Endoscopic Endonasal Repair of Spontaneous and Traumatic Cerebrospinal Fluid Rhinorrhea

A Review and Local Experience

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KEYWORDS

• Paranasal sinuses • Cerebrospinal fluid • Endoscopic endonasal approach • Rhinorrhea

KEY POINTS

- Surgical repair is the mainstay of management in cases of persisting cerebrospinal fluid (CSF) rhinorrhea.
- The principal indication is prevention of the possible complications that include ascending meningitis, intracranial abscess, and pneumocephalus.
- Endoscopic endonasal repair is an effective and well-tolerated procedure for the vast majority of CSF rhinorrhea cases, with primary closure rates of greater than 90% in large series and systematic reviews.
- Compared with the traditional open approaches, endoscopic endonasal repair carries similar results with fewer complications.

Videos of the endoscopic views of a spontaneous cribriform plate defect with associated meningoencephalocele and an iatrogenic frontal sinus CSF leak accompany this article at www.neurosurgery.theclinics.com/

INTRODUCTION

General

Cerebrospinal fluid (CSF) rhinorrhea is caused by an abnormal communication between the subarachnoid space and the nasal cavity. This condition most commonly occurs secondary to a predisposing event, such as accidental or iatrogenic trauma. Nevertheless, CSF rhinorrhea may also occur spontaneously, a condition associated with benign intracranial hypertension (BIH). Surgical repair of CSF rhinorrhea is recommended to prevent the potential serious sequelae that include ascending meningitis, intracranial abscess, and pneumocephalus.

The most common anatomic sites leading to CSF rhinorrhea are located in the anterior skull

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base (ASB), namely the ethmoid roof, the olfactory groove, the roof of the sphenoid sinus, and the posterior wall of the frontal sinus. Historically, these defects have been repaired via an external approach, including a frontal craniotomy, and pericranial flap closure. However, the development of endoscopic endonasal skull base approaches in the last 2 decades provides an alternative to the traditional open approaches and has gradually gained popularity.

Following a thorough review of the existing literature, this article discusses the pathophysiology, diagnosis, and management of spontaneous and traumatic CSF rhinorrhea and provides a comprehensive description of the endoscopic endonasal approach (EEA) for repairing ASB CSF leaks.

Anatomic Considerations

CSF rhinorrhea refers to CSF leakage into the nasal cavity. Most commonly, CSF enters the nasal cavity through defects in the ASB. Understanding the anatomy of the related components of the cranial base, nasal cavity, and paranasal sinuses is essential for successful management of this condition. This section focuses on the anatomic interface between the intracranial and sinonasal cavities, outlining the areas that are prone to injury.

The ASB is formed by the ethmoid, sphenoid, and frontal bones and is separated from the middle cranial base by the sphenoid ridge, joined medially by the chiasmic sulcus. Two parts form the medial part of the ASB: the crista galli and the cribriform plate of the ethmoid bone anteriorly, and posteriorly, the planum and the body of the sphenoid bone.[1] The nasal cavity is bounded superiorly by the anterior cranial fossa above and is divided sagittally into 2 compartments by the nasal septum.[2] The paranasal sinuses are 4 pairs of pneumatic cavities: namely, the frontal, ethmoid, sphenoid, and maxillary sinuses. Each paranasal sinus is named after the bone in which it is located, and they all communicate directly with the nasal cavity. Excluding the maxillary sinuses, all the paranasal sinuses are superiorly bounded by the cranium.[3]

The frontal sinuses are housed in the frontal bone between the inner and outer tables. The inner table forms the posterior wall of the sinus, separating it from the anterior cranial fossa. Anatomically, it is much thinner than the outer table, and thus prone to injury.[3] The frontal recess constitutes the frontal sinus outflow tract.[4]

The ethmoid sinuses are formed by 5 components: the crista galli, cribriform plate, perpendicular plate, and paired lateral ethmoidal labyrinths, which contain the ethmoid air cells. The ethmoid cells are divided by the basal lamella of the middle turbinate into anterior and posterior divisions, which drain into the middle meatus and the sphenoethmoidal recess, respectively.[5] The roof of the ethmoid labyrinth, which separates the ethmoidal cells from the anterior cranial fossa, is formed by the relatively thick orbital plate of the frontal bone, called the fovea ethmoidalis. The fovea ethmoidalis attaches medially to the thinner lateral lamella of the cribriform plate (LLCP), completing the roof of the ethmoid air cells. Therefore, the ethmoid roof contains a transition from a thick bony part laterally to the thinner LLCP medially. The olfactory fossa is the region of depression of the horizontal cribriform plate below the level of the fovea ethmoidalis, and between the lateral lamellas. The vertical attachment of the middle turbinate divides the ASB into the cribriform plate medially and the fovea ethmoidalis laterally. Consequently, the anterior part of the nasal cavity's roof between the vertical attachment of the middle turbinate and the nasal septum is located directly under the horizontal cribriform plate (**Fig. 1**).[3]

The sphenoid sinus originates in the sphenoid bone at the junction of the anterior and middle cranial fossa and separates the pituitary gland from the nasal cavity. The sphenoid bone has a central portion called the body, which contains the sphenoid sinus. Three pairs of extensions spread out of the sphenoid body to form the complete sphenoid bone: 2 lesser wings that spread outward from the superolateral part of the body, 2 greater wings that spread upward from the lower part, and 2 pterygoid processes that are directed downward.[2] During embryogenesis, the sphenoid bone is formed from the ossification and fusion of 5 cartilaginous areas that subsequently fuse into a single bone. As first described in 1888 by Sternberg, incomplete fusion of the greater wing with the central cartilaginous precursors can result in a persistent lateral craniopharyngeal canal, called Sternberg canal.[6]

Following a systematic literature review of endoscopic approaches for repairing CSF leaks, Psaltis and colleagues[7] reported that the central part of the ASB is the most susceptible region to injury. Specifically, the ethmoid roof and cribriform region were found to be affected in more than half of the cases, independent of cause. This observation might be explained by several previously reported anatomic findings: first, the LLCP was found to be the thinnest, and therefore, the most vulnerable structure of the entire skull base.[5,8] Second, it has been reported that the horizontal cribriform plate is a thin and fragile bone that is covered only by an arachnoid layer, and hence, missing the protection of a true dural investment.