Sinus Surgery in Patients With Previously Repaired Cerebrospinal Fluid Leaks

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Objective: To explore surgical technique and outcomes of revision endoscopic sinus surgery (ESS) in patients with previously repaired cerebrospinal fluid (CSF) leaks.

Design: A case series of 13 patients with previously repaired iatrogenic CSF leaks who underwent revision ESS for recurrent sinus disease; a review of the preoperative workup, intraoperative findings, and postoperative outcomes.

Setting: Two academic medical centers.

Patients: Patients were included if they had a history of previously repaired skull base defect and iatrogenic CSF leak in the vicinity of the planned revision ESS.

Interventions: Revision ESS was performed in the vicinity of the previously repaired CSF leak. Dissection was carefully performed to avoid a recurrent CSF leak.

Main Outcome Measures: Preoperative workup, intraoperative findings, surgical technique, and complications were reviewed.

Results: The study population consisted of 7 men and 6 women. Surgical navigation was used for all cases. Intrathecal fluorescein was not used in any case. In no instances was an active preexisting CSF leak identified or a new leak created. No minor or major postoperative complications arose in any of the study patients. All patients were discharged home within 24 hours. The mean (SD) follow-up was 26.0 (16.7) months.

Conclusions: Previous skull base injury with CSF leak is not a contraindication to revision ESS. Safe ESS in this setting can be performed and may be recommended to such patients with symptomatic recurrence of their sinus disease.


ENDOSCOPIC SINUS SURGERY (ESS) has become a common otolaryngologic procedure, with over 500,000 cases performed per year.1 The reported incidence of major complications associated with ESS, including diplopia, blindness, skull base injury with cerebrospinal fluid (CSF) leak, and intracranial injury, ranges from 0% to 2.5%.1,2 Iatrogenic dural injury and CSF leak during ESS has a reported incidence of less than 0.5%.2,3 In patients presenting with CSF rhinorrhea, iatrogenic skull base injury is the most common cause, followed by trauma and spontaneous CSF leaks.4,5 Leaks of CSF that occur during ESS are often identified intraoperatively and repaired at the time of surgery.

The lifetime revision rate in patients undergoing ESS is approximately 15%,6 while the number of revision ESS cases continues to increase because of the growing population of postsurgical patients. With this increasingly large number of patients presenting for revision ESS, it stands to reason that some surgical candidates will have a history of previously repaired skull base defects and CSF leaks resulting from prior surgery. To our knowledge, no studies have evaluated the surgical approach and outcomes in this special group of patients. The purpose of the present study was to review the treatment of patients with previously repaired skull base defects and CSF leaks caused by prior ESS who require revision sinus surgery.

METHODS

A retrospective medical chart review of patients undergoing ESS between January 1993 and January 2007 was conducted at 2 tertiary care hospitals, the Massachusetts Eye and Ear Infirmary (Boston) and St Louis University Hospital (St Louis, Missouri). The medical records of patients undergoing revision ESS by 2 of us (R.M. and R.S.) for treatment of chronic rhinosinusitis (CRS) refractory to medical therapy were reviewed. Inclusion criteria were a history of previously repaired skull base defect and iatrogenic CSF leak in the vicinity of the planned revision ESS. Cases in which the patients were undergoing an endoscopic exploration and revision CSF leak repair for a suspected active leak...
RESULTS

Thirteen patients were identified (7 men and 6 women; mean [SD] age, 43.5 [14.5] years) who had undergone revision ESS for CRS after having a CSF leak repair. All of the patients’ skull base injuries were documented complications of a prior ESS for the treatment of CRS. The CSF leaks were identified and repaired intraoperatively during the initial sinus surgery in 8 of the study patients. Delayed recognition and secondary endoscopic repair was performed in 5 patients whose CSF leaks were identified postoperatively. The sites of skull base injury are listed in the Table, and locations were identified as the anterior ethmoid roof (9 of 13), posterior ethmoid roof (3 of 13), and the posterior wall of the frontal recess (1 of 13). These repairs were performed with free mucosal grafts alone (8 of 13), mucosal and temporalis fascia grafts (1 of 13), or mucosal grafts with septal cartilage (4 of 13). None of these patients had intracranial injuries causing neurologic deficit or required neurosurgical intervention.

Specific indications for revision surgery included CRS without polyps (n = 8; 61%), CRS with polyps (n = 3; 23%), cystic fibrosis (n = 1; 8%), and allergic fungal sinusitis (n = 1; 8%) (Table). One patient had a history of intermittent clear rhinorrhea prior to revision ESS. His nasal secretions tested negative for the presence of beta-2 transferrin. None of the other patients had signs or symptoms suggestive of an active CSF leak such as clear rhinorrhea, headache, or recent history of meningitis, and thus no other beta-2 transferrin assays were performed. The mean (SD) time between the patients’ initial skull base injury and revision ESS was 20.2 (12.3) months (range, 4-48 months).

The mean (SD) Harvard7 and Lund-McKay8 sinus CT scores were 3.3 (0.7) and 10.6 (4.2), respectively. After careful review of the imaging with a radiologist, evidence of a skull base injury such as a bony defect or obvious signs of a CSF leak repair was identified on the preoperative CT scan in only 1 revision ESS case (Figure 1). In 1 other patient, a preoperative magnetic resonance imaging scan obtained by the referring physician was also reviewed, and no abnormalities in the area of the skull base were seen. Computed tomographic imaging was the only imaging technique used for the preoperative workup of patients in this study.

Intrathecal fluorescein, used routinely during the repair of CSF leaks, was not used in any of the study patients during their revision ESS. In 2 cases, the site of the CSF leak repair could be identified on endoscopic examination as an area of pulsating mucosa. In the remaining 11 cases, no specific abnormality was identified that would suggest a skull base injury other than the presence of scar tissue at the repair site (Figure 2). Intraoperative CT image guidance was used in each case to help identify the skull base in the general region of the previous CSF leak. Care was taken to avoid aggressive dissection in the vicinity of the repair. Polyps adjacent to the area of previous injury were carefully removed using conventional instruments without disruption of underlying scar tissue. None of the 13 patients had an active CSF leak identified during their revision ESS. No minor or major complications, including recurrent CSF leak, occurred during revision ESS in any of the cases. All patients were discharged home within 23 hours.

The median follow-up was 23.0 months (range, 2-57 months). During the follow-up period of the study, only 1 patient required a subsequent surgery after the revision ESS. This patient with cystic fibrosis underwent an endoscopic ethmoidectomy and frontal sinusotomy for recurrent

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Indication</th>
<th>CT Stage (Harvard7/Lund-McKay8)</th>
<th>Surgical Procedure</th>
<th>Site of CSF Leak</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CRSwNP</td>
<td>II/6</td>
<td>Right TE, FS</td>
<td>Posterior ethmoid roof</td>
</tr>
<tr>
<td>2</td>
<td>CF, CRSwNP</td>
<td>IV/20</td>
<td>Endoscopic transseptal frontal drillout (modified Lothrop)</td>
<td>Frontal sinus posterior wall</td>
</tr>
<tr>
<td>3</td>
<td>CRS</td>
<td>NA</td>
<td>Bil TE, FS, MMA</td>
<td>Anterior ethmoid roof</td>
</tr>
<tr>
<td>4</td>
<td>CRS, sinonasal adhesions</td>
<td>III/9</td>
<td>Bil TE, FS, septoplasty</td>
<td>Anterior ethmoid roof</td>
</tr>
<tr>
<td>5</td>
<td>CRS, sinonasal adhesions</td>
<td>III/10</td>
<td>Bil TE, Bil endoscopic frontal obliteration via trephination</td>
<td>Anterior ethmoid roof</td>
</tr>
<tr>
<td>6</td>
<td>CRS</td>
<td>III/12</td>
<td>Bil TE, FS, MMA, S</td>
<td>Anterior ethmoid roof</td>
</tr>
<tr>
<td>7</td>
<td>CRSwNP</td>
<td>IV/12</td>
<td>Bil TE, FS, MMA, S</td>
<td>Anterior ethmoid roof</td>
</tr>
<tr>
<td>8</td>
<td>CRS</td>
<td>III/5</td>
<td>Bil TE, MMA</td>
<td>Anterior ethmoid roof</td>
</tr>
<tr>
<td>9</td>
<td>CRSwNP</td>
<td>IV/13</td>
<td>Bil TE, FS, MMA, S</td>
<td>Anterior ethmoid roof</td>
</tr>
<tr>
<td>10</td>
<td>CRSwNP</td>
<td>IV/12</td>
<td>Bil TE, FS, MMA, S</td>
<td>Posterior ethmoid roof</td>
</tr>
<tr>
<td>11</td>
<td>AFS</td>
<td>IV/14</td>
<td>Bil TE, FS, MMA, S</td>
<td>Anterior ethmoid roof</td>
</tr>
<tr>
<td>12</td>
<td>CRS</td>
<td>III/6</td>
<td>Bil TE, FS, MMA</td>
<td>Posterior ethmoid roof</td>
</tr>
<tr>
<td>13</td>
<td>CRS</td>
<td>III/6</td>
<td>Bil TE, FS, MMA</td>
<td>Anterior ethmoid roof</td>
</tr>
</tbody>
</table>

Abbreviations: AFS, allergic fungal sinusitis; Bil, bilateral; CF, cystic fibrosis; CRS, chronic rhinosinusitis; CRSwNP, CRS with nasal polyposis; CSF, cerebrospinal fluid; CT, computed tomography; FS, frontal sinusotomy; MMA, middle meatal antrostomy; NA, not available; S, sphenoidotomy; TE, total ethmoidectomy.
polypsis 4 years after his first revision surgery. No complications were encountered during either of the revision procedures.

**COMMENT**

The occurrence of an intraoperative CSF leak is of major concern to every endoscopic sinus surgeon. This concern is understandably heightened when the surgeon is confronted with a patient requiring revision sinus surgery who has already undergone previous repair of an iatrogenic CSF leak. The most common location of ESS iatrogenic CSF leaks is the ethmoid roof, followed by the frontal recess, cribiform, and sphenoid sinus. These locations are similar to those encountered in the present study in which 12 patients with prior ESS had ethmoid roof CSF leaks, and 1 had an injury to the posterior wall of the frontal recess. Most intraoperative CSF leaks are recognized and repaired endoscopically at the time of injury, as was the case in 8 of the 13 patients in this study. From 87% to 91% of iatrogenic CSF leaks are repaired successfully using endoscopic techniques. All of the patients in the present study underwent successful endoscopic repair of their CSF leaks prior to revision ESS. None of these patients had an active leak at the time of their revision ESS.

In a patient with a history of a repaired CSF leak, the surgeon should rule out the presence of an active leak through clinical evaluation, nasal endoscopy, and beta-2 transferrin assay if indicated. Beta-2 transferrin is a highly specific test used to identify the presence of CSF in nasal secretions. Only 1 of the patients in the present study had this test performed prior to revision ESS. This patient had a history of intermittent clear rhinorrhea on the side of the prior CSF leak. The patient’s negative test results reassured the surgeon that there was likely no active leak that would need to be identified and repaired during revision ESS. Preoperative collection of nasal secretions for beta-2 transferrin assay is not recommended for patients with recurrent sinus disease and a previous CSF leak repair, unless the surgeon suspects that an active leak is present.

In this study, preoperative CT imaging was used to assess the severity of sinus disease and determine the location of the disease in relation to the previous CSF leak repair site. Only one of these patients had a skull base defect visualized on CT prior to revision surgery. While the preoperative CTs were not helpful in identifying the exact location of the leak in most patients, they were useful in demonstrating sinus disease in the general vicinity of the repair site. Additionally, MRI may be useful to rule out meningoencephalocele in patients displaying a significant bony skull base defect in close proximity to soft tissue or polyps.

Revision surgery was performed on sinuses in the vicinity of the prior CSF leak in all of the study cases. In each case, an attempt was made to visualize the site of

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**Figure 1.** Computed tomographic (CT) images of patient 1. A, Preoperative coronal CT shows the site of a previous cerebrospinal fluid leak (arrow), where the right ethmoid roof defect was repaired with a mucosal graft. B, Revision surgery was performed to drain a symptomatic opacified right frontal and anterior ethmoid sinus.

**Figure 2.** Intraoperative endoscopic view of patient 1 showing an area of dense scar tissue and overlying mucosa at the previous repair site (arrow). The enlarged sphenoid is also apparent (arrowhead).
previous CSF leak repair. Two patients had areas of pulsating mucosa at the repair site, indicating the proximity of underlying dura. In both of these cases, the repair had been performed without the use of cartilage or bone. Most patients in this study had no identifiable abnormality at the prior CSF leak site other than dense scar tissue in the vicinity of the repair. While it can be challenging to identify the site of a previously repaired CSF leak after adequate healing has occurred, it is important for the surgeon to be aware of the approximate location of the skull base injury. Preoperative review of the operative record and even personal communication with the referring surgeon (if the injury and repair were performed elsewhere) are important considerations if repeated injury is to be avoided during revision surgery.

As illustrated by this study, CT imaging is not always helpful in identifying areas of a previously repaired CSF leak. Intraoperatively, gentle palpation and inspection may be used to identify an area of missing bone along the skull base. An image guidance system may also be of value to identify the repaired CSF leak site, particularly in those patients whose skull base defect can be visualized on CT. Intrathecal fluorescein dye, commonly used to identify a CSF leak intraoperatively during endoscopic repair, was not used in this study because no patient had a suspected active CSF leak at the time of revision ESS. Although the risks associated with the use of intrathecal fluorescein are low, it should be reserved for those patients in whom an active leak has been established preoperatively.

The surgeons in this study avoided extensive dissection in the region of the previous CSF leak repair whenever possible. In all cases, they carefully removed diseased or polypoid tissue involving the previous site of injury without disruption of the underlying scar tissue and repair. They used blunt probes to palpate the skull base to assist with identification of the defect. Through-cutting Blakesley forceps and spoon curettes were used to gently remove polyps from underlying scar tissue. This dissection was performed slowly and deliberately using conventional, nonpowered instruments. Microdebriders do not provide the tactile feedback necessary in such delicate cases, and they may inadvertently pull or cut scar tissue from the area of previous injury causing a recurrent CSF leak. The application of microdebriders close to the skull base in a patient with a previously repaired CSF leak is not advised.

Previous studies have demonstrated an improvement in objective and subjective quality of life measures after revision ESS equivalent to those achieved by primary ESS. Valid concerns over recurrent skull base injury, however, may dissuade surgeons from attempting a revision procedure in a patient with a history of a repaired iatrogenic CSF leak. These patients also may choose to live with recurrent symptoms rather than undergo a revision procedure. To our knowledge, no studies have looked at either complications or outcomes in this specific population of patients. In the present series of patients, there were no instances of recurrent skull base injury or CSF leak during any of the revision procedures. Only 1 patient required a subsequent revision ESS for cystic fibrosis–related CRS and nasal polyposis (8%), which is similar to the 8% revision ESS failure rate found by others. The results of the present study suggest that in experienced hands, successful revision ESS can be performed safely without complications in patients with previously repaired iatrogenic CSF leaks.

Limitations of this study include its relatively small sample size and lack of a control group.

In conclusion, previous skull base injury with CSF leak is not a contraindication to revision sinus surgery. Safe surgery in this setting can be performed on patients with symptomatic recurrence of sinus disease. Preoperative CT scans are rarely beneficial in identifying the site of the previous CSF leak repair; however, intraoperative surgical navigation may be useful to identify the skull base and avoid repeated injury. Beta-2 transferrin assay and intrathecal fluorescein dye are helpful only in those patients in whom an active CSF leak is suspected.

Submitted for Publication: October 31, 2007; final revision received January 29, 2008; accepted March 15, 2008.

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Author Contributions: Dr Sindwani had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Reh, Metson, and Sindwani. Acquisition of data: Reh, Metson, and Sindwani. Analysis and interpretation of data: Reh, Metson, and Sindwani. Drafting of the manuscript: Reh and Sindwani. Critical revision of the manuscript for important intellectual content: Reh, Metson, and Sindwani. Statistical analysis: Reh and Sindwani. Administrative, technical, and material support: Reh and Sindwani. Study supervision: Metson.

Financial Disclosure: None reported.

REFERENCES