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Management Of Cerebrospinal Fluid Leakage In The Sphenoid Sinus With A Transpterygoid Endoscopic Approach

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Abstract
Introduction: *Cerebrospinal fluid (CSF) leakage occurs when there is a direct communication between the subarachnoid space and the sinonasal mucosa, often due to trauma or iatrogenic injury. Accurate localization of the leakage site and differentiation from other nasal fluids are essential for appropriate management. This case report describes a sphenoid sinus CSF leak in a 65-year-old woman and discusses the efficacy of the transpterygoid endoscopic approach as a treatment option.*
Methods: *A 65-year-old woman with 2-month clear rhinorrhea. HRCT result showed a left sphenoid sinus defect. Endoscopic transpterygoid surgery was performed, and reconstruction was done using abdominal fat and bone graft, with mucosa harvested from the middle turbinate.*
Results: *Postoperative recovery proceeded without complications, with complete symptom resolution and no recurrence on follow-up.*
Conclusions: *The transpterygoid endoscopic approach is a minimally invasive and effective treatment option for sphenoid sinus CSF leakage, offering high success with low morbidity compared to conventional transcranial techniques.*
Keywords: *CSF leakage; sphenoid sinus; endoscopic repair; transpterygoid approach; Sternberg's canal.*

INTRODUCTION

Cerebrospinal fluid (CSF) leakage occurs when there is a direct communication between the intracranial subarachnoid space and the sinonasal mucosa. The most common causes of CSF leakage are head trauma or iatrogenic injury. Cerebrospinal fluid leakage may also result from increased intracranial pressure, tumors, erosive diseases, congenital anomalies, or may occur spontaneously without a specific etiology. Most traumatic CSF leaks resolve with conservative management, while persistent cases require definitive interventional treatment.[1]

Approximately 90% of CSF leaks are due to traumatic causes, with the majority involving skull base fractures; however, only 10–30% of skull base fractures are associated with CSF leakage. Non-traumatic causes are less common, occurring primarily in adults over 30 years of age, and are rare in children under two years old. Spontaneous CSF leakage tends to be more common in middle-aged women with obesity.[2]

The diagnosis and management of CSF leakage remain challenging, as accurate identification of the leakage site and differentiation from other nasal discharge are essential. Diagnosis can be determined through medical history and physical examination, with findings of clear, watery nasal discharge. Localization of the leak may be aided by nasoendoscopy, high-resolution computed tomography (CT) scan, and magnetic resonance imaging (MRI). While CT scanning may not definitively diagnose the leak, it can indicate its origin.[3]

The gold standard for confirming the presence of CSF is β_2-transferrin testing. Other diagnostic methods include glucose testing, cisternography, and CSF spotting for a halo or ring sign, although these are considered less sensitive and specific in the literature. An alternative biomarker is β-trace protein (bTP), also known as lipocalin-type prostaglandin D_2 synthase. The management of rhinorrhea caused by CSF leakage focuses on selecting the most appropriate treatment approach. Optimal care requires collaboration among multiple disciplines, including otorhinolaryngology–head and neck surgery, neurosurgery, and neuroradiology. Treatment options include conservative management and surgical intervention, with approaches via transcranial or extracranial routes.

Endoscopic techniques using a transnasal, transsinus approach to the defect have, in recent years, largely replaced older surgical methods
This report aims to present a case study on the management of sphenoid sinus CSF leakage using an endoscopic transpterygoid approach.

CASE SUMMARY
A 65-year-old woman presented to the otorhinolaryngology–head and neck surgery outpatient clinic of Dr. Soetomo General Academic Hospital with a chief complaint of clear, watery nasal discharge from both nostrils for the past two months, more frequently from the left nostril. The discharge occurred spontaneously and intermittently rather than continuously. The volume increased when the patient was in a head flexion position. In the supine position, the fluid was occasionally perceived as flowing into the throat. The patient also reported facial pain around the left eye and occipital region for the past two months. There was no history of nasal obstruction, nasal pain, headache, or olfactory disturbance (Fig. 1).

Fig 1. Clinical photograph of the patient

The patient had a history of a motorcycle accident 15 years prior, which was a single-vehicle crash. She was wearing a helmet at the time of the incident but could not clearly recall the details of the event. There was no history of other trauma. She had a history of hypertension and routinely took two types of medication, the names of which she did not know.
On general examination, the patient appeared in good condition with stable hemodynamics. Anterior rhinoscopy revealed clear fluid in the left nasal cavity without turbinate edema or hyperemia. No abnormalities were observed in the right nasal cavity. When the patient bent her head forward, clear, watery fluid was observed dripping from the nostril (positive "tea pot sign"). The handkerchief test demonstrated that the fluid was clear, non-sticky, and did not stiffen after drying.
Nasoendoscopic examination revealed a patent left sphenoid ostium without evidence of fluid flow. Paranasal sinus CT scan revealed defect in the lateral recess of the left sphenoid sinus (Fig. 2)

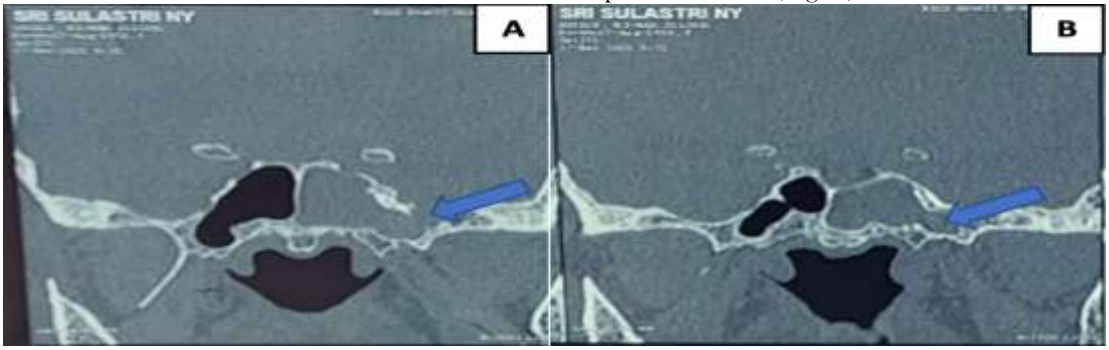

Fig 2. Paranasal sinus CT scan. (A) Defect in the lateral recess of the left sphenoid sinus (blue arrow). (B) Hyperdense fluid appearance consistent with meningocele (blue arrow).

Endoscopic sinus surgery was performed under general anesthesia using a Karl Storz Spies Series camera system and a 0-degree, 4 mm, 18 cm telescope. The patient was placed in the supine position with a 20° reverse Trendelenburg tilt. The facial area was disinfected with 70% alcohol, followed by application of sterile drapes. Both nasal cavities were decongested using Merocel® packs soaked in 0.05% oxymetazoline and 1% lidocaine. Trimming of nasal hair was performed while waiting the full effect of the decongestant.
The procedure was carried out on the left side, beginning with an uncinectomy using reverse cutting forceps, followed by a middle meatal antrostomy. A total ethmoidectomy and sphenoidectomy were subsequently performed using various appropriate endoscopic instruments. Partial resection of the middle and superior turbinates was done to gain better access (Fig. 3).

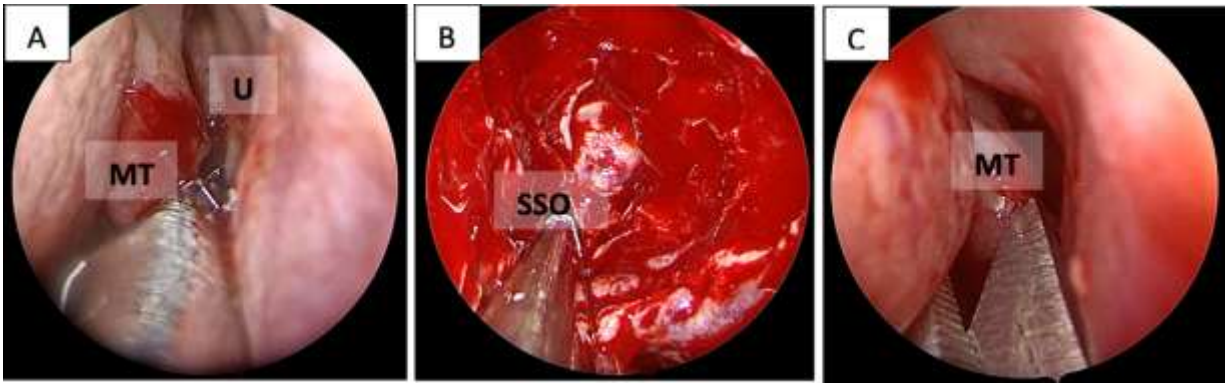

Fig 3. Left nasal cavity. A. Uncinectomy; B. Sphenoidectomy; C. Middle turbinate resection

The procedure continued with identification of the sphenopalatine foramen, followed by cauterization of the sphenopalatine artery and nerve immediately after their emergence from the foramen. The entire basal lamella of the middle and superior turbinates was removed, and the vertical part of the palatine bone was resected. The pterygoid process and the inferior portion of the anterior wall of the sphenoid bone were drilled down. The Vidian artery and nerve were identified, transected, and cauterized. The lateral recess of the sphenoid sinus was then exposed. A bony defect measuring 3 mm in diameter was identified, accompanied by a meningoencephalocele and CSF flow. The meningoencephalocele was subsequently excised (Fig. 4).

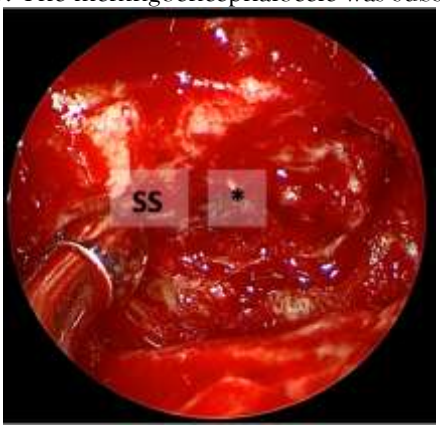

Fig 4. Left lateral recess of the sphenoid sinus. A bony defect is identified, indicated by CSF leakage (*). The image shows (SS) sphenoid sinus

The defect was closed by placing abdominal fat, a bone graft, and a middle turbinate mucosal graft. Evaluation revealed no further CSF leakage. Fibrin glue was then applied, followed by placement of an absorbable hemostat Surgicel®), and subsequently, in sequence, fibrin glue, gelfoam, and a final layer of fibrin glue were applied (Fig. 5). The bleeding was approximately 50 mL and no CSF leakage was observed on the final evaluation after the procedure.

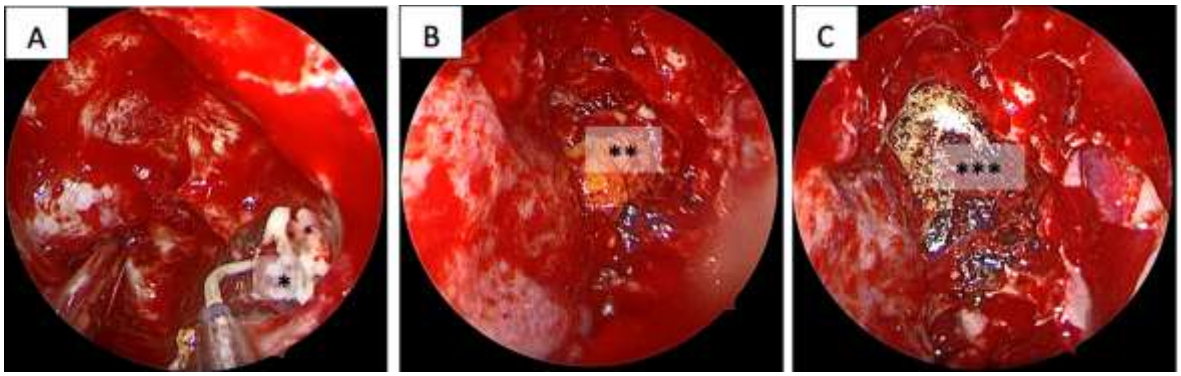

Fig 5. Left nasal cavity. A. Cauterization in the lateral recess of the sphenoid sinus (*). B. Abdominal fat graft and middle turbinate mucosal graft (**). C. Layers of fibrin glue and gelfoam (***)

Postoperatively, the patient received intravenous ceftriaxone 1 gram every 12 hours, intravenous metamizole 1 gram every 8 hours for analgetic, and topical ofloxacin nasal drops. She was placed on bed rest for four days with the head of the bed elevated at 20°. The patient was instructed to avoid nose blowing, bending forward, straining, and lifting weights over 7.5 kg. She was advised to keep her mouth open if coughing or sneezing. The patient was discharged on the fourth postoperative day with oral cefixime 200 mg capsules twice daily for seven days. Nasal irrigation with 0.9% NaCl twice a day was permitted starting two weeks postoperatively. She was advised to avoid nose blowing, leaning forward, performing Valsalva maneuvers, and lifting objects weighing more than 7.5 kg for six months. A follow-up visit at the outpatient clinic was scheduled for four weeks postoperatively for evaluation with nasoendoscopy.

At one-month follow-up, the patient reported left nasal crusting. Nasoendoscopic evaluation revealed gelfoam, blood clots, purulent secretions, and the graft in place (Fig. 6A). She was scheduled for another follow-up one month later and advised to continue nasal irrigation with 0.9% NaCl twice a day, along with ofloxacin nasal drops (five drops into the left nostril, three times a day).

Two-month follow-up, the patient had no complaint. Nasoendoscopic evaluation showed wound healing, the graft securely in place, and no evidence of leakage (Fig. 6B). She was scheduled for another follow-up one month later.

At three-month follow-up, the patient remained asymptomatic. Nasoendoscopic evaluation again demonstrated complete wound healing, an intact graft in position, and no signs of leakage (Fig. 6C).

Fig 6. Nasal endoscopy of the left nasal cavity. A. One month post-operation (*). B. Two months post-operation (**). C. Three months post-operation (***)

DISCUSSION

The presence of CSF rhinorrhea discharge from the nasal cavity is an abnormal finding. The most common sites of leakage are the cribriform plate, fovea ethmoidalis, sphenoid sinus, and temporal bone. CSF leaks can be classified according to their etiology as traumatic (accidental or iatrogenic), spontaneous, neoplasm-related, or congenital.[8] Approximately 70% of CSF is produced by the choroid plexus within the lateral, third, and fourth ventricles, while the remaining 30% results from a combination of capillary ultrafiltration and water metabolism.

Cerebrospinal fluid is produced at a rate of approximately 20 mL/hour, or 350–500 mL/day. The total CSF volume in an adult ranges from 90–150 mL. Under normal conditions, CSF flows from the lateral ventricles into the third and fourth ventricles and ultimately into the subarachnoid space surrounding the brain and spinal cord.[3]

Most CSF leaks occur in adults during the fourth decade of life, with a higher incidence in females than males (2:1). In adults, head trauma accounts for 80–90% of cases. The most common fracture sites leading to CSF leakage after traumatic brain injury are the frontal sinus (30.8%), sphenoid sinus (11.4–30.8%), ethmoid sinus (15.4–19.1%), cribriform plate (7.7%), frontoethmoidal region (7.7%), and sphenoethmoidal region (7.7%).[9,10]

Recent data suggest that the sphenoid sinus is increasingly recognized as the most frequent site of spontaneous CSF leakage, with spontaneous cases now outnumbering secondary ones. The most common site of spontaneous sphenoid sinus leakage due to a bony defect is the superior portion of the lateral recess, often associated with congenital dehiscence of this area due to persistence of the lateral craniopharyngeal canal (Sternberg's canal).[6]

Sternberg's canal is a complex anatomical entity resulting from incomplete fusion between the presphenoid and postsphenoid during sphenoid bone development. This failure of fusion, which normally completes in childhood, leaves a narrow tract covered only by connective tissue and creates a structurally weak area in the skull base. The canal is located in the posterolateral wall of the sphenoid sinus, medial to the foramen rotundum and superior orbital fissure, just anterior to the opticocarotid recess, and lies inferior–lateral to the maxillary division of the trigeminal nerve.[11,12]

Extensive pneumatization into the pterygoid process and greater wing may further thin this region. Although cerebrospinal fluid leakage through Sternberg's canal is rare, it poses significant diagnostic and surgical challenges for endoscopic management, and the limitation of studies has prevented the establishment of standardized management guidelines. [11,12] In the present case, the patient was a 65-year-old woman with CSF leakage from the left lateral recess of the sphenoid sinus, without an identifiable precipitating cause, despite a history of motor vehicle accident. The prior trauma was considered unrelated to the current leak.

The most common clinical symptom of CSF leakage is clear, watery rhinorrhea or otorrhea, often position-dependent. Rhinorrhea may be accompanied by headache, neck pain, or stiffness.[10,13] In this case, the patient presented with a three-month history of clear nasal discharge from the left nostril, which increased when bending forward or during prostration. There was no headache, neck pain, or stiffness. Several diagnostic methods exist for confirming suspected CSF rhinorrhea. The leak can be provoked by forward head flexion (teapot sign). The handkerchief test involves placing the nasal fluid onto a white handkerchief or dry gauze and allowing it to dry; CSF remains clear and non-sticky, whereas nasal secretions are cloudy and viscous.[10,14] In this case, the teapot sign was positive, and the handkerchief test revealed clear, non-viscous fluid.

The halo sign is used when fluid is mixed with blood, demonstrates a ring of clear fluid surrounding the blood spot when placed on filter paper. β2-transferrin assay, which detects a protein specific to CSF, is the most specific diagnostic test.[13,14] In this patient, the halo sign was not performed because there was no blood admixture, and β2-transferrin testing was unavailable.

Rigid nasoendoscopy can assist in diagnosing CSF rhinorrhea, potentially revealing a pulsatile, glistening mass in the olfactory cleft, although negative findings are possible.[1] In this patient, nasoendoscopy revealed a patent left sphenoid ostium without visible fluid flow or pulsatile mass. High-resolution computed tomography scan (HRCT scan) is the imaging modality of choice for localizing CSF leaks, providing optimal visualization of the bony anatomy for surgical planning. Further imaging is unnecessary if a single bony defect is identified that correlates with clinical findings.[14] In this case, HRCT demonstrated a defect in the left sphenoid sinus lateral recess; no further imaging was required.

The timing of CSF leakage onset is clinically important as it affects long-term prognosis and risk of complications such as infection. Onset is categorized as early (within 48 hours post-trauma), delayed (after one week or recurrent), or very-late (often associated with infection). Delayed leaks may occur due to age-related cerebral atrophy, reopening the defect site. Friedman *et al.* reported that, among 51 patients with traumatic CSF leaks, only eight developed symptoms months or years later, with most occurring within days.[10,15] In this patient, symptoms appeared 15 years post-trauma, likely related to cerebral atrophy with aging.

While many CSF leaks resolve spontaneously without surgical intervention, defects in the sphenoid sinus lateral recess typically require surgical repair.[3] In this case, spontaneous closure did not occur, and endoscopic transnasal surgery was planned Historically, CSF leaks were repaired via intracranial approaches, including craniotomy and

temporal lobe retraction to access the sphenoid defect. The endoscopic transnasal approach is now the gold standard, offering low morbidity and high success rates. [3,16]

The first successful intracranial repair was reported by Dandy in 1926, with gradual technical evolution until Wigand in 1981, performed the first endoscopic repair. Advantages of endoscopy include superior visualization, precise graft placement, shorter operative time, and improved outcomes. Common endoscopic repair techniques include free tissue grafts, vascularized flaps, tissue sealants, or combinations thereof.[14]

Surgical technique selection depends on leak location. Lateral recess sphenoid leaks are not accessible via standard transnasal or transethmoidal approaches used for central sphenoid defects. A transpterygoid approach provides access to the lateral sphenoid sinus. This involves wide maxillary antrostomy, ethmoidectomy, and sphenoidotomy to establish landmarks. The posterior maxillary sinus wall is removed to expose the pterygomaxillary fossa (PMF), and dissection within the PMF reveals the internal maxillary artery. Care must be taken to preserve the sphenopalatine ganglion, vidian nerve, greater and lesser palatine nerves, and infraorbital nerve. The pterygoid process forming the anterior wall of the lateral recess is carefully drilled to gain exposure.[1]

In this case, the defect in the lateral recess was identified after removal of the medial pterygoid process and anterior wall of the lateral recess. Intraoperatively, a meningocele with CSF flow was identified. The anterior sphenoid sinus wall was widened laterally. The mucosa around the defect has to be removed for at least 5 mm, and surrounding bone has to be cleared to ensure graft adherence. The encephalocele has to be resected using bipolar cautery. Grafting materials may include fascia, fat, mucosa, bone, cartilage, or combinations thereof; closure can be achieved with free grafts or obliteration using abdominal fat.[14,17] In this case, abdominal fat, bone, and middle turbinate mucosa were combined with fibrin glue and gelfoam for defect closure. No CSF leakage was observed upon intraoperative evaluation after graft placement.

Postoperative care includes bed rest in reverse Trendelenburg position for several days and prophylactic antibiotics to prevent nasal packing–related complications. Nasal packs are removed after three to four days. Head elevation of approximately 30° reduces CSF pressure at the repair site. [3,6,18] In this case, ceftriaxone 1 g twice daily was administered intravenously, and head elevation was maintained at 20°.

The patient was instructed to perform only light activities, keep the mouth open during sneezing, and was prescribed antiemetics, laxatives, and antitussives to prevent significant increases in intracranial pressure that could dislodge the graft.[19] The patient was advised to avoid nose blowing, forward bending, straining, and lifting objects over 7.5 kg, and to sneeze or cough with the mouth open.

Once the bony defect is sealed and nasal CSF leakage ceases, intracranial pressure may rise. Surgical success and prevention of recurrent CSF leakage—either at the same or a different site—depend on controlling intracranial pressure, as its reduction increases the likelihood of repair durability.[20] In this case, follow-up visits at one, two, and three months postoperatively revealed no rhinorrhea. Nasoendoscopic examinations confirmed wound healing, intact graft.

CONCLUSION

A case report of a 65-year-old woman with cerebrospinal fluid leakage in the lateral recess of the left sphenoid sinus. The patient underwent endoscopic transpterygoid approach surgery for closure of the CSF leak in the sphenoid sinus. The defect was repaired using abdominal fat, bone graft, and mucosal graft harvested from the middle turbinate. The patient was discharged on the fourth postoperative day with no complaints of clear, watery rhinorrhea from the left nostril. Postoperative nasoendoscopic evaluations at one, two, and three months revealed proper wound healing, grafts well adhered in place, and no evidence of leakage.

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