sinus leak showing contrast flowing via the defect (arrow) into the left sphenoid sinus

Methods

This retrospective study was carried out in a tertiary care hospital in South India between 2010 and 2020 and included 7 patients who underwent repair of CSF leak through Sternberg's canal via a trans-nasal trans-sphenoid endoscopic approach.

A detailed history was taken, in which all patients presented with watery rhinorrhoea which was aggravated by bending the head. This was followed by a complete ENT examination. To confirm the composition of the nasal discharge as CSF, analysis of the fluid (glucose levels of 30mg/dl strongly suggestive of CSF) and the β2 Transferrin assay was performed on the fluid after collecting it in a sterile container.

The workup also included a diagnostic nasal endoscopy and CT cisternography (Fig. 1) or MRI with highly weighted T2 sequences (CISS_3D) which would be able to detect the site of CSF leak, presence of meningocele or meningoencephalocele and any osteodural defects, enabling measurements of the size of the same. The patients with osteodural defects and CSF leaks from the lateral recess of the sphenoid sinus were included in the study. Patients with a history of traumatic or post-surgical CSF rhinorrhoea and those who were lost to follow-up were excluded from the study. Benign intracranial hypertension was ruled out in all 7 patients by a neurological examination, with no evidence of papilledema, no signs on MRI Brain imaging and normal CSF pressures wherever necessary.

After confirmation of the diagnosis, written informed consent was taken and the patients underwent Trans nasal Endoscopic CSF Rhinorrhoea repair under General anesthesia by the same experienced surgeon. Hypotensive anesthesia was administered by experienced Neuro-anesthetists for all cases. The present study is a retrospective compilation of unique cases in routine clinical practice, adhering to standards and ethics of patient care.

Surgical procedure

All 7 patients underwent trans-nasal endoscopic repair of the CSF leak. General anesthesia was administered to all and the same experienced surgeon performed all the cases. After decongesting the nasal cavities, a zero-degree rigid endoscope (Karl Storz, Tuttlingen, Germany) was introduced and the trans-nasal trans-sphenoid wide endoscopic corridor was created in each case after raising a pedicled naso-septal flap on the same side of the leak

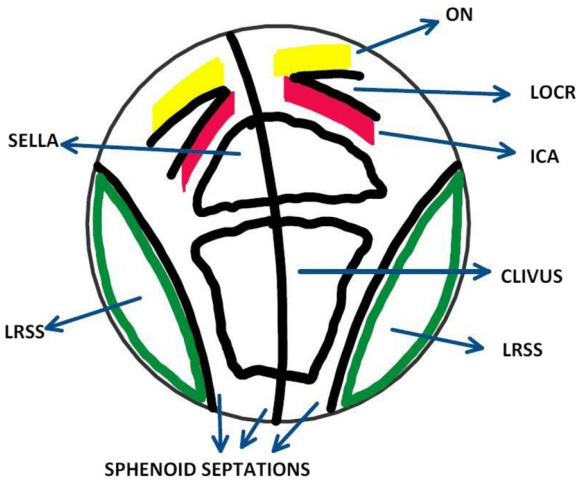

Fig. 2 Line diagram showing the endoscopic anatomy in the sphenoid sinus. ON, optic nerve; LOCR, lateral opticocarotid recess; ICA, internal carotid artery; LRSS, lateral recess of sphenoid sinus

and performing a posterior septectomy. The sphenoid ostium was widened and mucosa was removed (Fig. 2). The rostrum of the sphenoid was removed and the intersinus septations were drilled out to make the sphenoid sinus a single smooth cavity. A 30-degree rigid endoscope was used at this step and the lateral recess was exposed to identify the site of the leak from Sternberg's canal.

Two of our patients had a CSF leak that was not directly amenable to repair via the transsphenoidal transostial approach as the site of the leak was too lateral. In these cases, we had to drill out the medial pterygoids and the inferolateral wall of the sphenoid with a neuro drill to have direct visibility of the site of the leak (trans-pterygoid approach). The bleeding vessels were coagulated with bipolar electrocautery. In the case of arachnoid herniation (Fig. 3 A), the content was coagulated and so was the mucosa around the defect, to make the area raw and define the edges of the defect thoroughly (Fig. 3 B).

The repair was begun by introducing the fat plug into the defect which controlled the leak (Fig. 3 C), over

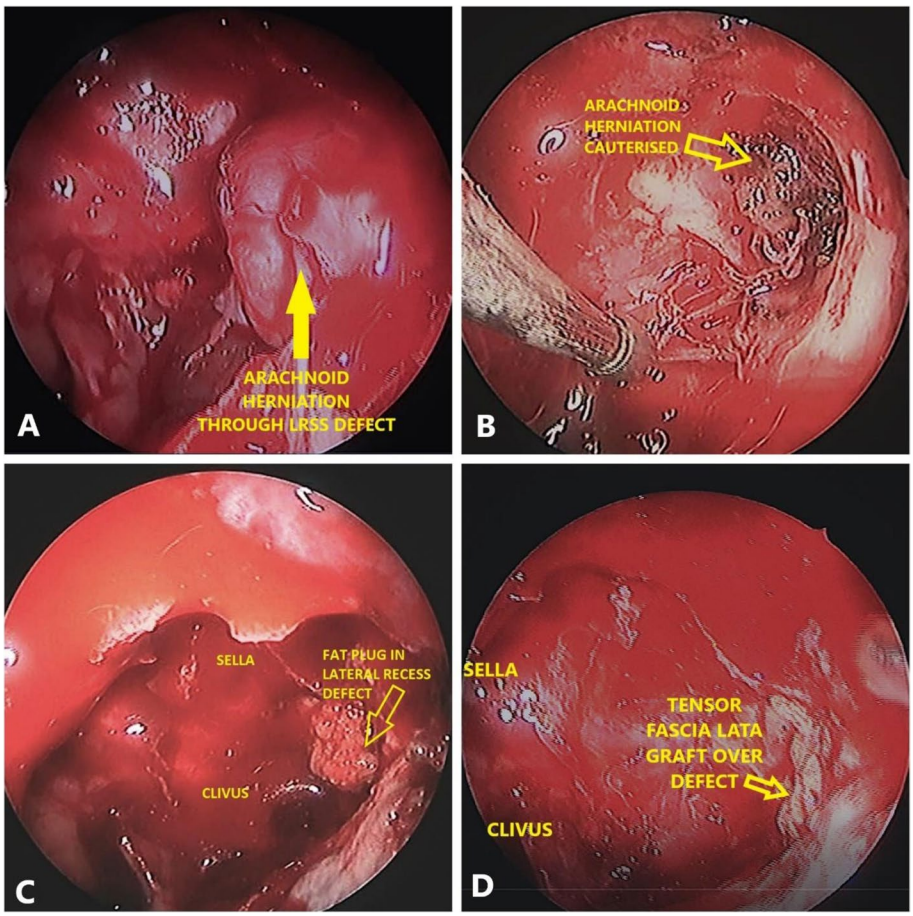

Fig. 3 Endoscopic images showing **A** arachnoid herniation through the left lateral recess of sphenoid defect, **B** arachnoid herniation after cauterization with bipolar cautery, **C** fat plug in the lateral recess defect, **D** tensor fascia lata placed over the fat plug in the defect

which tensor fascia lata with glue was placed by the overlay technique (Fig. 3 D). The pedicled naso-septal flap was placed over the plugged area. Surgicel and gel foam was placed over the reinforced area and nasal packing was done. Lumbar drains were placed for all patients and periodically drained.

All patients received antibiotics and antihistamines for 15 days post-operatively. They were advised to avoid straining factors such as coughing, sneezing, nose blowing, and straining while passing stools. Nasal packs were removed on postoperative day 4, following which they were prescribed decongestant and saline nasal drops.

They were followed up at regular intervals, post-operatively and the review of medical records included a 2-year follow-up for each patient. None of the patients in our series had complaints of a persistent or recurrent leak at their follow-up visits.

Results

A total of 7 patients were included in this case series, 4 males and 3 females. The mean age among all patients was 38.4 years, and the mean body mass index was 27.08 implying that most of the patients in our series were overweight.

One case out of 7 in our series had already undergone previous surgery for the same, despite which he continued to have symptoms.

The side of the leak was left-sided in 3 cases and right-sided in 4 cases. Arachnoid herniation was seen through the defect in 4 cases. The details of our patients are listed in Table 1.

The defect was closed in multiple layers (3/4) in all cases, with the most commonly used method being the closure of the defect with a fat plug, then tensor fascia lata via an overlay technique which was sealed with tissue glue and then reinforced with the naso-septal flap. In one case of a recurrent leak, an additional layer of muscle was also used.

Discussion

The lateral craniopharyngeal canal or Sternberg's canal represents a complex anatomical entity explainable by the embryological development of the sphenoid bone. The cartilaginous precursors include the presphenoid (sphenoid body, lesser wings, and tuberculum sellae) and the postsphenoid (greater wings, dorsum sellae, and pterygoid plates) [9]. These precursors fuse at the time of birth by a weak cartilaginous union, with bony fusion commencing soon after. In cases of incomplete fusion of the posterior part, a narrow canal remains, covered only by connective tissue, thus being the weakest part of the skull base [3, 10]. This lateral craniopharyngeal canal or Sternberg's canal is located in the posterior–lateral wall of the sphenoid sinus and is anatomically inferior–lateral to the maxillary division of the Trigeminal nerve (Fig. 4). The recess is thought to be created by extensive pneumatization laterally into the pterygoid process and greater wing, hence thinning the skull base at that region. CSF leaks from the Sternberg's canal are indeed a rare clinical entity and their endoscopic management is difficult owing to the complex approach to the site of the leak and the diagnosis of the leak itself. The limited literature on these and the lack of large cohorts means that no specific guidelines exist for their management.

Our study describes the endonasal repair in 7 patients, 4 males and 3 females, 4 of whom had arachnoid herniation through the defect. We also found that most patients in our series were overweight, reiterating the fact that

Table 1 Patients presentation with size and site of defect and treatment employed

Sl No.	Gender	Age (yrs)	BMI (kg/m^2)	Side of leak	Size of defect (mm)	Arachnoid herniation	Primary or revision surgery	Defect closure
1	Female	16	26.7	Left	5 x 5	No	Primary	Fat plug, fascia lata, tissue glue, naso-septal flap
2	Female	23	29.8	Left	3 x 6	Yes	Primary	Fat plug, fascia lata, tissue glue, naso-septal flap
3	Female	40	27.5	Right	3 x 6	No	Primary	Fat plug, fascia lata, tissue glue, naso-septal flap
4	Male	36	24.9	Right	3 x 6	Yes	Primary	Fat plug, fascia lata, tissue glue, naso-septal flap
5	Male	51	23.8	Left	6 x 10	Yes	Primary	Fat plug, fascia lata, tissue glue, naso-septal flap
6	Male	48	30.8	Right	5 x 5	Yes	Primary	Fat plug, fascia lata, tissue glue, naso-septal flap
7	Male	55	26.1	Right	5 x 5	No	Revision	Fat plug, muscle, fascia lata, tissue glue, naso-septal flap

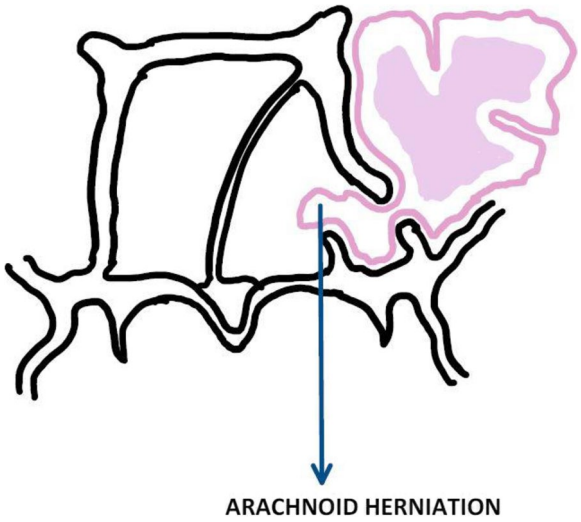

Fig. 4 Sketch of arachnoid herniation through the defect in the lateral recess of sphenoid sinus

BMI has a causal relationship to spontaneous CSF leaks. Repeat surgery for a possible case of recurrence was performed in one case.

Their clinical presentation at the initial visit also varied, with some having continuous watery nasal discharge, especially on bending the head down; while others had symptoms of post-nasal drip — indicating a posterior leak. Identification of the leak by diagnostic nasal endoscopy itself posed certain challenges, due to the laterality of the leak from the Sternberg's canal. Hence, High resolution computed tomography with iodinated contrast helped in the detection and confirmation of the side and site of the leak, in cases where detection with nasal endoscopy was difficult.

A wide sphenoidotomy was performed in all cases, with the site of the leak being directly approached in most cases, but 2 cases required additional exposure which was achieved by drilling the pterygoids and inferior-lateral wall of sphenoid along with employing angled 30-degree endoscopes for lateral access.

Autografts, owing to their superior immune tolerance and easy availability during surgery have always been the first choice for skull base reconstruction. We advocate a multi-layered closure, comprising of fat from the anterolateral thigh that was used to plug the defect by the "bath-plug" technique over which tensor fascia lata was placed via an overlay technique. This was sealed by tissue glue over which the naso-septal flap was placed. The naso-septal flap has the advantage of being vascularized and easy to harvest from the nasal septum, covering a large defect area, hence reducing the chance of recurrence of leak. Fascia lata having a high tensile strength and being available in abundance was chosen. In one case of a recurrent leak, additional reinforcement of the closure was done with muscle from the tensor fascia lata. Lumbar drains were placed in all cases as it helped reduce the intracranial pressure in the immediate post-operative period which promoted graft stabilization at the defect site. This in turn ensured no recurrence of a leak in any of our cases.

Endoscopic approaches offer several advantages over open surgery such as being minimally invasive with lesser morbidity, lesser brain retraction, and a shorter hospital stay. They can also manage the leaks that are not amenable to repair via the transcranial approach.

The post-operative period among all 7 patients was found to be uneventful. The patients were followed up for 2 years at regular intervals (1 month, 3 months, 6 months, 12 months, and 24 months) and none had reported any recurrence of symptoms.

Conclusions

This study highlights the importance of correct identification of the site of CSF leak and the variations in the surgical management of different cases of Sternberg's canal CSF rhinorrhea.

The challenges faced were not only in the identification of the leak to make a diagnosis but also the exposure of the defect during endoscopic repair, which was overcome by trans pterygoid drilling and the use of angled endoscopes and instruments.

Endoscopic surgery with multi-layer closure enabled lesser morbidity with no major complications with a faster road to recovery, all while ensuring good outcomes and no recurrence of CSF leaks among the patients in our series.

Abbreviations

CSF: Cerebrospinal fluid; CT: Computed tomography; CISS_3D: Three-dimensional (3D) constructive interference in steady state; β 2 Transferrin: Beta 2 Transferrin; MRI: Magnetic resonance imaging; BMI: Body mass index; ON: Optic nerve; LOCR: Lateral opticocarotid recess; LRSS: Lateral recess of sphenoid sinus; ICA: Internal carotid artery.

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Authors' contributions

CC is the primary consultant who has performed all 7 surgeries and was responsible for patient care and post-operative follow-up. The neurosurgical perspective of surgical management and coordination and planning during surgery was provided by ATJ. Pre-operative workup, case selection, and diagnosis were done by CC and ATJ. Post-operative follow-up was done by CC, HNR, and SN. SN and CC drafted the manuscript, which was subsequently checked by ATJ and HNR. HNR revised the article and performed an up-to-date literature review. All authors have read and approved the manuscript.

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
Ethical clearance was obtained for the study from the Ethical committee of Ramaiah Medical College Hospital, Bangalore. The present study is a compilation of unique cases that were retrospectively compiled during routine clinical practice, adhering to the standards and ethics of patient care.

Consent for publication
Consent to publish this article has been obtained from all the study participants and a letter of no objection to publishing has been obtained from our Institutions Ethics Committee

Competing interests
The authors declare that they have no competing interests.

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