Endoscopic endonasal repair of anterior skull base non-traumatic cerebrospinal fluid leaks, meningoceles, and encephaloceles

Clinical article


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Object. The endoscopic endonasal approach has become the preferred technique for CSF leak and encephalocele repair of the anterior skull base. The purpose of this study is to identify patient characteristics; review adjunctive perioperative treatments, reconstruction techniques, and outcomes; and identify risk factors for failure in patients undergoing endoscopic endonasal repair of anterior skull base CSF leaks and encephaloceles.

Methods. This is a prospective observational study of patients undergoing endoscopic endonasal repair of a CSF leak between October 2004 and May 2009. Twenty-eight consecutive patients underwent 32 procedures. Twenty-two of the patients were women, which represents a statistically significant trend toward the female sex (p < 0.05). The average body mass index (33.9) was significant for obesity. The origin of the skull base defect included the cribiform plate (in 9 cases), fovea ethmoidalis (in 7), combined fovea ethmoidalis/cribiform plate (in 2), lateral sphenoid sinus (in 6), sella (in 4), clivus (in 3), and frontal sinus (in 1).

Results. The overall endonasal closure rate was 93.8% (30 of 32 procedures). One failure occurred due to overaggressive postoperative debridement, while the other recurred along the posterior wall of the frontal sinus, and endoscopic repair would have occluded the recess.

Conclusions. The endoscopic endonasal approach for the treatment of CSF leaks and encephaloceles of the anterior skull base is the preferred method of repair in the vast majority of cases. The authors’ 93.8% closure rate in a variety of anatomical locations compares favorably with the transcranial approach and echoes the results of other endoscopic series. (DOI: 10.3171/2009.10.JNS08986)

KEY WORDS • endoscopic approach • encephalocele • cerebrospinal fluid leak • endoscopic skull base

S urgical repair of encephaloceles and CSF rhinorhea is recommended to prevent meningitis, intracranial abscess, and pneumocephalus. Traditionally, CSF leaks have been managed via a craniotomy with a 70–80% successful closure rate.7 Advantages of the transcranial approach include direct visualization of the dural defect, the ability to address associated brain injury, and the potential to use a large vascularized pericranial flap. However, many studies have reported a 40% recurrence rate with this approach and significant patient morbidity including anosmia, frontal lobe retraction, seizures, memory deficits, and intracranial hemorrhage.1,13,14 In attempt to avoid these complications and improve closure rates, the endonasal endoscopic approach has evolved to address CSF leaks of the anterior skull base. This involves pathology along the cribiform plate (Fig. 1), fovea ethmoidalis, sphenoid bone, or temporal bone. The endoscope not only provides excellent visualization, but outcome studies have demonstrated decreased morbidity and improved closure rates.3,6,10,13,18 The approach also allows for close postoperative surveillance of the wound site and the ability to identify recurrences. Nevertheless, many neurosurgeons still continue to close CSF leaks of the anterior skull base via a craniotomy, having not been trained in endoscopic endonasal surgery.

Cerebrospinal fluid leaks can be divided into post-traumatic, iatrogenic, and spontaneous, the first of which generally resolve without surgical intervention. The lat-
ter 2 categories can be particularly challenging to repair due to their high volume of flow, the difficulty in identifying the precise location of the leak, the potential for unrecognized mild increases in intracranial pressure, or congenital thinning of the skull base. The purpose of this study was to review a series of patients who underwent purely endonasal, endoscopic repair of CSF leaks caused by a variety of nontraumatic factors. We define patient characteristics; review adjunctive perioperative treatments, reconstruction techniques, outcomes; and identify risk factors for failure in patients undergoing endoscopic endonasal repair of anterior skull base CSF leaks and encephaloceles as an incentive for more neurosurgeons to adopt these techniques in their practice.

Methods

This is a prospective, observational study of all patients undergoing endoscopic repair of a CSF leak caused by a spontaneous meningocele, meningoencephalocele, prior craniotomy, sinus surgery, or remote endoscopic skull base surgery between October 2004 and May 2009. Patients with posttraumatic CSF leaks were excluded. Patients with CSF leaks caused by recent (< 8 months) endonasal endoscopic skull base surgery were also excluded. All patients were treated by the senior authors at the Institute for Minimally Invasive Skull Base and Pituitary Surgery at Weill Cornell Medical College, New York Presbyterian Hospital (V.K.A., A.K., and T.H.S.). The diagnostic methods used to confirm the presence and site of the lesion included any combination of β-2 transferrin testing, rigid nasal endoscopy, CT imaging, MR imaging, cisternography, and intraoperative intrathecal fluorescein. This review evaluated demographic data, location, cause, approach, management, recurrence, and length of follow-up.

A total of 32 consecutive endonasal endoscopic surgeries for CSF leak and encephalocele repairs were performed in 28 patients. The group included 22 women who represent 78.5% of the patients. This represents a statistically significant trend toward female sex (p < 0.05, Fisher exact test). The average patient age was 53.6 years (range 27–73 years). Twenty-four cases (75%) were performed in patients who were overweight or obese (BMI > 25), and 19 (59.4%) were obese (BMI > 30). The average BMI was 33.9 (range 17.2–49.2).

Skull base defects were repaired through an endoscopic endonasal approach that included a single corridor or any combination of the transsphenoidal, transethmoidal, transcribriform, transclival, or transpterygoidal corridors. The details of these approaches have been described in previous articles. Intraoperative fluorescein was used to help localize the CSF leak, determine the extent of the defect, and ensure a watertight closure (Fig. 2). Skul

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Endoscopic encephalocele repair

Results

Nine surgeries were performed for a CSF leak due to iatrogenic surgical trauma, 2 of which were caused by transcranial skull base surgery and 7 of which were caused by remote endonasal sinus or pituitary surgery. The remaining 23 surgeries were to repair either a spontaneous meningocele or a meningoencephalocele. All patients experienced CSF rhinorrhea as a presenting symptom, 7 (25%) had a history of meningitis, 3 (10.7%) had significant headaches, and 1 patient (3.6%) had a nasal obstruction. Five patients were identified to have an empty sella syndrome on preoperative imaging. The origin of the CSF leaks is shown in Fig. 3.

Multiple approaches were used in combination to clearly identify and patch the skull base defect. The approach varied depending on the individual’s anatomy and previous surgical interventions, along with the size and location of the defect (Fig. 4). In many cases, multiple approaches were used. The average length of follow-up was 90.5 weeks (range 8–203 weeks).

A total of 24 cases (75%) had a lumbar drain placed perioperatively. Two patients had recurrent CSF leaks at the site of the initial endonasal closure for a success rate of 93.8%. One recurrence was in a patient with a BMI of 31.4 who underwent successful endoscopic closure of her encephalocele until a leak developed immediately after overaggressive debridement by a resident postoperatively. She continues to have a CSF leak and has deferred surgical intervention at this time despite medical counsel otherwise.

The second patient was a 71-year-old woman (BMI 49.2) with a large meningoencephalocele (1.5 cm) who underwent successful endonasal repair but then developed a new defect in the posterior table of the frontal sinus, adjacent to our original closure, after a car accident. An attempt was made to repair the defect, but it was thought that an aggressive repair would have a high risk of obstructing the natural outflow from the frontal sinus and result in sinusitis and/or mucocele formation (Fig. 5). After recurrence, the patient was successfully treated via a transcranial approach with a pericranial flap to seal the defect.

Two other patients developed recurrent spontaneous CSF leaks in new locations, indicating that the original repair was successful, but the leaks were predisposed to meningocele formation. One of the patients was a 63-year-old woman who underwent resection of a right-sided vestibular schwannoma via a craniotomy. This procedure was complicated by an encephalocele formation through the temporal bone that was successfully repaired through a craniotomy. Four months later, she developed an unrelated encephalocele of the right lateral sphenoid sinus that was successfully repaired endonasally as well. Two years later, she again developed an encephalocele from the left fovea ethmoidalis that was successfully repaired endonasally as well. On multiple occasions, the patient refused placement of a VP shunt to prevent future leaks. This patient was morbidly obese (BMI 37) and had diabetes in addition to a history of chemotherapy for recurrent breast cancer.

The second patient was a 51-year-old woman (BMI 23) with a history of a pituitary macroadenoma that was partially resected and treated with radiation therapy. She had undergone 4 previous CSF leak repairs at an outside institution. Her first endonasal, endoscopic repair at our institution was successful. Six months later the leak recurred at a new site, which was again repaired endonasally, and a VP shunt was placed the following day to prevent further leaks. A year and a half later, she continues to be without a CSF leak.

Fig. 2. Intrathecal fluorescein is injected to identify the site of CSF leak. A: Fluorescein-tinted CSF with normal white light. B: Excitation of the fluorescein with blue light leads to emission in the green wavelength that highlights the site of the CSF leak. C: A blocking filter can be placed to remove the blue wavelengths, further highlighting the green wavelengths of the fluorescein.

Fig. 3. Pie chart showing the anatomical location of CSF leaks.
There were 3 cases of postoperative sinusitis that were treated successfully with a course of antibiotics. One patient developed chronic headaches and another a urinary tract infection. A multivariate regression analysis did not identify any significant risk factors for recurrence.

Discussion

The management of nontraumatic spontaneous or iatrogenic CSF leaks, meningoceles, and meningoencephaloceles has an extensive history characterized by a cornucopia of surgical approaches and different graft materials used to repair the skull base defect.\textsuperscript{1,3,6,7,10,11,13,14,18} This study confirms the ability of the endoscopic endonasal approach to reliably identify and repair these cranial defects in multiple locations along the anterior skull base. Our 93.8% closure rate compares favorably with outcomes reported using a craniotomy and echoes the results of other endoscopic series.\textsuperscript{1,3,6,7,10,11,13,14,18} These data further solidify the endoscopic approach as the preferred method to address CSF leaks of the anterior skull base that are not associated with additional pathology that requires a transcranial approach, thereby eliminating the risks of brain retraction, seizure, brain hemorrhage, and contusion.

The choice of graft material and how to place the graft varies greatly between surgeons. We prefer an inlay technique with autogenous materials (fascia lata) or DuraGuard along with a rigid buttress (vomer or Medpor) and a vascularized flap (nasoseptal or middle turbinate) if the defect is > 1 cm. We have found a final layer of DuraSeal to be helpful in all cases. However, experienced surgeons have yielded similar results using different graft materials and with onlay repair techniques.\textsuperscript{2,20} Thus, the choice of graft materials and technique of repair mostly depends on the surgeon’s experience and preference.

Nonetheless, a few critical practices uniformly improve closure rates. First, the entire defect must be circumferentially identified and accessible for instrumentation. This requires relatively wide exposure. For example, in cases of lateral sphenoid lesions, a transpterygoid approach is usually required in addition to the transsphenoidal, transthyroidal corridor. The herniated dura should be resected or reduced into the intracranial cavity. Brain that has herniated into the nasal cavity is rarely functional and considered a potential intracranial source of infection if not resected.\textsuperscript{5} Another important step is to remove the mucosa surrounding the defect to allow the graft to adhere firmly to the skull base.

Our analysis revealed that female sex (p < 0.05) was a statistically significant risk factor for developing an encephalocele or CSF leak. In addition, the average BMI of our patients (33.9) was in the range of obese and significantly higher than a healthy range (BMI between 18.5 and 25). The small number of surgical failures prevented multivariate analysis of our data. However, 2 important teaching points were identified to help prevent recurrence. Conservative nasal debridement in the postoperative period is mandatory. Second, while the endonasal endoscopic approach is the preferred method in the vast majority of cases, one anatomical location that requires careful scrutiny regarding the favored approach is the frontal sinus. This may be a precarious location to reconstruct via an endonasal approach when lesions are far lateral, the frontal recess is narrow, or the reconstruction materials obstruct the outflow from the frontal sinus. Obstruction of the frontal recess due to scarring or from the graft materials often results in sinusitis or mucocele formation, both being technically challenging problems to correct. A transcranial approach with a pericranial flap proved useful in the patient in our series with a posterior table frontal sinus encephalocele. The surgeon must...
Endoscopic encephalocele repair

carefully examine the preoperative images to define the extent and location of the skull base defect along with the native anatomy of the frontal sinus to determine the best approach.

An area of controversy regarding management involves the use of CSF diversion techniques such as lumbar drainage or a VP shunt. This debate highlights the challenge of treating patients with unrecognized increased CSF pressure. Some authors hypothesize that regardless of the reconstruction technique, patients with increased CSF pressure are at increased risk of persistent or recurrent CSF leak at the reconstruction site or elsewhere along the skull base. While some groups do not favor the use of perioperative lumbar drainage because closure rates may not improve and fear of eliciting pneumocephalus or “brain sag,” others use lumbar drainage to measure intracranial pressure to select patients for permanent CSF diversion. Multiple studies have demonstrated higher failure rates in patients with documented hydrocephalus based on CSF opening pressures or presumed hydrocephalus due to conditions such as obesity in patients with a “spontaneous” CSF leak or an empty sella syndrome. Thus, in our study, we liberally used lumbar drainage at a low drainage rate and short duration without complication to help prevent pooling at the reconstruction site. We do not measure CSF pressure or prophylactically place VP shunts but rather prefer to observe the endonasal closure and reserve shunt placement for patients with recurrent CSF leaks. We calculate the morbidity of shunt placement along with the potential shunt failure rate, which can be as high as 27%, as greater than the possible benefit of preventing a recurrent CSF leak in a small patient population. We aggressively promote weight loss programs in patients with an elevated BMI, prescribe stool softeners, and in rare cases have used acetazolamide to decrease the production of CSF in the perioperative period. Moreover, the addition of vascularized flaps like the nasoseptal or middle turbinate flap to the reconstruction armamentarium may decrease the incidence of recurrence at the reconstruction site and the need for permanent shunting.

We recognize that this study is limited by the inherent problems of a retrospective analysis and the use of historical comparisons as a control group. Moreover, the duration of follow-up is limited and may not accurately predict the rate of meningocele or encephalocele recurrence in a disease process that may be chronic. Further prospective multiinstitutional studies are warranted to better understand long-term outcomes, identify patients at risk to experience a recurrence, and the indications for VP shunt treatment in the management of encephaloceles of the anterior skull base.

Conclusions

The endoscopic endonasal approach for treatment of CSF leaks and encephaloceles of the anterior skull base is the preferred method of repair in the vast majority of cases except the posterior wall of the frontal sinus, where repair may obstruct the frontal recess. Our 93.8% closure rate in a variety of anatomical locations permits the avoidance of a craniotomy and VP shunt placement in the vast majority of cases. These latter treatment modalities should be reserved for only recurrent and refractory cases.

Disclaimer

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

References


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