Cerebrospinal Fluid Diversion in Endoscopic Skull Base Reconstruction

An Evidence-Based Approach to the Use of Lumbar Drains

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KEYWORDS

• Endoscopic skull base reconstruction • Minimally invasive skull base surgery
• Cerebrospinal fluid leak • Cerebrospinal fluid diversion • Lumbar drains
• Subarachnoid drains

KEY POINTS

- Lumbar drains are not necessary in most low-flow or high-flow CSF leaks encountered during endoscopic skull base surgery.
- Placement of a lumbar drain is an invasive procedure and has a 5% minor and 3% major complication rate.
- Use of a lumbar drain can be advantageous in selected high-risk settings in which a high-flow leak is anticipated and the patient has significant risk factors that make closure of the leak more challenging.
- Risk factors for postoperative cerebrospinal fluid leak include intracranial hypertension, previous radiation therapy to the skull base or sinonasal cavity, unusually large or complex defects, certain aggressive or extensive tumors, and in settings in which preferred reconstructive options (ie, pedicled flaps) are not available.

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INTRODUCTION

Endoscopic skull base surgery has evolved dramatically over the past decade, and so have techniques for skull base reconstruction. Lumbar drain (LD) placement was initially routinely performed for cerebrospinal fluid (CSF) diversion in the setting of CSF leak and skull base reconstruction because there was uncertainty about how the dural repair would heal. In open cranial procedures, LDs are used to provide brain relaxation to minimize retraction-related cerebral edema. With the endoscopic endonasal approach, retraction is not an issue and the drain is used primarily to reduce stress on the skull base repair. The LD is often kept in place postoperatively to reduce intracranial pressure by continuous CSF drainage, which is believed to facilitate wound healing and improve the success rate of the reconstruction in obtaining a watertight closure.

The size and anatomic site of the defect are factors that are predictive of postoperative CSF leaks.[1,2] For example, larger defects that span the tuberculum sellae and the planum sphenoidale are inherently more complex to reconstruct than smaller defects involving only a small portion of the sella. Most pituitary tumors are resected either without a CSF leak or with a resulting low-flow CSF leak and should be considered as a separate category. Low-flow CSF leaks, as a rule, are easier to control than high-flow leaks. Low-flow CSF leaks can be defined as leaks that occur after dural opening but do not involve an opening into the ventricle or arachnoid cistern (such as the basilar or suprasellar cistern). In contrast to most pituitary tumors, other tumor types, such as meningiomas and craniopharyngiomas, may also be at increased risk for intraoperative and postoperative CSF leak; however, this may be more related to tumor size rather than to disease type.[1,3]

CSF diversion has been considered of particular importance when a high-flow CSF fistula is encountered during a procedure, because these are inherently more challenging to manage. In the setting of endoscopic endonasal surgery, high-flow CSF leaks, as defined by Patel and colleagues,[2] are an instance in which there is violation of a cistern or ventricle. Although debated by some, we strongly agree with this definition of CSF leaks because it is the most clinically relevant and meaningful. With the increased dependability of vascularized pedicled flaps for skull base reconstruction, the need for routine LDs in skull base reconstruction is being challenged, even when there is a high-flow fistula. There is an increasing body of evidence to suggest that LDs are not necessary in the setting of endoscopic skull base reconstruction. Proponents argue that there is no significant difference in the postoperative CSF leak rate when a vascularized pedicled flap is used. In this article, the complications associated with LDs and the evidence on the usefulness of LDs in preventing postoperative CSF leaks after endoscopic skull base reconstruction are reviewed. A rational framework for the use of LDs in endoscopic skull base surgery is also proposed.

CEREBROSPINAL FLUID PHYSIOLOGY AND PRINCIPLES OF DIVERSION

Total CSF volume is estimated to average about 125 to 150 mL in adults.[4] The choroid plexuses of the ventricles produce most CSF. About 20% of CSF is in the ventricles at 1 time and the remainder is within the subarachnoid space. It circulates from the lateral ventricles to the third ventricle and then into the fourth ventricle via the cerebral aqueduct. It then exits the fourth ventricle through the foramen of Magendie (medially) and the 2 foramen of Luschka (laterally) into the subarachnoid space surrounding the brain and spinal cord. It is then absorbed by the arachnoid granulations into the venous system. CSF is renewed about 4 times within 24 hours in an adult; the secretion rate varies between 15 and 25 mL per hour.