Endoscopic repair of cerebrospinal fluid leaks in the lateral sphenoid sinus recess

Clinical article

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Object. Cerebrospinal fluid leaks may occur as a result of trauma or following surgery, and occasionally may also be spontaneous. Leakage of CSF from the lateral sphenoid recess is rare and challenging to treat. The authors present their experience with repairs of 10 CSF leaks that were confined to the lateral sphenoid recess and were treated at the Singapore General Hospital.

Methods. A retrospective chart review was conducted for all patients who underwent operations for lateral sphenoid recess CSF leaks between 2001 and 2008.

Results. Ten repairs were performed in 8 patients by using a transpterygoid approach, with a 90% success rate. In 3 cases the transcranial approach had failed prior to endoscopic repair. “Sandwich reconstruction” under direct vision was performed in all cases, and was completed using cartilage or bone as a rigid support.

Conclusions. This series demonstrates that CSF leakage can be managed safely and effectively by using an endoscopic transpterygoid approach in patients in whom both external and endoscopic attempts have failed. The transpterygoid approach used in all of the cases in this series provides wide exposure around the skull base defect, which is crucial for successful repair. (DOI: 10.3171/2009.7.JNS09306)

Key words • lateral sphenoid recess • cerebrospinal fluid leak repair • endoscopic transpterygoid approach • cerebrospinal fluid

Cerebrospinal fluid leakage may occur as a result of compromised skull base integrity, and results in CSF flowing into the sinonasal or middle ear cavity, presenting the risk of subsequent pneumocephalus, meningitis, or brain abscess. The most common causes of CSF leakage are trauma and iatrogenic injury to the skull base following surgery. Unusual causes include congenital defects and intracranial hypertension, and in some cases no cause can be found. The location of the CSF leak can be anywhere in the skull base. When it occurs in the sphenoid, the defect may be situated around the midline (usually due to pituitary surgery), or may rarely occur in the lateral aspect of the sinus. This is considered a difficult site to repair1,2 due to the proximity of vital structures like the carotid artery, cavernous sinus, and optic nerves, and because exposure and manipulation around the defect may require dissection of the PPF or the infratemporal fossa. For these reasons, some authors recommend obliteration of the sphenoid sinus rather than direct repair, whereas others prefer a transpterygoid approach and open surgery.

In the past, the external approach was the standard technique to get access to the skull base, yet in recent years endoscopic surgery has provided an alternative means for treating a variety of skull base pathological conditions. Although many authors have already discussed the different issues regarding endoscopic CSF leak repair, and some have specifically addressed the sphenoid sinus, only a few have described their experience and the outcome of surgical repair of the lateral sphenoid recess.1,7 A variety of materials have been described for CSF leak repair, including synthetic materials, autologous fascia, bone, fat, and cartilage. Using all of these materials, reconstructions with single or double layers, with or without rigid support have been described, with success rates ~90%, regardless of the methods, materials, and surgical techniques used.2,3,6 The aim of this study was to describe our experience at the Sin-
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gapore General Hospital with a unique group of patients who underwent repair of CSF leaks in the lateral sphenoid recess, and to outline the surgical technique, results, and follow-up findings in these patients.

Methods

The files of all patients undergoing CSF leak repair between 2001 and 2008 at the Singapore General Hospital were reviewed. Only patients with CSF leaks without an apparent cause from the lateral recess of the sphenoid sinus were included in the study. Patients with a leak following pituitary surgery, a history of trauma or skull base surgery, or a leak from a lesion not located in the lateral aspect of the sphenoid were excluded. The patients' age and sex, the cause of the CSF leak, the method of repair, and the outcome were recorded. All patients underwent a preoperative CT scan and, if necessary, MR imaging or CT cisternography were also performed to define the leak location more precisely. A CSF leak seen on CT cisternography (Case 5) is presented in Fig. 1.

The same surgical technique was used for all patients, and it was similar to the approach described by Bolger, with some modifications as described below. A middle meatal antrostomy was created and widened backward to the posterior wall of the maxillary sinus. The sphenopalatine artery was identified at the point of entry into the nasal cavity and preserved (in Bolger's description the artery was resected). The contents of the PPF were retracted laterally, identifying the sphenopalatine artery branches, most of which could be preserved in all cases. Retraction of the PPF content allowed exposure of the sphenoid sinus floor and the pterygoid process. The sphenoid sinus was then accessed through the superior meatus and the sphenethmoid recess, and a wide sphenoidotomy was made on the side of the lesion. The leak was verified using a 70° endoscope, without fluorescein. The anterior and inferior walls of the sphenoid sinus were then resected, enlarging the sphenoidotomy, until the skull base defect could be seen by direct vision with a 0° endoscope. This resection was performed to allow insertion of instruments into the sphenoid sinus, and to provide adequate space for manipulation of the reconstruction materials around the defect, both on the side of the sphenoid sinus and inside the intracranial cavity. During resection of the anterior and inferior sphenoid sinus walls, the vidian canal and the maxillary division of the trigeminal nerve were exposed and preserved. Particular care was taken in the region of the lateral sphenoid wall, because the carotid artery and the cavernous sinus are right next to it.

When adequate access to the defect was possible, the sinus mucosa around the site of the leak was dissected to define the extent of the bone defect (Fig. 2). Soft tissue on the inner aspect of the defect, both on the side of the sphenoid sinus and inside the intracranial cavity. During resection of the anterior and inferior sphenoid sinus walls, the vidian canal and the maxillary division of the trigeminal nerve were exposed and preserved. Particular care was taken in the region of the lateral sphenoid wall, because the carotid artery and the cavernous sinus are right next to it.

When adequate access to the defect was possible, the sinus mucosa around the site of the leak was dissected to define the extent of the bone defect (Fig. 2). Soft tissue on the inner aspect of the defect was dissected away from the bone. Abdominal fat was tucked into the cranial side of the lesion (an underlay technique). Cartilage or bone taken from the septum or ear was inserted into the cranial side of the defect to provide rigid support for the intracranial cavity contents. Another piece of fat was then placed into the bone defect itself, and a free mucosal graft was placed on the outer side of the defect, to create a “sandwich reconstruction.” A third piece of fat was then put on the mucosal graft and covered with a Silastic sheet. A gauze pack was inserted into the sinonasal cavity to give support to the Silastic sheet, and was left in place for 3 days. No lumbar drain was used in this series. Postoperatively, strict bed rest with the head elevated 30° for 3 days and avoidance of physical activity for 3 weeks were recommended to all patients. The Silastic sheet was removed 2 weeks postoperatively.

Results

Eight patients were included in the study (5 women
and 3 men), who are presented in Table 1. Their mean age was 51 years (range 40–64 years). In 5 cases the CSF leak was on the left, in 2 cases it was on the right, and it was bilateral in the patient in Case 1 (see preoperative CT in Fig. 3). The study cohort consisted of 10 CSF leak repairs, because 2 repairs were made for a patient with bilateral disease (Case 1), and in 1 patient surgery was performed twice (Case 4). The cause of the CSF leak was spontaneous in all cases, apart from the patient in Case 2, in whom the leak developed after nasopharyngectomy for nasopharyngeal carcinoma.

Six unsuccessful repairs (4 craniofacial and 2 endoscopic) had been attempted in other institutions prior to these patients’ referral to the Singapore General Hospital. In the patient in Case 3, 1 endoscopic and 2 open attempts had failed. He had a CSF leak located in the distal lateral part of the sphenoid sinus (see preoperative CT in Fig. 4). He was successfully treated endoscopically in our department via a transpterygoid approach.

One repair failed in our department; this was in the patient in Case 4, whose bone defect was on a vertical bone plate facing laterally, in the lateral sphenoid recess (see CT scan in Fig. 5). Exposure of the defect was difficult, and the first attempt, in which we used a conventional technique, failed. A second operation was performed 6 months ago, in which the bone defect was enlarged anteriorly, giving better access to the intracranial side of the defect. Reconstruction was performed again by using the “sandwich technique” (see endoscopic view of the reconstruction in Fig. 6), successfully sealing the defect.

Rigid reconstruction was obtained by means of conchal cartilage from the ear in all but 2 cases (the patients in Cases 5 and 8), in whom septal bone was used. The patients were followed up for an average period of 33.7 months (range 1–84 months). The first attempt at repair was successful in all cases except the patient in Case 4 (90% success rate), whose repair was successful the second time. The endoscopic approach was thus sufficient to control the CSF leak in 100% of cases in the second attempt, without the need for an open approach.

### Table 1: Summary of data in 8 patients with skull base defects

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Side</th>
<th>Previous Ops</th>
<th>Cause of Leak</th>
<th>Rigid Reconstruction</th>
<th>Follow-Up (mos)</th>
<th>Outcome</th>
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<td>spontaneous</td>
<td>cartilage</td>
<td>84</td>
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<td>postop</td>
<td>cartilage</td>
<td>24</td>
</tr>
<tr>
<td>3</td>
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<td>1</td>
<td>2</td>
<td>spontaneous</td>
<td>cartilage</td>
<td>36</td>
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<tr>
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<td>0</td>
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<tr>
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<td>1</td>
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<td>bone</td>
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<tr>
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<td>bone</td>
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</tbody>
</table>

* Seven unsuccessful repair attempts were performed in 4 patients (4 transcranial and 3 endoscopic). All procedures were performed at other institutions, except for Case 4, in which endoscopic repair in Singapore General Hospital failed.

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**Fig. 3.** Case 1. A CT scan obtained in this patient, in whom bilateral skull base defects can be seen (right defect, thick arrow; left defect, thin arrow). Most of the sphenoid sinus is opacified bilaterally as a result of encephalocele formation.

**Fig. 4.** Case 3. A CT scan of a skull base defect situated in the far-lateral aspect of the sphenoid sinus (arrow). One endoscopic and 2 craniofacial repair attempts had failed prior to referral to us. An air-fluid level can be seen in the lower aspect of the sphenoid sinus.
Cerebrospinal fluid leakage is a rare entity, usually caused by trauma to the skull base, either from an accident, assault, or iatrogenic injury. In 3–4% of CSF leaks, the cause cannot be determined.5

Access to the medial aspect of the sphenoid sinus for repair of CSF leaks is straightforward, and requires the removal of the sphenoid rostrum and part of the anterior wall. Repair of the lateral recess of the sphenoid is more challenging,9 and is associated with an increased risk of failure,8 because its exposure requires dissection of the PPF, and because vital structures like the carotid artery, cavernous sinus, and optic nerve are very close.

In our series, most of the patients had a spontaneous CSF leak. In other reports of spontaneous leakage, the mean patient age was similar to that of patients in our series,4 and spontaneous leakage was identified as a risk factor for failure of the operation.11 Incomplete fusion of the greater sphenoid wing to the presphenoid/basisphenoid bones during childhood results in a dehiscent area, which can be the underlying cause of meningomyelocele formation in this area later in life.11

Wide exposure of the skull base defect is an essential step for successful CSF leak reconstruction.3 When dissection is extended laterally to the anterior and inferior walls of the sphenoid, the neurovascular structures of the PPF must be correctly identified and preserved. Despite the danger of injury to the internal carotid artery and the cavernous sinus, when dissection is performed in the lateral sphenoid recess we believe that wide exposure of the sphenoid sinus is crucial to identify the full extent of the skull base defect and to allow instruments to be inserted, so that the different reconstruction materials can be correctly positioned. The cause of endoscopic repair failure in this series might be the lack of adequate exposure of the defect, because the transpterygoid approach was not used in these cases. We use 3 different reconstructive elements to ensure long-lasting sealing of the skull base defect: 1) soft-tissue reconstruction material; 2) a rigid support; and 3) covering material. For soft-tissue reconstruction, we routinely use abdominal fat, which is abundant, easy to harvest, and carries minimal donor site morbidity. The fat is tucked in between the dura mater and the bone on the cranial side of the defect, creating the first layer of the underlay seal. Briggs and Wormald2 described fat as the only means of reconstruction for creating a “bath plug” seal; however, soft-tissue reconstruction alone might not be enough to provide long-term support, and may result in delayed meningomyelocele formation. Moreover, because increased intracranial pressure may be the underlying cause of spontaneous leaks, robust reconstruction has a better chance of resisting raised intracranial pressure.10

For these reasons, we routinely use rigid material such as cartilage or bone, which is placed between the fat and bone defect on the intracranial side, providing support and creating a second layer of the seal. Additional fat and a free mucosal graft are then used to create a multilayer reconstruction. This method has been described by other authors as their preferred reconstruction technique.1,12

Our success rate for a first attempt at reconstruction of the lateral sphenoid recess is 90%, which is comparable to other published series in which repair of less challenging skull base sites or sphenoid sinus leaks has been described.7 The overall success rate in our series is
actually 100%, because the only failure was successfully repaired on the second attempt.

Obliteration of the sphenoid has been described as the preferred approach for lateral sphenoid CSF leaks,5,13 and although a high success rate has been reported, the mean follow-up period was not stated in one study,13 and was only 18 months in a second one.5 This might not be long enough to exclude the possibility of late mucocele formation as a result of incomplete removal of sphenoid sinus mucosa, because complete removal is difficult to perform.12 We believe that in experienced hands, the risk of injury to the skull base structures is minimal, and the benefit of wide exposure and underlay positioning of tissue in the bone defect without obliteration outweighs the risk.

The main drawback of our series is the small number of patients, which makes it difficult to draw any definite conclusions. In addition, no control group was included in the study, which would have allowed us to make a comparison between a multilayer technique and other reconstruction methods, and to prove the former’s technical superiority.

Conclusions

Our results show that reconstruction of lateral sphenoid sinus defects can be performed safely and effectively by using an endoscopic transpterygoid approach. Wide exposure of the lesion is needed to enable tissue manipulation and avoid failure. An open approach can thus be avoided even when dealing with CSF leaks in difficult-to-reach skull base areas.

Although methods and materials for skull base reconstruction continue to be controversial, we believe that multilayer reconstruction with rigid autologous tissue is the most reliable way to provide a long-lasting seal. For sphenoid sinus CSF leaks, we prefer reconstruction of the defect instead of obliteration.

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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