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# Sellar Reconstruction and Rates of Delayed Cerebrospinal Fluid Leak after Endoscopic Pituitary Surgery

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## Abstract

**Objectives** Delayed cerebrospinal fluid (CSF) leaks are a complication in transsphenoidal surgery, potentially causing morbidity and longer hospital stays. Sella reconstruction can limit this complication, but is it necessary in all patients?

**Design** Retrospective review.

**Setting** Single-surgeon team (2005–2012) addresses this trend toward graded reconstruction.

**Participants** A total of 264 consecutive patients with pituitary adenomas underwent endoscopic transsphenoidal resections. Sellar defects sizable to accommodate a fat graft were reconstructed.

**Main outcomes** Delayed CSF leak and autograft harvesting.

**Results** Overall, 235 (89%) had reconstruction with autograft (abdominal fat, septal bone/cartilage) and biological glue. Delayed CSF leak was 1.9%: 1.7%, and 3.4% for reconstructed and nonreconstructed sellar defects, respectively ( $p = 0.44$ ). Complications included one reoperation for leak, two developed meningitis, and autograft harvesting resulted in abdominal hematoma in 0.9% and wound infection in 0.4%.

**Conclusion** In our patients, delayed CSF leaks likely resulted from missed intraoperative CSF leaks or postoperative changes. Universal sellar reconstruction can preemptively treat missed leaks and provide a barrier for postoperative changes. When delayed CSF leaks occurred, sellar reconstruction often allowed for conservative treatment (i.e., lumbar drain) without repeat surgery. We found universal reconstruction provides a low risk of delayed CSF leak with minimal complications.

## Keywords

- ▶ pituitary tumor
- ▶ sella
- ▶ cerebrospinal fluid rhinorrhea
- ▶ neuroendoscopy
- ▶ complications

## Introduction

Rates of delayed cerebrospinal fluid (CSF) leak (diagnosed in the immediate postoperative setting) vary widely from 0.1 to

17%, with most series reporting rates of  $\leq 5\%$ .<sup>1–9</sup> Patients who develop delayed CSF leaks often undergo repeat surgery or lumbar drainage, and potential complications include meningitis and pneumocephalus.<sup>2,10–12</sup> Therefore, minimizing

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these leaks is important not only to decrease morbidity but to avoid longer hospitalizations for treatment of this complication.<sup>9</sup>

For reducing delayed CSF leaks, clinicians have attempted various methods of sellar reconstruction. These typically use a filling material (i.e., fat, collagen sponge) in the sella followed by a floor reconstruction of various materials that include but are not limited to bone, cartilage, titanium mesh, and polymer/absorbable synthetics.<sup>5,7,13</sup> Other more elaborate reconstructions attempted to further reduce leaks include dural suturing, dural flaps, fibrin glue sandwiches, vascular clips, and recombinant membranes.<sup>8,13-16</sup> Following surgery for sellar/suprasellar pathology and sellar reconstruction, multiple studies have reported CSF leak rates < 3% regardless of the exact type of reconstruction used.<sup>2,9,10,17-20</sup>

Despite the low delayed CSF leak rate with sellar reconstruction, there is a growing trend toward graded reconstruction.<sup>1,2,6-9,15-17</sup> Because an intraoperative leak has been correlated with a six-fold increase in the relative risk of postoperative leak,<sup>21</sup> risk stratification and resultant reconstruction has been tried. Strategies have varied from binary reconstruction based on the presence of an intraoperative leak to more complex grading systems of stepwise sellar repair.<sup>1,9,12</sup> For example, some authors reconstruct fully for any intraoperative leak and do not reconstruct those without leaks, whereas others progressively reconstruct with fat graft and fibrin glue depending on the amount or volume of CSF and size of arachnoid defect. The increasing use of endoscopy in transsphenoidal pituitary surgery may also have an impact on the choice of reconstruction because improved visualization can better identify occult intraoperative CSF leaks.

Although graded reconstruction is attractive, delayed CSF leaks still occur in those without intraoperative leakage.<sup>2,9,12</sup> Because sellar reconstruction has been shown to minimize delayed CSF leakage, the question remains, "Is reconstruction in many worthy of complication prevention in a few?" Our retrospective study reports on resection of pituitary adenomas via a solely endoscopic transsphenoidal approach (EETA), hypothesizing that reconstruction of *all* sellar defects is fast, safe, and minimizes the risk of postoperative CSF leak. We propose that universal reconstruction would allow nonsurgical management of delayed leaks by avoiding the potential risk of pneumocephalus with the use of a lumbar drain in an unreconstructed sella. Thus all patients with sellar defects large enough to accommodate a graft were reconstructed with fat, cartilage, and biological glue. Quantifying the rates of delayed CSF leak and complications of reconstruction in EETA in our patients with pituitary adenomas, we attempt to further the debate on the optimal algorithm for sellar reconstruction following pituitary surgery.

## Methods

### Study Design

With approval by the institutional review board of the University of Cincinnati, our pituitary database included all patients who underwent EETA for removal of pituitary adenomas by a single-surgeon team from November 2005 to

July 2012 (►Table 1). Chart and imaging review obtained demographic data, tumor type, sellar reconstruction type used, development of a CSF leak (intra- or postoperatively), and other postoperative complications (i.e., meningitis, wound infection, and abdominal wound hematomas). To reduce bias, the primary reviewers had no prior information on the clinical outcome or any other aspects of the clinical care of the patients included. Serial magnetic resonance imaging (MRI) was used to evaluate extent of resection and recurrence. Standard imaging protocols at our institution included immediate postoperative MRI, a scan within the first year, and follow-up yearly scans.

### Sellar Reconstruction

After tumor resection, the sella was visually evaluated to determine extent of tumor removal and identify intraoperative CSF leakage. When hemostasis was achieved, all sellar defects large enough to accommodate an autologous graft were repaired. Those without defect, usually small functional microadenomas, were not repaired, and biological glue was placed. Reconstruction in all others consisted of an abdominal fat graft filling the sellar defect, cartilage or bone from the posterior nasal septectomy holding the fat in place inside the sellar defect, and biological glue bolstering along the reconstructed anterior wall of the sella. NasoPore (Polyganics, Rozenburglaan, The Netherlands) was then placed in the posterior nasal cavity between the middle turbinate and septum to prevent scarring.

After surgery, all patients were admitted to the neurosurgical unit and monitored for nasal drainage; they were instructed to avoid activities that could cause fluctuations in intranasal pressure. If obvious CSF rhinorrhea was observed, a lumbar drain was placed for 3 to 5 days to drain at 5 to 10 mL/hour. If questionable drainage occurred—often scant and mucus or blood tinged—a nasal mustache dressing was applied to monitor the amount discharged. Additional provocative maneuvers (e.g., leaning forward) were not regularly attempted. Reoperation was only preformed for those in which a lumbar drain was either ineffective or technically unfeasible.

Postoperative wound care included oxymetazoline decongestant spray 3 times/day for 3 days and saline nasal spray 5 to 6 times/day until evaluation in the office 1 week after surgery.

**Table 1** Clinical characteristics of 264 patients who underwent endoscopic transsphenoidal approaches for pituitary tumors

Characteristics	No. (%)
Age, y	51.8
Male	133 (50.4)
Female	131 (49.6)
Microadenoma	53 (20.0)
Macroadenoma	211 (80.0)
Nonsecreting	188 (71.2)
Secreting	76 (28.8)

**Table 2** Comparison with or without sellar reconstruction in 264 consecutive patients with pituitary adenomas

Leak repair	No. (%)	Postoperative leak (%)
Total	264	5 (1.89)
Reconstruction	235 (89)	4 (1.7)
No reconstruction	29 (11)	1 (3.4)

### Statistical Analysis

Statistical analysis was performed in comparing the rates of CSF leaks in the reconstructed and the nonreconstructed group by the Fisher exact test. Statistical significance was considered a  $p \leq 0.05$ . There were no missing data or patients who were lost during follow-up.

## Results

### Clinical Findings

The 264 consecutive patients who underwent EETA for pituitary adenoma resection (November 2005 to July 2012) included 133 men and 131 women (average age: 51.8 years) (► **Table 1**). Tumors consisted of 80% macroadenomas and 20% microadenomas. Pathologically, 71.2% of the tumors were nonfunctioning/gonadotroph adenomas, whereas the remaining 28.8% were endocrine active. Ten patients (3.8%) later underwent reoperation for tumor recurrence/progression, and 8% received further medical treatment or radiation. Mean follow-up was 18.5 months.

### Complications

Among all patients, 235 (89%) had sellar reconstruction and 29 (11%) had small sellar defects not reconstructed (► **Table 2**). Of intraoperative leaks noted in 17 patients (6.4%), all underwent sellar reconstruction at the end of tumor resection; no delayed leaks occurred in this group. Four of 235 patients (1.7%) in the reconstructed group developed a delayed CSF leak versus 1 of 29 (3.4%) in the nonreconstructed group; this difference was not statistically significant using the Fisher exact test. Delayed CSF leak developed in 4 of the 235 patients (1.7%) with sellar reconstruction versus 1 of the 29 patients (3.4%) in patients without; this difference was not statistically significant using the Fisher exact test.

All delayed leaks were treated with a lumbar drain (► **Table 3**). One patient underwent repeat surgery for revision

of her reconstruction and intraoperative placement of a lumbar drain secondary to body habitus. In the cohort of 264 patients, meningitis occurred in two patients (0.9%), one of whom had a delayed CSF leak. Of two patients (0.9%) who developed postoperative abdominal wound subcutaneous hematomas, one had a reexploration of the abdominal incision. Another abdominal wound infection (0.44%) was successfully treated with a course of oral antibiotics.

## Discussion

Our retrospective review, representing the largest study of delayed CSF leak rates following endoscopic resection of pituitary adenomas to date, indicates that universal sellar reconstruction in endoscopic transsphenoidal resection of pituitary adenomas was safe and effective and minimized the rates of delayed leak. Although all sellar defects in our patients were reconstructed, the approach and frequency of reconstruction reported in the literature varies and remains controversial. In theory, universal intraoperative repair would minimize the chance of delayed leaks but with the potential for additional complications. Alternatively, not performing a repair avoids an abdominal incision but does not protect against delayed postoperative CSF leaks. In the presence of an open unreconstructed sellar defect, return to the operating room is the safest and sometimes only option because a lumbar drain for CSF diversion is relatively contraindicated for the risk of pneumocephalus. Graded repair attempts to strike a balance between these two; yet its success in preventing delayed CSF leaks is variable as reported in the literature.<sup>1,2,6-9,15-17</sup>

### Strategies to Minimize Sellar Repair

Attempts to successfully minimize the rate of sellar repair have been reported. Compared with their 1985 report of a 4.2% postoperative CSF leak rate for repair of 82% of sellas,<sup>21</sup> Cappabianca et al noted in their 2002 series a 2.3% leak rate by using sellar reconstruction in only 27.6% of 170 patients.<sup>12</sup> Although the impetus for repair in the remainder of patients is unclear, a major reason for reconstruction was intraoperative leak that occurred in 14%. To further reduce the need for sellar reconstruction, Mehta and Oldfield reportedly used intraoperative lumbar drainage to decrease intraoperative leaks, their main indication for sellar reconstruction.<sup>1</sup> In their two-arm prospective study, the authors reported significantly fewer intraoperative leaks; resultant sellar repair in the lumbar drainage group maintained an equivalent rate of postoperative CSF leak (5%). Routine insertion of intraoperative lumbar drains, although safe, is

**Table 3** Cerebrospinal fluid leak treatment and complications

Treatment	No.
Lumbar drain	5
Surgical repair	1
Complications (%)	
Meningitis	2 (0.9)
Abdominal hematoma	2 (0.9)
Wound infection	1 (0.44)

associated with postoperative positional headaches and is not used in our institution.

Although the previously mentioned studies had acceptable delayed CSF leak rates, most occurred in patients without intraoperative leaks. Among patients with delayed leaks, no sellar reconstructions had been used in three of the four patients in Cappabianca et al or either of the two patients in the lumbar drain arm in Mehta and Oldfield. Evidence of delayed leaks in the absence of intraoperative leaks was apparent in Romero Adel et al<sup>2</sup> and our study. That is, 50% of the leaks developed in the patients of Romero Adel et al without intraoperative fistula, and none of our patients with delayed leaks had evidence of an intraoperative leak.

Intraoperative leaks are well known to carry a much higher rate, up to 43%, of postoperative leak,<sup>2,22</sup> and sellar reconstruction is reported to decrease the development of delayed leaks to  $\leq 5\%$ .<sup>9,10,17–20,23</sup> The previously mentioned studies have acceptable rates of delayed leaks, suggesting that intraoperative leaks were adequately repaired. However, most of the leaks in these studies occurred in the setting of unrepaired sellar defects, and operative interventions were performed to fix most of the leaks. Although the percentage of delayed leaks in patients without intraoperative fistulas is low, the question remains whether universal sellar reconstruction in the previously cited studies limited the overall delayed leak rate as well as the need for repeat surgery.”

One approach may be to limit reconstruction and accept the rate of delayed leaks in those with minimal risk factors. An alternative approach is to stratify patients by treating with increasingly comprehensive reconstructions that depend on the type of CSF leak present. In a 2007 study of a four-tiered system, Esposito et al<sup>9</sup> progressively repaired leaks based on their size; they identified intraoperative leaks in 57% of their patients, a rate at the upper range of published reports, by using provocative measures (i.e., Valsalva maneuver, Trendelenburg position). Thus more complex sellar reconstruction was completed in most of their patients. When they then noticed unexpected delayed leaks in those with minimal intraoperative leaks, they revised their protocol to include a fat graft instead of a collagen sponge for very small leaks and a sizable sellar defect. With these modifications toward increasingly comprehensive sellar reconstruction, their reported delayed leak rates of 1.2% became one of the lowest rates in the literature.

Are delayed CSF leaks without intraoperative leaks postoperatively induced or occult leaks undetected in the operating room? Although it remains unclear, a combination of both is likely. To identify occult leaks, maneuvers (i.e., Valsalva, Trendelenburg position) are often used in clinical practice as reported by Esposito et al.<sup>9</sup> More recently, fluorescein has been used to identify leaks; however, its use intrathecally is not universally accepted.<sup>24</sup> Whether increasing experience with endoscopic approaches for pituitary adenoma resection will result in a more accurate identification of intraoperative CSF leaks remains to be seen. Moreover, endoscopy may allow for more direct and minimal direct repairs of intraoperative CSF leaks that would not require an autograft and the resultant additional incision. For the present time, delayed leaks

will still likely occur because no test will be 100% sensitive in identifying intraoperative leaks, and some leaks likely start postoperatively.

Rather than attempting to detect as many CSF leaks as possible intraoperatively, we repair all sellar defects. Our approach aligns with that used by Esposito et al,<sup>9</sup> who achieved one of the lowest delayed leak rates in the literature. Given their strategy and nuanced evaluation to identify intraoperative CSF leak, they ended up repairing leaks in most of their patients. In general, harvesting autograft has proven to be safe; it has a  $< 1\%$  complication rate for hematoma and infection, and it adds little or no time to the operation because the fat can be obtained by a second surgeon while the nasal approach is being performed. In cases of delayed leaks, sellar reconstruction has already been completed and the lumbar drain can be placed (as we did for four of five patients who developed delayed leaks).

### Study Limitations

Our retrospective study is subject to significant bias. Delayed CSF leak rates are low in both reconstructed and unreconstructed sellas and not statistically significant between the groups. Although we use autologous fat grafts and cartilage, we did not study other nonautologous materials that might be equally effective. The cosmetic effect of an abdominal incision, even a periumbilical one, can be troubling for some patients; however, this concern was not expressed by our patients.

The consistent treatment delivered to this entire cohort as a consecutive series was by a single surgeon, and the algorithm to determine who received sellar reconstruction remained simple and unchanged throughout the study. Nonetheless, a prospective trial to compare two or more arms of sellar reconstruction would provide a more accurate estimate of the most effective algorithm to prevent delayed CSF leaks.

In contrast with most other studies that assess rates of delayed CSF leaks, our study included only pituitary adenomas and excluded other sellar pathologies, such as Rathke cleft cysts, arachnoid cysts, and craniopharyngiomas. Consequently, any comparison of rates of delayed leaks between our study and others may be inaccurate and misleading. However, our focused approach to sellar reconstruction in EETA of pituitary adenomas is specific, providing another resource with respect to the efficacy and safety of universal sellar reconstruction.

### Conclusion

In our retrospective series, universal sellar reconstruction was a safe and effective algorithm in the prevention and treatment of delayed CSF leaks associated with endoscopic transsphenoidal resection of pituitary adenomas. This strategy allowed for preemptive treatment of a missed intraoperative low-flow CSF leak and provided a barrier for postoperative local CSF pressure changes around the sellar arachnoid that may have resulted in a leak. When delayed CSF leaks do occur, sellar reconstruction is already complete, and treatments can be conservative (i.e., lumbar drain) and therefore often eliminate the need for repeat surgery. Our series demonstrated that universal reconstruction achieved a very low risk of delayed

CSF leak with minimal complications. and the use of conservative treatment was effective for this complication.

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