Perioperative lumbar drain utilization in transsphenoidal pituitary resection

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ABSTRACT

الأهداف: لتقييم فعالية استنزاف القطني (LD) في استئصال عبر الأنف لورم الغدة النخامية للوقاية من تسرب السائل النخاعي بعد العملية الجراحية (CSF)، سلامة التقنية، والتأثير على طول الإقامة في المستشفى.

الطريقة: أجريت مراجعة البيانات بأثر رجعي لمرضى ورم الغدة النخامية في مستشفانا وخضعوا لعملية جراحية خلال الفترة من ديسمبر2006م حتى يناير 2013م. جميع المرضى لعملية الاستئصال الجراحي الكامل لأورام الغدة النخامية. تم تقسيم المرضى إلى مجموعتين: المجموعة 1 تلقت استنزاف ما قبل الجراحة، في حين لم يتم إدراج الاستنزاف القطني قبل الجراحة في المجموعة 2. في حالات الأورام مع تمديد فوق الكاحل مع توقع تسرب عالي التدفق، تم إدخال LD بعد أن تم تنبيب المريض وفي الموضع الجانبي. تم استخدام استنزاف القطني لمدة 48 ساعة، وتم إزالة الصرف إذا لم يلاحظ أي تسرب بعد العمل الجراحي. في مرضى تسرب السائل النخاعي بعد العملية الجراحية مع عدم وجود استنزاف قبل الجراحة، تم علاج تسرب من قبل باستخدام LD قبل إعادة العملية الجراحيه. الحالات التي تم فيها تسرب تم استبعادها 6 أشهر بعد العمل الجراحي.

النتائج: يتكون مجتمع الدراسة لدينا من 186 مريضا، 99 امرأة (53%) و 87 رجلا (47%)، مع متوسط عمر 50.3±16.1 سنة. حدثت مضاعفات في 7 مرضى (13.7%) في المجموعة 1 مقابل 21 (15.5%) في المجموعة 2 (*p*=0.72). وقد لوحظ تسرب CSF بعد العملية الجراحية في 1 مريض (1.9%) في المجموعة 1 و 7 (5%) في المجموعة 2 (اختبار فيشر=0.3). بلغ متوسط طول مدة الإقامة في المستشفى 4.7±1.9 يوم في المجموعة 1 ومتوسط 2.7±2.4 يوم في المجموعة 2 (*p*<001). وكان السبب الأكثر شيوعا لتمديد البقاء في المستشفى هو ضبط مرض السكري الكاذب.

الخاتمة: على الرغم من أن استخدام LD يعتبر عموما آمنة مع خطر منخفض من مضاعفات، فإنه يزيد من طول المستشفى. وتشمل المضاعفات البسيطة الصداع وعدم الراحة لدى المريض.

Objectives: To evaluate lumbar drain (LD) efficacy in transnasal resection of pituitary macroadenomas in preventing postoperative cerebrospinal fluid (CSF) leak, technique safety, and effect on length of hospital stay.

Methods: We conducted a retrospective data review of pituitary tumor patients in our institution who underwent surgery between December 2006 and January 2013. All patients were operated on for complete surgical resection of pituitary macroadenoma tumors. Patients were divided into 2 groups: group 1 received a preoperative drain, while LD was not preoperatively inserted in group 2. In cases of tumors with suprasellar extension with anticipation of high-flow leak, LD was inserted after the patient was intubated and in a lateral position. Lumbar drain was used for 48 hours, and the drain was removed if no leak was observed postoperatively. In documented postoperative CSF leak patients with no preoperative drain, the leak was treated by LD trial prior to surgical reconstruction. Cases in which leak occurred 6 months postoperatively were excluded.

Results: Our study population consisted of 186 patients, 99 women (53%) and 87 men (47%), with a mean age of 50.3±16.1 years. Complications occurred in 7 patients (13.7%) in group 1 versus 21 (15.5%) in group 2 (*p*=0.72). Postoperative CSF leak was observed in 1 patient (1.9%) in group 1 and 7 (5%) in group 2 (Fisher exact test=0.3). Length of hospital stay was a mean of 4.7±1.9 days in group 1 and a mean of 2.7±2.4 days in group 2 (*p*<001). The most common reason to extend hospital stay was management of diabetes insipidus.

Conclusion: Although LD insertion is generally considered safe with a low risk of complications, it increases the length of hospitalization. Minor complications include headaches and patient discomfort.

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Approaches and techniques have advanced since the first description of transsphenoidal surgery (TSS) by Schloffer, Cushing, and Hirsch.[1] The transnasal approach to pituitary and sellar lesions has replaced the sublabial approach as a safer and more effective alternative. Nonetheless, it is not without complications such as cerebrospinal fluid (CSF) leak, diabetes insipidus, and hypopituitarism.[2] Pituitary adenomas are common primary brain tumors in adults representing 25% of cranial neoplasms.[3] The transsphenoidal approach, through the skull base, carries the risk of CSF leak, which is one of the most common complications of skull base operations.[4] It can present either preoperatively, intraoperatively, or postoperatively, and the role of lumbar drain (LD) in each instance is controversial. CSF leak is conservatively managed with LD for 3–5 days or with surgical repair. However, clear guidelines are not present on managing CSF leak following TSS.[5]

Indications for LD use in endoscopic skull base surgery include intracranial hypertension, treatment for postoperative CSF fistula, the use of intrathecal fluorescein, poor or limited reconstructive options (pedicled flaps unavailable), and high-flow CSF leak. Perioperative LD use is speculated to help decrease intracranial pressure and brain swelling by external diversion of CSF, which in turn promotes dural repair healing postoperatively. In addition, it aids in better access to anterior skull base tumors with intraoperative saline infusion. Multiple studies reports significant lower rate of postoperative CSF leakage in patients with a preoperatively placed LD.[6,7] The majority of the study authors use LD rather than prophylactic treatment in case of detection of a CSF leak. This study aim is to evaluate lumbar drain (LD) efficacy in transnasal resection of pituitary macroadenomas in preventing postoperative cerebrospinal fluid (CSF) leak, technique safety, and effect on length of hospital stay.

Methods. We conducted a retrospective data review of adult pituitary tumor patients at our institution who had undergone surgery between December 2006 and January 2013. The sample included cases of pituitary macroadenoma tumors. Patients were divided into 2 groups: group 1 included patients who received a perioperative drain, while group 2 consisted of patients in whom LD was not preoperatively inserted.

In cases of tumors with suprasellar extension, where a high-flow leak is anticipated, LD was inserted in the operating room after the patient was intubated and in a lateral position. It was used for 48 hours, and if no leak was observed after surgery the drain was removed. In patients with documented postoperative CSF leak with no preoperative drain, the leak was treated using a drainage trial prior to surgical reconstruction. Cases of patients in whom the leak occurred 6 months after surgery were excluded. Variables such as complications, presence of postoperative leak, and LD effect on length of hospital stay were investigated, and Statistical analysis was performed by the IBM SPSS Statistics for Windows version 23.0 (IBMCorp, Armonk, NY, USA).

Results. Between December 2006 and January 2013, 186 patients who met the inclusion criteria were identified. The population understudy consisted of 99 females (53%) and 87 males (47%) with a mean age of 50.3±16.1 years. Majority of the tumors were nonfunctional in both groups, with 42 (82.3%) nonfunctional tumors in group 1 and 73 (54%) in group 2 (p<0.001). The most prevalent histopathological subtype was non-staining adenoma (**Table 1**).

Table 2 shows the histopathological characteristics of our population. Cavernous sinus (CS) involvement was noted in 16 patients (31%) in group 1, while 26 patients (19%) in group 2 had CS involvement. Complications occurred in 7 patients (13.7%) in group 1 versus 21 (15.5%) in group 2 (p=0.72). General complications (major and minor) included diabetes insipidus, CSF leak, deep venous thrombosis (DVT), cardiac arrhythmia, electrolyte imbalances, intracranial bleeding, and visual loss. Major complications such as cerebral herniation, pneumocephalus, or meningitis were not observed. Postoperative CSF leak was observed in 1 patient (1.9%) in group 1 and 7 (5%) in group 2 (Fisher exact test=0.3). Methods for treating postoperative CSF leak in both groups are described in **Table 3**.

The mean length of hospital stay was a mean of 4.7±1.9 days in group 1 and a mean of 2.7±2.4 days in group 2 (p<001). **Table 1** summarizes the comparison between groups 1 and 2. The most common reason for extending hospital stay was the management of diabetes insipidus. **Table 4** summarizes the reasons for extended hospital stay in this case series.

Discussion. The literature is indecisive regarding the efficacy of LD use in TSS in preventing postoperative

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Table 1 - Group comparison between groups 1 and 2.

Characteristics	Group 1	Group 2	*P*-value
Number of patients	51	135	NA
Postoperative CSF Leak	1 (1.9)	7 (5)	0.3*
Complications	7 (13.7%)	21 (15.5)	0.72
LHS (mean±SD)	4.7±1.9 years	2.7±2.4 years	<0.001
Functional	7 (19)	62 (45.9)	<0.001*

*Fisher exact test due to chi square assumption violation, CSF - cerebrospinal fluid, LHS - Length of hospital stay

Table 2 - Histopathology characteristics of our patients.

Histopathology	n	(%)
Non-staining adenoma	41	(23.5)
Prolactin-producing adenoma	26	(14.9)
FSH-producing adenoma	21	(12)
LH-producing adenoma	1	(.5)
GH-producing adenoma	19	(10.9)
ACTH-producing adenoma	21	(12)
GH-, prolactin-producing adenoma	6	(3.4)
FSH-, LH-producing adenoma	12	(6.8)
Alpha-hCG-producing adenoma	3	(1.7)
ACTH-, LH-producing adenoma	1	(.5)
FSH-, alpha-hCG-producing adenoma	7	(4)
Alpha-hCG-, FSH-, LH-producing adenoma	7	(4)
TSH-, alpha-hCG-, prolactin-producing adenoma	1	(.5)
TSH-, alpha-hCG-, GH-producing adenoma	1	(.5)
FSH-, LH-, Atypical WHO II-producing adenoma	1	(.5)
Not specified adenoma	2	(1.1)
ACTH-, FSH-, GH-, prolactin-producing adenoma	1	(.5)
TSH-producing adenoma	1	(.5)
Spindle cell oncocytoma	1	(.5)
Corticotroph cell hyperplasia	1	(.5)

TSH - Thyroid Stimulating Hormone, LH - Luteinizing Hormone, HCG - Human chorionic gonadotropin, FSH - Follicle Stimulating Hormone, ACTH - Adrenocorticotrophic hormone, GH - growth hormone

Table 3 - Management of patients with postoperative cerebrospinal fluid leak.

Patients	Treatment
1	Conservatively, by lumbar drain
2	Conservatively, by lumbar drain
3	Conservatively, by lumbar drain
4	Surgical repair
5	Conservatively, by lumbar drain
6	Surgical repair
7	Conservatively, by lumbar drain
8	Conservatively, by lumbar drain

Table 4 - Reasons for extending hospital stay (comparison between 2 groups).

Reasons	Group 1	Group 2
	n (%)	
CSF leak	1 (1.9)	7 (5)
Nasal bleeding	1 (1.9)	1 (0.74)
Bradycardia	None	1 (0.74)
Hemodynamic instability	None	1 (0.74)
Electrolyte abnormalities	None	2 (1.4)
Headache	2 (3.9)	None
Deep venous thrombosis	None	2 (1.4)
Wound infection*	1 (1.9)	None
Sinusitis	None	1 (0.74)
Intracranial bleeding	None	1 (0.74)
Pulmonary embolism	None	1 (0.74)
Urinary tract infection	None	1 (0.74)
Subdural hematoma	None	1 (0.74)
Visual loss†	1 (1.9)	1 (0.74)‡
Hematuria§	None	1 (0.74)
Cardiac arrest	None	1 (0.74)
Diabetes insipidus	None	10 (7.4)
Thyroid storm	None	1 (0.74)

*Wound infection at abdominal fat graft site, †Due to overpacking during surgical repair, this patient required reoperation, ‡An ophthalmic artery aneurysm was detected and surgically treated, §Related to Foley catheter, CSF - Cerebrospinal fluid

CSF leak and other complications. Placing a LD preoperatively and draining 20–60 ml of CSF as the tumor is removed has been proposed to reduce the incidence of intraoperative CSF leak, hence decreasing postoperative leaks.[6,7] Ransom et al[8] also suggested that intraoperative CSF diversion by LD reduces the tension on the arachnoid making it less likely to rupture, which in turn alleviates the requirement for sellar floor defect. The introduction of nasoseptal flap by Hadad et al[9] is believed to have decreased the rate of postoperative CSF leak by 50%;[10] whether it is due to the type of flap alone or the combination of LD use and nasoseptal flap has not yet been determined.

Surgical repair technique. The nasoseptal flap was prepared early during the procedure in cases of macroadenomas with suprasellar extension. The surgical cavity was obliterated using fat graft and then Surgicel (ETHICON, New Jersey, USA). Solid floor reconstruction was performed in all cases using Medpor

Table 5 - Histopathologic subtype and other variables in group 2 patient with postoperative CSF leak.

Patient	Sex	Histopathology	Functional
1	F	Adenoma, alpha subunit	No
2	F	Adenoma, FSH, alpha-hCG	No
3	F	Adenoma, ACTH	No
4	M	Adenoma, non-staining	No
5	F	Adenoma, ACTH, FSH, GH, prolactin	No
6	F	Adenoma, FSH	No
7	F	Adenoma, non-staining	No

TSH - Thyroid Stimulating Hormone, LH - Luteinizing Hormone, HCG - Human chorionic gonadotropin, FSH - Follicle Stimulating Hormone, ACTH - Adrenocorticotrophic hormone, GH - growth hormone

implants (Stryker, Kalamazoo, MI, USA). Next, a layer of TISSEEL (BAXTER, Deerfield, Illinois, USA) was used, and the septal flap was applied followed by nasal packing for 3 days. In cases where leak was not expected but observed, the nasoseptal flap was raised after tumor resection was complete, and the remainder of the floor reconstruction process was performed in a similar manner.

Risk factors. Multiple factors may precipitate a postoperative leak: tumor size, histopathology, redo surgery, intraoperative CSF leak,[5] and obesity.[11] Macroadenomas are associated with a large intrasellar dead space following tumor resection,[12] which aggravates the requirement for surgical reconstruction and increases the risk of postoperative leak.[7] In this case series, perioperative LD was inserted in patients with a suprasellar extension as a high-flow leak was expected. Despite the high likelihood of developing a leak in this group, those patients had a lower rate of postoperative CSF leak (1.9%) (Fisher exact test=0.3). This observation may be associated with LD utilization or the lack of correlation between tumor size per se and CSF leak after endoscopic endonasal approaches.[13] While observing patients who developed CSF leak in group 2, the majority (6) of cases were female (85%), and all 7 tumors were nonfunctional adenomas. However, in our sample no significance was observed between postoperative leak and tumor size. Histopathologic subtype and other variables in group 2 are listed in **Table 5**.

Tumor pathology. Histopathological subtype aids in predicting the behavior of pituitary adenomas in terms of invasion of surrounding structures such as CS, optic chiasm, or regrowth after surgery.[3] The most common histopathological subtype was non-staining adenoma (23.5%), followed by prolactin-secreting adenoma (14.9%), Follicle Stimulating Hormone-secreting adenoma (12%), and adrenocorticotrophic hormone (ACTH)-secreting adenoma (12%). ACTH-secreting tumors were also associated with higher CSF leak rates;[5,14] we found ACTH-secreting adenomas in 2 patients who developed a postoperative leak. In accordance with the literature,[3] the majority of tumors were nonfunctional in both groups, with 42 (82.3%) nonfunctional tumors in group 1 and 73 (54%) in group 2 ($p<0.001$).

CSF leak grading. Intraoperative CSF leaks have been subcategorized by flow type and grade. Petal et al[13] proposed that the site and size of the defect determine which vascular tissue flap is utilized in low-flow leaks, while in high-flow leaks reconstruction solely depends on the defect site. In contrast, Esposito et al[12] categorized intraoperative CSF leak into 4 grades, where external CSF diversion by LD for 48 hours is reserved for grade 3 CSF leaks combined with surgical repair.[12]

Complications. Lumbar drain complications are a major concern and cause for decreased utilization of LD. Complications such as pneumocephalus, meningitis, overdrainage, neurological deficit, headache, thromboembolic events caused by activity restriction,[15] and catheter disconnection was reported in a study by Ransom et al,[8] to be higher than what surgeons recognize in endoscopic skull base cases and may outweigh the risk of postoperative leak. Complication rates for LD were reported as low as 3%,[10] and the rate in our study population was similar between the 2 groups (7 [13.7%] and 21 [15.5%] in groups 1 and 2, respectively [$p=0.72$]). Fortunately, we did not encounter any cases of pneumocephalus or meningitis and did not witness any mechanical complications.

Major and minor complications were encountered in patients sample understudy; a description of cases with these complications follows. Two patients developed nasal bleeding postoperatively that was treated by nasal packing. One patient developed bradycardia that spontaneously resolved and 2 patients suffered from cerebral salt wasting necessitating hospital admission for sodium replacement.

One patient had a headache 8 days postoperatively, and there was no imaging evidence of an intracranial bleed, cerebral edema, or pneumocephalus that could be attributed to LD utilization. Sinusitis was documented in 3 patients for whom 1 extra day of hospital stay was needed for intravenous antibiotics. Two patients had visual loss; in 1 case, an ophthalmic artery aneurysm was detected, and visual loss was attributed to overpacking during surgical repair in the other case in which the

patient required reoperation. A narcotic overdose manifested by nausea, vomiting, and pleural effusion occurred in 1 case in which the patient required hospital admission. The same patient was readmitted because of hyponatremia and required sodium replacement. New-onset atrial fibrillation was documented in 1 case; however, the patient did not require hospital admission. Intracranial bleeding occurred in 1 case in which the patient was re-operated on, and asymptomatic subdural hematoma occurred in another patient and the case was conservatively managed.

One patient's postoperative course was complicated by an asystolic cardiac arrest, which required epinephrine, atropine, and Cardio Pulmonary Resuscitation, for which spontaneous circulation quickly returned. We believe that her macroglossia produced an upper airway obstruction after extubation, resulting in aspiration and subsequent hypoxia, which contributed to her hypoxic asystolic arrest.

Length of hospital stay. A proposed shortcoming of LD utilization is extended length of hospital stay[5] in cases where CSF diversion has failed to prevent a leak. When comparing both groups, LD utilization increased the length of hospital stay; mean length of hospital stay was 4.7±1.9 years in group 1 versus 2.7±2.4 years in group 2 (p<0.001), a statistically significant difference.

Nonetheless, when comparing both groups (**Table 4**), the most common reasons for increased hospital stay in group 1 were headache, nasal bleeding, and CSF leak management. In group 2, the most common reasons to extend hospital stay were treatment of diabetes insipidus, CSF leak, electrolyte abnormalities, and DVT. However, we believe that the benefit of preventing CSF leak while using LD outweighs the hazard of extended length of hospital stay once a leak occurs.

Perioperative LD use in TSS is still controversial. Pepper et al[16] compared 2 groups of patients, in which 1 group received LD and the other group did not, and postoperative CSF leak rate was similar in both groups.[16] Further, Zhan et al[15] reported a higher complication rate in the LD group as well as an improvement in postoperative leak by conservative management with no drain in the control group and proposed that 2–10 days should be the required period for repair material to set in. We note that the best use for perioperative LD is in a highly specific subgroup of patients in whom high-flow leak is predicted and in which the patients have risk factors such as redo surgery, radiotherapy, large tumor size, or previous sinus procedures. Nevertheless, higher sample numbers are necessary for further research and for answering this question.

Limitations. Unfortunately, data regarding intraoperative CSF leak was not graded in this analysis, and data regarding obesity in our patient sample were not collected. This is a limitation of our retrospective review and an area we aspire to address in the future with further research.

In conclusion, LDs are commonly used for perioperative CSF diversion as a prophylactic measure and/or as treatment for CSF rhinorrhea following transsphenoidal pituitary surgery. The complication risk with the use of LDs is low. Although generally considered safe, LD insertion increases the length of hospitalization. Minor complications include headache and patient discomfort. While complications increase health care costs, the presence of LD alone increases resource utilization by adding extra hospital days, laboratory studies, and/or imaging procedures. Thus, LDs should be prudently utilized.

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