Case Series

The Intraoperative Diagnosis and Management of CSF Leaks in Endoscopic Sinus and Skull Base Surgery. New Paradigm: Topical Fluorescein - Zeina Korban*, Nader Al Souky, Racha Abi Melhem and Usamah Hadi

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Endoscopic techniques have been widely adopted in sinus and skull base surgery replacing the traditional intracranial/extracranial approaches. However, one of the most common complications is an iatrogenic Cerebrospinal Fluid (CSF) leak, which places the patient at risk for meningitis, pneumocephalus and brain herniation. The instant intraoperative CSF leak diagnosis and consequent repair is crucial to avoid these complications. Traditionally, intrathecal fluorescein injection was utilized to aid in the diagnosis. However, this technique is not FDA approved and encompasses major drawbacks (seizure, lower extremity paresis, cranial nerve palsies and patient discomfort). The purpose of this case series is to introduce a new diagnostic paradigm using topical fluorescein strips “FLUORETS”. It has shown promising prospects due to its safety, accuracy and sensitivity in identifying CSF leaks.

**Keywords:** Cerebrospinal fluid leaks; Endoscopic sinus surgery; Topical fluorescein

## Case Report

We hereby present the case of a 55-year-old gentleman, BMI (Body Mass Index) of 25, with a history that is remarkable for endoscopic sinus surgery ten years prior to presenting to our institution. Patient was diagnosed and treated for meningitis on two occasions. Preoperative work-up, including CT with metrizamide, failed to demonstrate the defect site. Patient did not consent for intrathecal fluorescein. Intraoperatively, under direct visualization, with the assistance of Valsalva maneuvers, no defect could be localized. We then utilized a topical fluorescein strip through the nasal cavity and laid at the site of the expected defect. CSF was confirmed by green discoloration at the site of the defect. Multilayered repair then ensued after confirmation.

### Case 1

We hereby present the case of a 55-year-old gentleman, BMI (Body Mass Index) of 25, with a history that is remarkable for endoscopic sinus surgery ten years prior to presenting to our institution. Patient was diagnosed and treated for meningitis on two occasions. Preoperative work-up, including CT with metrizamide, failed to demonstrate the defect site. Patient did not consent for intrathecal fluorescein. Intraoperatively, under direct visualization, with the assistance of Valsalva maneuvers, no defect could be localized. We then utilized a topical fluorescein strip through the nasal cavity and laid at the site of the expected defect. CSF was confirmed by green discoloration at the site of the defect. Multilayered repair then ensued after confirmation.

### Case 2

We present another case of a 30-year-old female, BMI of 20...
Case 1

A 24-year-old male presented with a history of bilateral recurrent headaches after being diagnosed with a craniopharyngioma that failed initial resection, presented to our institute for endoscopic endonasal transphenoidal surgery.

Intraoperatively, following resection, the sterile strip technique of fluorescein was applied at the lateral face of the sphenoid sinus. A pool of green discoloration was seen indicating the defect site (Figure 2, 3a, 3b). Repair was attempted using a multilayer technique. Abdominal fat was also harvested and used for the repair. At the end of the repair where no CSF was directly visualized, application of a fluoret strip revealed a persistent leak. Further repair using mucosal grafts was performed; following which another strip was performed demonstrating a successful repair with no discoloration.

Case 2

A 18-year-old female presented with a history of rhinorrhea following a pediatric encephalitis. A nasal endoscopy was done and CSF analysis with beta-2 transferrin confirmed CSF leakage. Following repair of the defect at the cribriform plate using a multilayer technique supplemented by a free septal mucosal graft, a fluoret strip was used to document complete cessation of CSF leak and hence secure repair of the defect (Figure 4).

DISCUSSION

Galen first described CSF rhinorrhea in the second century AD [6]. The first repair of a CSF leak did not occur until 1700 years later, when Dandy performed an open based craniotomy procedure using a fascia lata graft for transcranial skull reconstruction [7]. In 1948, Dohlman was the first to utilize the extracranial approach via an external ethmoidectomy [8] making it the standard of care with success rates as low as 60% [9]. Endoscopic repair of CSF leaks did not occur until 1981 when it was first described by Wigand [10].

The endoscopic approach is a safe and effective procedure, which has grown to be the standard of care for most anterior skull base defects with success rates approaching 90% [11]. Principles mirror those of open repair with lower operative morbidity and higher accuracy. The most frequent inciting factor for CSF leaks is accidental trauma (44%) followed by surgical trauma (29%) and tumors, whether benign or malignant (22%) [12]. Congenital and spontaneous sources have also been described in literature [12].

Iatrogenic CSF leaks are attributed to transphenoidal resection of pituitary tumors (15%), and functional endoscopic sinus surgery (3%) [1]. Most can be missed, and on other occasions, the leak is suspected but cannot be proven. Hence, inadvertent or no repair may be performed.

Accurate diagnosis and localization of defects can be challenging even for the most experienced surgeon. Localizing the site of origin is fundamental and plays a role in the surgical approach. Iatrogenic CSF leaks most commonly arise at the ethmoid roof (35%), followed by the cribriform plate (27%) and the sphenoid sinus (19%) [13]. Otolaryngologists’ experience with CSF leaks is primarily composed of repair post sinus surgery or transphenoidal surgery.

Intraoperative CSF leaks are reported in 15-30%. Postoperative complications of CSF leaks and inadequate repair include tension pneumocephalus and meningitis [2]. Ozturk et al. found that 46% and 36% of patients presenting with CSF leakage had meningitis or recurrent meningitis respectively [5].

At present, some authors advocate the use of lumbar drains alone or in adjunct with intrathecal fluorescein to assist in graft placement and localize fistulas. [1] Intrathecal fluorescein can cause potential complications and is not FDA approved. This has limited its clinical use.
Topical strip intranasal fluorescein introduces a new, minimally invasive, simple and convenient method for localizing CSF fistulas. This technique was recently utilized in our institute in all our cases of suspected CSF leaks with a high success rate.

This consists of applying fluorescein strips (Fluorets) that are sterile and used by ophthalmologists to stain corneal ulcers. Fluorescein strip gives a yellow color when it gets in contact with water, saline and nasal secretions (Figure 5). A change to green color indicates presence of CSF.

![Figure 5: Yellow color of the Fluorescein strip in the following control groups (a) Nasal secretion (b) Saline (c) Water.](image)

The concept of topical fluorescein was first utilized by Jones whereby he achieved 100% accuracy in localizing a CSF leak in 3 patients with no adverse side effects. He introduced the concept of cotton pledges soaked in fluorescein [14]. However; this technique has its disadvantages in terms of resources, standardization of concentrations and intranasal contact time. Saafan was also successful in achieving 100 % accuracy used topical intranasal 5% fluorescein for preoperative diagnosis and intraoperative localization of the site of the leak [15].

Topical nasal fluorescein is an easy, sensitive, safe and highly accurate tool in the intraoperative localization of the site and extent of CSF fistulas. In our hands, it has proven to be effective in diagnosing the site of CSF leak. It has also been useful in documenting complete seal after a presumed successful repair. It bypasses the adverse side effects associated with the use of a lumbar drain and intrathecal fluorescein and should be sought as a noninvasive alternative and a principle tool in diagnosis. Topical intranasal fluorescein represents an alternative method for skull base repair after tumor resection avoiding the need of a lumbar drain and the use of intrathecal fluorescein. In addition; the use of intrathecal fluorescein may be refuted on occasions by patients after the risk is explained. The use of the fluorescein strip technique avoids these consequential issues and is widely accepted by patients in our institution. However, one drawback to this technique is its inability to detect multiple defects of CSF leakage while intrathecal fluorescein injection does.

CONCLUSION

Repair of skull base defects using minimally invasive and endoscopic techniques continues to evolve. A comprehensive understanding of the anatomy, physiology, diagnosis and surgical approaches is needed to ensure proper treatment. Diagnostic measures play a crucial role in preventing adverse sequelae. We have achieved success in identifying leak sites using our technique of topical fluorescein strips (Hadi-Korbam Technique) that has proven to be effective in diagnosing the site of CSF leak and documenting complete seal after a presumed successful repair. It has introduced a new paradigm in diagnosis and management.

REFERENCES