Combined Supraciliary and Endoscopic Endonasal Approach for Resection of Frontal Sinus Mucoceles: Technical Note

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Key words
- supraciliary craniotomy
- endoscopy
- keyhole approach
- frontal sinus mucocele

Abstract

Objective: Mucoceles are progressive, slow-growing lesions of the paranasal sinuses that, left untreated, can erode into surrounding structures. Complete obliteration and exenteration of the frontal sinus via a bicoronal skin incision and frontal craniotomy is the standard neurosurgical approach to treat these lesions.

Technique: We describe two patients who underwent a combined supraciliary "keyhole" craniotomy and endonasal endoscopic resection of mucoceles with frontal sinus obliteration. The technique takes advantage of a smaller incision, while preserving adequate visualization and the ability for surgical instrumentation. Through the craniotomy, the frontal sinus mucosa is fully exenterated, the posterior table of the sinus is removed to establish communication with the intracranial space, and the nasal frontal ducts are packed with autologous tissue. The endoscopic endonasal route allows a minimally invasive access to the frontal nasal duct to ensure its blockage from the intracranial compartment. Additionally, the endoscope can be used from above through the supraciliary approach to allow for contralateral frontal sinus exposure and mucosal exenteration.

Conclusion: The combined supraciliary-endoscopic endonasal approach provides a minimally invasive access for the treatment of sinonasal disease with frontal sinus mucoceles that invade the intracranial cavity.

Introduction

Advances in endoscopy, microneurosurgery, and microscopy have resulted in minimally invasive procedures as alternatives to traditional exposures of intracranial pathology. Minimal access surgery has the potential to decrease operative time, reduce operative morbidity, and speed up patient recovery. The supraciliary craniotomy is a minimal access approach to lesions of the anterior cranial fossa [1–3]. It is a modification of the "supraorbital approach," as first described by Jane et al. [4]), in that it affords a subfrontal view of the ventral skull base without a bicoronal incision. The supraciliary keyhole craniotomy has been used to treat a variety of pathology including aneurysms, tumors, and abscesses [5–12]. We describe two cases using a combined supraciliary craniotomy and endonasal endoscopic approach to treat a frontal sinus mucocele and to obliterate the frontal nasal duct. This approach is a safe and effective method to treat sinonasal disease with associated frontal sinus mucoceles and spares the patient a bicoronal skin incision.

Patients and Methods

Illustrative cases

Case 1

The patient was a 75-year-old female with a history of nasal polyps and chronic sinusitis, who presented with complaints of frontal headache and nasal congestion for multiple weeks. She did not have any ophthalmological complaints. Her neurological exam was normal, without any focal motor, sensory, or cranial nerve findings. CT scan (**Fig. 1A**) and MRI (**Figs. 1B, C**) demonstrated a right frontal sinus mucocele with extension into the orbit as well as the contralateral frontal sinus.

Case 2

The patient was a 72-year-old female with a history of chronic sinusitis refractory to multiple endoscopic procedures, who presented with long-standing complaints of frontal and left orbital headache. There were no constitutional complaints of fever or chills. Her examination

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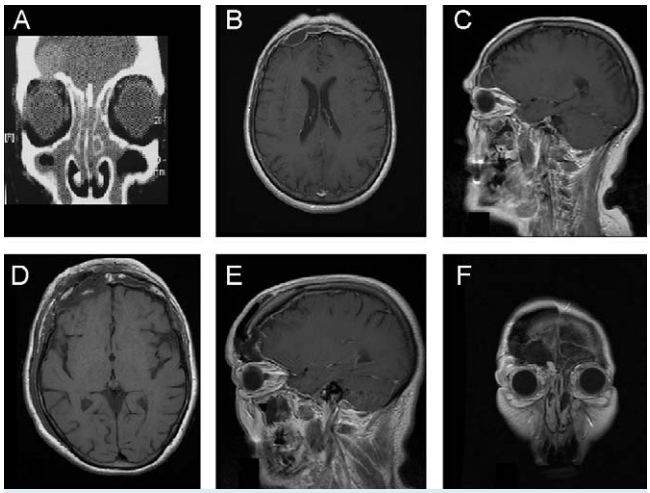

Fig. 1 Patient #1: Pre-operative coronal CT scan (**A**) and contrast-enhanced axial (**B**) and sagittal (**C**) T_1-weighted MRI demonstrating a right frontal mucocele with extension into the right orbit and the contralateral frontal sinus. Post-operative contrast-enhanced axial (**D**), sagittal (**E**), and coronal (**F**) T_1-weighted MRI demonstrating resection of the frontal sinus mucocele and packing of the nasal frontal ducts with autologous fat.

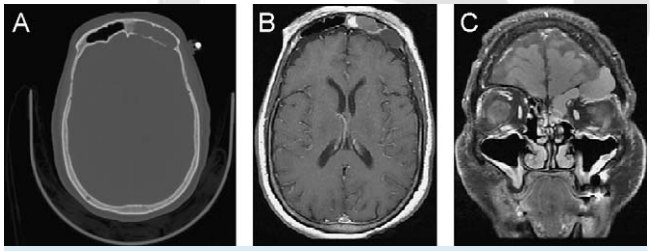

Fig. 2 Patient #2: Pre-operative axial CT scan (**A**) and contrast-enhanced axial (**B**) and coronal (**C**) T_1-weighted MRI demonstrating a left frontal sinus mucocele with dehiscence of the posterior table of the frontal sinus, intracranial extension, and orbital extension with mass effect on the left orbit.

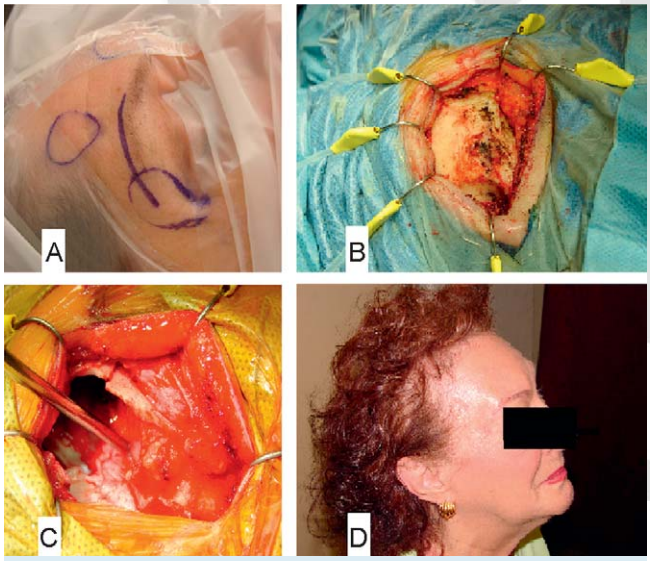

Fig. 3 Operative technique: intra-operative photograph of the 5 cm supraciliary skin incision utilized for the approach (**A**). A pericranial vascularized flap is elevated to expose the underlying bone that will be elevated (**B**). The frontal sinus is entered and the mucosa is exenterated (**C**). Post-operative photograph of the healed supraciliary skin incision (**D**).

was remarkable for left proptosis, however, her neurological exam was normal, with no focal motor, sensory, or cranial nerve findings. CT (**Fig. 2A**) and MRI (**Figs. 2B, C**) demonstrated a left frontal sinus mucocele with orbital extension and proptosis, as well as intracranial extension through a dehiscence in the posterior table of the frontal sinus.

Surgical technique

The patients were placed in the supine position with the head fixed in a 3-point device, slightly elevated above the level of the heart. The entire procedure was performed under frameless stereotactic image-guided navigation. Given the anterior location of the lesion, the head was turned between 45–60 degrees in the contralateral direction. An approximately 5 cm curvilinear incision (**Fig. 3A**) was made starting lateral to the supraorbital foramen and extending to the frontozygomatic suture, with careful preservation of the pericranium. A curvilinear incision was made in the pericranium, which was elevated as a vascularized pedicle flap, and the bone was exposed with self-retaining retractors (**Fig. 3B**). A burr hole was placed in the "keyhole" and a supraorbital craniotomy was carried out with the craniotome. The supraorbital ridge osteotomy was performed with a high-speed air drill. The frontal sinus was visualized and the mucosa was fully exenterated (**Fig. 3C**). The posterior wall of the sinus was cranialized to the anterior fossa using a high-speed air drill. In Patient #1, the contralateral frontal sinus was explored and further exenterated. The frontal nasal ducts were packed with fat harvested from the umbilicus. An endoscope was advanced transnasally to resect the patient's multiple polyps, to assess the nasal duct packing from below, and to further obliterate any communication between the frontal sinus and other paranasal compartments. In Patient #2, the nasal frontal ducts were packed with autologous temporalis fascia harvested during the cranial opening. An endoscope was advanced into the craniotomy opening to look around acute angles for any remaining mucosa and to ensure adequate obliteration of the ducts.

Post-operative course

The pathology report for both patients revealed inflammatory mucosal epithelium without evidence of abscess. Both patients reported relief of frontal and orbital headaches, and did not manifest symptoms of CSF leak or infection. The supraciliary osteotomy site and incision healed with good cosmetic outcome (**Fig. 3D**). Post-operative MRI in Patient #1 demonstrated good resection of both the frontal mucocele and the inflammatory mucosa extending into the contralateral sinus, as well as obliteration of the frontal nasal ducts with autologous fat (**Figs. 1D–F**).

Discussion

Mucoceles are benign lesions that develop in the paranasal sinuses following obstruction of sinus drainage. They are lined by respiratory epithelium and can produce mucous in a physiological manner. The most frequent location is the frontal sinus (60%), and these slow-growing processes can erode surrounding bony structures resulting in adjacent cranial and orbital extension [13]. A long-standing untreated mucocele can become infected, forming a mucopyrocele, putting the patient at risk for meningitis/cerebritis, orbital cellulitis, and osteomyelitis. Common etiologies for their development include inflammatory and

allergic processes, neoplasms, and post-operative/post-traumatic sequelae [14]. They occur equally in both genders and predominate in the fourth to seventh decades of life [15]. Presenting symptoms can vary, and may include frontal headaches, diplopia, orbital edema, and proptosis.

The ultimate goal of surgical intervention involves reestablishment of sinus drainage or obliteration of the sinus cavity [16]. Surgical approaches to these lesions include endonasal endoscopic and open external osteoplastic and cranialization techniques [17–22]. Regardless of the technique chosen, the determinant approach necessitates adequate visualization and room for instrumentation. Open procedures are traditionally reserved for cases that have been refractory to endoscopic techniques, large mucoceles with extension into adjacent cranial structures, and unfavorable frontal recess anatomy for an endoscopic approach [16].

Open craniotomy to access frontal sinus pathology typically entails a bicoronal skin incision in order to provide enough scalp retraction. The supraciliary incision and "keyhole" craniotomy is a modification of the standard coronal approach both in terms of incision and craniotomy [4,23,24]. It allows for adequate visualization and instrumentation while minimizing exposure and dissection of normal anatomy. The approach affords contralateral exposure of the anterior fossa and frontal sinus, as the intracranial field enlarges with increasing distance from the craniotomy entrance [25–29]. Eyebrow craniotomies have been utilized for multiple intracranial pathologies. A large series of patients treated since 1985 with this procedure have comprised of aneurysms, tumors, cysts, and vascular malformations within the anterior and central cranial fossa [29]. This report underscores its use as a tool to treat frontal sinus disease.

The two cases illustrated also highlight the collaborative use of the endoscope, whether endonasally or through the craniotomy, to enhance visualization. When used endonasally, the endoscope can ensure good obliteration of the nasal frontal ducts, as well as assist in anterior frontal mucosal exenteration. When placed directly into the craniotomy site, it brings light into the operative field that may have otherwise been compromised with the smaller opening [29]. The endoscope can be used to visualize the contralateral frontal sinus in order to remove inflamed mucosa and to see around acute angles and corners within the operative cavity.

Conclusion

As neurosurgeons continue to expand the field of minimally invasive neurosurgery, we can offer our patients treatment options through smaller incisions and openings, without sacrificing surgical technique or visualization. The supraciliary incision and supraorbital craniotomy afford a minimal access technique for addressing pathology of the anterior cranial fossa. Its utilization, in combination with the advantages of endoscopic technology, obviates the need for traditional bicoronal incisions to treat frontal sinus disease. We present two patients who had successful resections of frontal sinus mucoceles, while maintaining adequate visualization into the contralateral sinus and around acute angles.

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