

Video Article



Turk Arch Otorhinolaryngol 2026; 64(2): 117-121

DOI: 10.4274/tao.2026.2025-11-20

Retrograde Transillumination: A Reliable Guide for Frontal Sinus Opening in Endoscopic Sinus Surgery

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Abstract

To describe and assess the feasibility of a simple, low-cost retrograde transillumination technique for identifying and confirming the frontal sinus opening during endoscopic frontal sinus surgery in a small series of patients. This single-center descriptive surgical series, conducted between November 2024 and January 2025, included five patients who underwent endoscopic frontal sinus surgery. The technique's five steps were standardized: angled endoscopic view (45°) of the frontal recess, probing the probable opening with angled instruments, darkening the room, placing the light source of the endoscope superomedial to the eyebrow, and observing a retrograde endonasal glow at the true ostium. In all cases, localization of the frontal opening was achieved by retrograde transillumination and independently verified with neuronavigation. Representative scenarios included nasal polyposis, pansinusitis, revision surgery (Draf III), and a pediatric patient with complicated sinusitis with epidural abscess. Retrograde transillumination enabled identification of the frontal sinus opening in all five cases and guided the extent of surgery (Draf IIa-b/III as indicated). It proved especially helpful when landmarks were distorted or when frontal recess cell variants obscured the pathway. In this limited series, retrograde transillumination appeared to be a pragmatic, cost-effective adjunct that complemented anatomical expertise, surgical experience, and neuronavigation for intraoperative localization of the frontal sinus opening. Larger comparative studies are needed to further evaluate its accuracy and generalizability.

Keywords: Chronic rhinosinusitis, endoscopic sinus surgery, frontal sinus, transillumination, revision endoscopic sinus surgery

Introduction

The frontal sinus and its outflow tract remain among the most challenging areas to approach in functional endoscopic sinus surgery (FESS) because of their narrow diameter, complex three-dimensional anatomy, and wide range of anatomical variants. The frontal sinus opening represents the narrowest point of this pathway, and scarring, polyps, or bony cell variants can further obscure this region and complicate safe surgical access (1). Detailed preoperative computed tomography (CT) review, ideally with multiplanar reconstructions, improves understanding of frontal recess anatomy (2).

Transillumination of the frontal sinus has been used to define the integrity and boundaries of the frontal sinus since 1930 (3). Caldwell radiography as an external-route framework for frontal sinus surgery was described in the mid-20th century, and with advances in technology, image-guided surgical systems (neuronavigation) have become widely used adjuncts in both endoscopic and open frontal sinus surgeries (4,5).

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Cite this article as: Kemal Ö, Demirel E, Çelebi M. Retrograde transillumination: a reliable guide for frontal sinus opening in endoscopic sinus surgery. Turk Arch Otorhinolaryngol. 2026; 64(2): 117-121

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Received Date: 30.11.2025

Accepted Date: 03.03.2026

Epub: 25.06.2026

Publication Date: 29.06.2026



Classical transillumination techniques typically illuminate the sinus from within to delineate its borders externally. In contrast, the presented video article describes a retrograde transillumination technique that places the endoscope light source externally at the superomedial eyebrow while the surgeon views the frontal recess endonasally. This approach aims specifically to localize and confirm the frontal sinus opening.

Our objective is to present a standardized five-step use of retrograde transillumination and to illustrate its application in five representative cases in which the ostium identified by this method was verified with neuronavigation.

Patients and Surgical Technique

This study was approved by the Clinical Research Ethics Committee of Ondokuz Mayıs University (approval no: OMÜ KAEK 2024/94, date: 29.02.2024). The study was conducted between November 2024 and January 2025 at Ondokuz Mayıs University Faculty of Medicine, Otorhinolaryngology Department with patients undergoing endoscopic frontal sinus surgery. Written consent was obtained from the patients for the use of their demographic and clinical data, as well as their intraoperative photographs and videos in this article.

Our report includes five patients to demonstrate the technique. For consistency and anonymity, patients were identified numerically throughout the text and accompanying media. Preoperatively, 1-mm slice paranasal CT was obtained from all patients. Table 1 summarizes the clinical characteristics of the patients and the surgical procedures performed. In all surgeries, the frontal sinus opening was found with the guidance of retrograde transillumination and confirmed with neuronavigation (Brainlab AG, Munich, Germany).

There are five key steps to the retrograde transillumination technique:

1. View the frontal recess with an angled endoscope (45° was used in our surgeries).
2. Identify the possible frontal sinus opening with angled instruments.

3. Turn the lights off in the operating room.
4. Detach the light source from the endoscope, check that the light source is not hot, and place it superomedial to the patient's eyebrow.
5. Observe retrograde transillumination of the frontal sinus opening on the screen.

Video 1 includes the title, introduction, intraoperative recordings from the five patients who underwent endoscopic frontal sinus surgery in which the retrograde transillumination technique was used, and the key points of the technique.

Patient 1 had nasal polyposis blocking the middle meatus and the frontal recess. After polypectomy, the agger nasi cell was opened and the frontal recess was viewed with a 45° endoscope. With the help of the retrograde transillumination technique, the frontal sinus opening was identified and a Draf IIa procedure was performed (Figure 1, Video 1).

Patient 2 had pansinusitis. Anterior and posterior ethmoidectomy were performed. The frontal recess was visualized with a 45° endoscope, and the potential frontal sinus opening was explored with angled instruments. With retrograde transillumination, a dim light was seen at the right frontal sinus opening (Video 1). The light guided us and we were able to reach the frontal sinus and perform a Draf IIa procedure.

Patient 3 had recurrent nasal polyposis, and this was his third surgery. Bilateral nasal cavities were obliterated with polyps. Following maxillary antrostomy, anterior and posterior ethmoidectomy, sphenoidotomy, and removal of polyps from the frontal recess, the frontal sinus ostium was localized using retrograde transillumination. A Draf III procedure was performed, and traditional transillumination of the bilateral frontal sinuses showed that the polyps and the cells located in the frontal recess and in the diseased frontal sinuses had been adequately cleared (Video 1).

Patient 4 had nasal polyposis, and this was her first surgery. Polyps were blocking the middle meatus. The maxillary sinus ostium was opened, an anterior ethmoidectomy was performed, and the polyps located in the frontal recess were removed. Again, with an angled endoscope and

Table 1. Demographic and surgical characteristics of study group

	Age	Sex	Indications	Surgery performed
Patient 1	39	Female	Polyposis	Draf IIa
Patient 2	32	Male	Polyposis	Draf IIa
Patient 3	61	Male	Recurrent polyposis (third surgery)	Draf III
Patient 4	51	Male	Polyposis	Draf IIa
Patient 5	10	Male	Pansinusitis (complicated)	Draf IIa

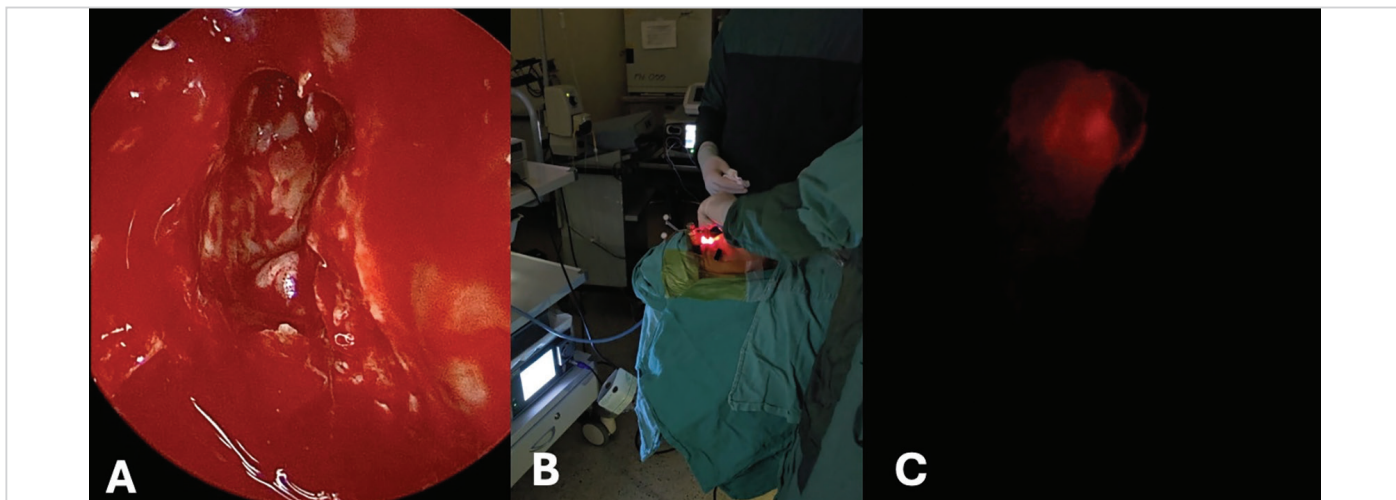


Figure 1. Identifying the frontal sinus opening with retrograde transillumination in patient 1. A, B, and C represent the view before the technique, the application of the technique, and the view after completing the frontal sinusotomy, respectively

angled instruments, the frontal sinus opening was searched. Retrograde transillumination became a guiding light to find the frontal sinus opening and a Draf IIa procedure was performed (Figure 2, Video 1).

Patient 5 was admitted to the pediatric emergency department with fever and confusion. After detailed examination and radiological imaging, an epidural abscess was detected in the right frontal lobe. After abscess removal by neurosurgeons, we performed endoscopic maxillary, ethmoid, and frontal sinus surgery. In this patient, a suprabullar cell made identification of the frontal sinus opening more difficult. In such cases, retrograde transillumination can help surgeons to find the frontal sinus opening; in our case, the light guided us directly to an opening located at the superior lateral aspect (Video 1).

Discussion

In this video article, we demonstrate that retrograde transillumination can be used as a practical adjunct to identify and confirm the frontal sinus opening during FESS. In five illustrative cases, including primary and revision surgeries, nasal polyposis, pansinusitis, and a pediatric patient with complicated sinusitis with epidural abscess, the technique allowed us to localize the ostium and tailor the extent of the frontal sinusotomy, with neuronavigation serving as an independent intraoperative reference.

Our observations build on the long history of frontal sinus transillumination. Campbell (3) first described transillumination of the frontal sinus nearly a century ago. In other fields, intraoperative transillumination has also been used to determine the frontal sinus extent during subcranial approaches to the anterior skull base, emphasizing its

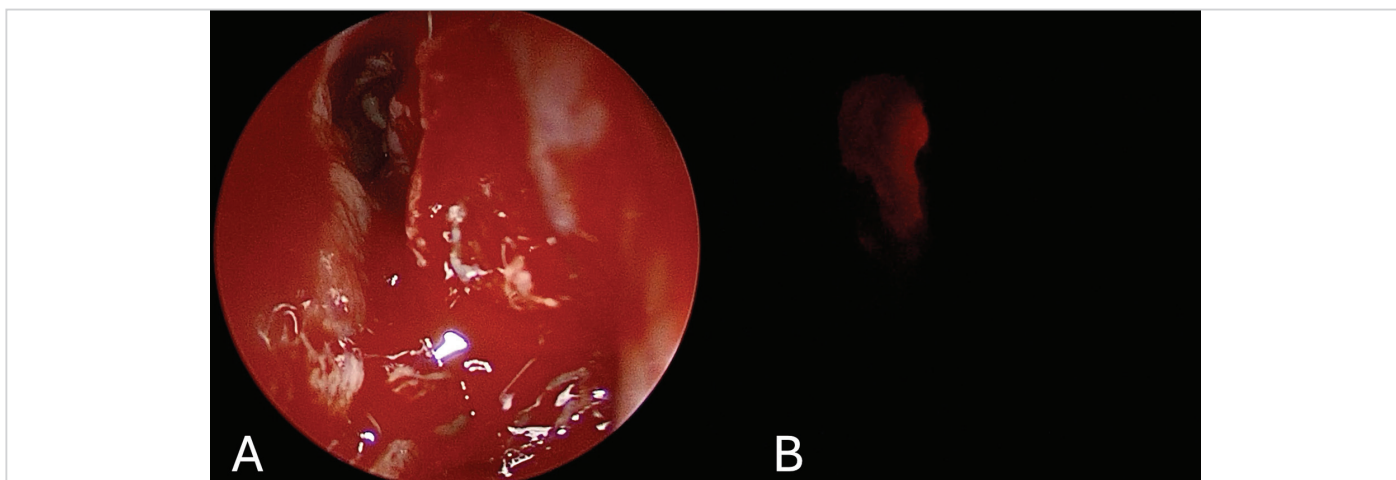


Figure 2. Identifying the frontal sinus opening with retrograde transillumination in patient 4. A and B represent the view before and after frontal sinusotomy, respectively

practical value as a real-time adjunct when landmarks are limited (6).

With advances in imaging, external-route techniques and radiographic approaches for frontal sinus surgery were reported in the mid-20th century, and modern image guidance has become an established adjunct in both open and endoscopic frontal sinus surgery (4,5). In a cadaver study of osteoplastic frontal sinus surgery, Melroy et al. (7) compared the CT guidance, Caldwell radiographs and the transillumination method and found that CT guidance most accurately predicted the frontal sinus borders, followed by Caldwell radiography and transillumination. Friedman et al. (8) later combined transillumination with neuronavigation to assess frontal sinus patency and reported that transillumination was useful for identifying the frontal sinus in 185 of 200 patients.

A conceptually related approach is diaphanoscopy after transcutaneous frontal sinus puncture. Al Kadah et al. (9) reported four revision cases of acute frontal sinus pyocele with bone defect following prior open frontal sinus surgery, in which the frontal sinus was accessed transcutaneously through a pre-existing bony defect using an endoscopic system; the resulting intraluminal illumination enabled clear endonasal identification of the frontal sinus floor by diaphanoscopy and guided a targeted endonasal opening (Draf IIb) in all patients. In contrast, our patients did not have a pre-existing anterior table defect; therefore, we used an external light source placed superomedial to the eyebrow to generate retrograde transillumination as a non-invasive cue for ostium localization without transcutaneous instrumentation.

Compared with these reports, our contribution is to apply the principle of transillumination in a retrograde fashion specifically to localize the frontal sinus opening during endoscopic surgery. By placing the endoscope light source externally at the superomedial eyebrow, the surgeon observes a focal glow at the ostium while simultaneously viewing the frontal recess endonasally. This technique does not replace preoperative CT analysis, where multiplanar reconstructions can improve depiction of the frontal sinus and the recess anatomy, or the detailed knowledge of frontal recess anatomy, or navigation; instead, it offers a simple, low-cost visual cue that may be particularly valuable when anatomical landmarks are distorted, when the frontal cells mimic the drainage pathway, or in centers where navigation is unavailable.

Our study also has limitations. Firstly, this is a small descriptive series without a control group or quantitative outcome measures; therefore, we cannot estimate the diagnostic accuracy or the long-term patency rates. Secondly, retrograde transillumination is less effective when the frontal

sinus is filled with dense polyps, granulation tissue, or thick mucosa, which may block or diffuse the light. In addition, the anterior table thickness, the frontal sinus size, and individual variations in the frontal cells may influence the intensity and localization of the glow. Finally, we verified the technique using neuronavigation in all patients, but we did not perform systematic comparisons of procedure time or complication rates with and without the technique.

Future studies with larger patient cohorts and prospective designs are needed to investigate the utility of the technique across different cell configurations to evaluate its validity and reliability (10). Such studies could compare its accuracy with that of navigation alone, assessing interobserver agreement.

Conclusion

In summary, retrograde transillumination may serve as a simple, low-cost adjunct to help localize the frontal sinus opening during endoscopic frontal sinus surgery, especially in challenging or revision cases and in settings without access to neuronavigation. The technique should be used together with thorough preoperative CT evaluation and anatomical knowledge, and its performance should be further validated in larger comparative studies.

Ethics

Ethics Committee Approval: This study was approved by the Clinical Research Ethics Committee of Ondokuz Mayıs University (approval no: OMÜ KAEK 2024/94, date: 29.02.2024).

Informed Consent: Written informed consent was obtained from all adult patients and from the parent or legal guardian of the pediatric patient for the use of demographic and clinical data, as well as intraoperative photographs and videos included in this article.

Footnotes

Authorship Contributions

Surgical and Medical Practices: Ö.K., E.D., M.Ç., Concept: Ö.K., E.D., M.Ç., Design: Ö.K., E.D., M.Ç., Data Collection and/or Processing: Ö.K., E.D., M.Ç., Analysis or Interpretation: Ö.K., E.D., M.Ç., Literature Search: Ö.K., E.D., M.Ç., Writing: Ö.K., E.D., M.Ç.

Conflict of Interest: Özgür Kemal Prof. MD is associate editor in Turkish Archives of Otorhinolaryngology. He had no involvement in the peer-review of this article and had no access to information regarding its peer-review.

Financial Disclosure: The authors declare that this study has received no financial support.

Main Points

- Frontal sinus opening can be difficult to localize in endoscopic sinus surgery, especially in revision cases and when frontal recess anatomy is distorted.
- We describe a simple five-step retrograde transillumination technique using the endoscope light source placed superomedial to the eyebrow to identify and confirm the frontal sinus opening intraoperatively.
- In five illustrative cases (nasal polyposis, pansinusitis, revision Draf III surgery, and pediatric complicated sinusitis with epidural abscess), retrograde transillumination enabled reliable localization of the frontal sinus opening and guided the appropriate extent of frontal surgery.
- Retrograde transillumination is a pragmatic, low-cost adjunct that complements anatomical expertise and neuronavigation, and may be particularly useful in centers without navigation systems or for less experienced surgeons.

Video 1. The video includes the title, introduction, intraoperative recordings from five endoscopic frontal sinus surgeries in which the retrograde transillumination technique was used, and key points of the technique.

Video 1 Link: <https://youtu.be/qkwcgLMaQGM>

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