Intraoperative Lumbar Drain Placement in Endoscopic Neurosurgical Procedures: Technical Challenges and Complications—A Prospective Observational Study

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J Neuroanaesthesiol Crit Care 2021;8:87–91.

Abstract

Background Perioperative placement of lumbar drain (LD) is being increasingly preferred in the endoscopic base of skull procedures to provide optimal surgical conditions. This study aims to determine the incidence of technical difficulties and complications associated with LD placement.

Materials and Methods A total of 50 patients undergoing transnasal transsphenoidal surgery were included in the study after obtaining written informed consent. Intraoperatively, LD was placed using an 18-gauge epidural catheter. Technical difficulties in LD placement were assessed by the number of attempts, levels attempted, difficulty in siting catheter, and obtaining free flow of cerebrospinal fluid (CSF). The incidence of complications such as postdural puncture headache (PDPH), meningitis headache, and backache was studied.

Results Successful LD placement in the first attempt was obtained in 36% of the patients. Technical difficulties were encountered in 64% of the patients. Despite successful LD placement in 90% of the patients, 32% required manipulations to increase CSF flow. The drain failure rate was 10%. Drainage of >20 to 30 mL of CSF/hour was significantly associated with better surgical conditions ($p < 0.05$). The incidence of headache was 56% and that of backache was 26%. Headache was significantly related to difficulty in tapping CSF ($p = 0.032$), and backache was significantly related to the number of attempts ($p < 0.001$), levels attempted ($p = 0.001$), and large CSF volume ($p = 0.004$). There were no incidences of PDPH or meningitis in our series.

Conclusion We conclude that the incidence of technical difficulties in LD placement with epidural catheters is high. Use of standard well-functioning LD catheters will assist in improving surgical conditions.

Keywords
- lumbar drain
- epidural catheter
- endoscopic surgery
- transnasal transsphenoidal surgery
- technical difficulties
- complications

Published online
June 30, 2020

DOI https://doi.org/10.1055/s-0040-1713560
ISSN 2348-0548.

Thieme Medical and Scientific Publishers Pvt. Ltd. A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

Introduction

In endoscopic procedures of the skull base, lumbar drain (LD) placement is required perioperatively to improve surgical conditions and is an important procedural skill in the armamentarium of the anesthesiologist.[1]

The goal of LD placement is to ensure a free, unobstructed flow of cerebrospinal fluid (CSF) to facilitate tumor removal, and to reduce intraoperative CSF leak. It also aids in bringing the superior portion of suprasellar tumors into the sella by the injection of air or saline and offers a therapeutic benefit in those with postoperative CSF leaks.[2] Insertion of LD is an invasive procedure associated with technical challenges and complications (5% minor and 3% major complication rate).[3,4-7] Often, LD is placed with epidural catheters instead of the standard LD catheters due to its prohibitive cost and unavailability.

Our study aimed to assess the incidence of technical challenges and complications with LD placement for endoscopic procedures. To our knowledge, there is a paucity of data on this aspect. We hypothesized that the incidence of technical challenges associated with LD placement using an epidural catheter is higher than with standard LD.

Materials and Methods

After approval from the Institutional Review Board (IRB Min No:10525 [OBSERVE] dated February 1, 2017), this prospective observational study was conducted in a tertiary care hospital over a period of 10 months.

A total of 50 American Society of Anesthesiologists (ASA) class I to III patients between 18 and 70 years of age scheduled for elective endoscopic neurosurgical procedures requiring LD were included in the study after obtaining written informed consent. The decision to insert LD was made by the operating surgeon depending on the nature of the surgery. The exclusion criteria included patient refusal, history of bleeding diathesis or deranged coagulation, local infection, systemic sepsis, meningitis (treated within the past 6 months), previous spinal surgery, preexisting neurologic deficits, clinical features of raised intracranial pressure, demyelinating lesions, CSF leak, or emergency procedures.

The 18-gauge epidural catheter (Portex [Smiths Medical] or BD Perisafe) was used as per the anesthesiologist's preference. The anesthesiologist involved in the placement of LD had more than five years of clinical experience. The technique of LD placement (midline vs. paramedian approach), timing of placement (awake vs. anesthetized), and level of placement were decided by the concerned anesthesiologist at the time of surgery. All LD placements were performed under standard sterile precautions, and the catheters were fixed to the skin with transparent film dressing (3M Tegaderm). The LD was allowed to drain at a rate of 20 to 30 mL/hour. The flow rate was adjusted to meet the surgical requirements, and LD was removed at the end of surgery if there was no CSF leak. If there was a CSF leak, the LD was left in place for a maximum of 5 days with antibiotic prophylaxis.

All patients received perioperative surgical prophylaxis as per institutional guidelines with ceftriaxone 2 g intravenously 30 minutes before incision and were treated with intravenous paracetamol 20 mg/kg every 8 hours and ondansetron 0.15 mg/kg every 8 hours for the first 24 hours and oral paracetamol for the next 24 hours. Based on the pilot study performed in our department, the prevalence of technical difficulty in LD patients was around 25% and the sample size calculated was 72. The expected sample size could not be achieved due to time constraints. A total of 50 cases were studied.

All demographic details, ASA class, and indication for the placement of LD were obtained. Technical difficulties with LD placement such as difficulty in tapping CSF space, number of attempts, number of levels attempted, difficulty in siting catheter, CSF drainage after final positioning, manipulations required to improve CSF flow, the total volume of CSF drained, and the intraoperative conditions as assessed by the surgeon were documented by the anesthesiologist. After removal of the catheter, the catheter tip was inspected to rule out any fracture of the catheter tip. The patients were kept in the supine position for at least 6 hours after removal of the LD and were ambulated thereafter.

The primary investigator followed up the patients during the next 48 hours and documented the outcome parameters related to complications associated with the LD as per the defined criteria (►**Appendix A**). Patients with LD in the postoperative period were followed up for 48 hours after removal of LD. Complications such as headache, postdural puncture headache (PDPH), backache, and others were studied over the period. The duration of hospitalization was also studied.

Statistical Analysis

Continuous data were expressed as mean (standard deviation) or as median (interquartile), whereas categorical data were expressed as numbers and percentages. The incidence of the complication rate was given with 95% confidence interval. The relation between complication rate and continuous variables was analyzed using independent *t*-test. A value of $p < 0.05$ was considered significant.

Results

The demographic details are presented in ►**Table 1**. A total of 50 patients were included in the study (56% males; 44% females). Of the patients, 92% underwent pituitary surgery, with 78% of them presenting with macroadenoma and 74% having suprasellar extension.

The technical difficulties and complications associated with LD placement are presented in ►**Table 2**. Of the LD, 90% were inserted in the anesthetized patient with midline being the preferred approach (88%).

Technical difficulties were present in 64%, with a technical failure rate of 2%. In more than 90% of them, there was difficulty in obtaining CSF tap, with 52% requiring more than two attempts and 45% required an attempt at a different level. Difficulty in siting the catheter was observed in 47%.

Table 1 Demographic details

	Mean	Range (SD)
Age (years)	42.18	18–76 (14.26)
Weight (kilograms)	83.14	43–110 (95.86)
BMI	26.48	16.9–33.9 (4.37)
	Description	**Number (%)**
Gender	Male	28 (56)
	Female	22 (44)
ASA	1	0
	2	50 (100)
Tumor type	Macroadenoma	39 (78)
	Microadenoma	7 (14)
	Unclassified	4 (8)
Suprasellar extension	Yes	37 (74)
	No	13 (26)
History of EVD/LSAD	Yes	5 (10)
	No	45 (90)
History of meningitis	Yes	1 (2)
	No	49 (98)

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; EVD, external ventricular drainage; LSAD, lumbar subarachnoid drainage; SD, standard deviation.

Table 2 Details of lumbar drain placement and technical difficulties encountered in the placement of lumbar drains

Variables	*n* (%)
Timing of placement	
Awake	5 (10)
Anesthetized	45 (90)
Approach	
Midline	6 (12)
Paramedian	44 (88)
Difficulties encountered in the placement of LSAD	32 (64)
Difficulty in tapping	29/32 (91)
Number of attempts	
<2	14/29 (48)
>2	15/29 (52)
Number of levels attempted	
1	16/29 (55)
≥2	13/29 (45)
Difficulty in siting the catheter	15/32 (47)
Unable to site the catheter	1/32 (3)
Decrease in the CSF flow after final positioning requiring manipulation	16/50 (32)
Significantly reduced CSF flow after manipulation	4/50 (8)
Unable to drain CSF	1/50 (2)
Drain failure rate	5/50 (10)

Abbreviations: CSF, cerebrospinal fluid; LSAD, lumbar subarachnoid drainage.

After successful LD placement, repositioning the patient to the supine position reduced the flow of the CSF (<10 mL/hour) in 32%. Manipulations such as flexion of the legs, placement of sandbags under the hips, retraction of the catheter, and flushing of the catheter improved the flow in 10 patients, and the flow was <10 mL/hour in four patients, with one patient having no CSF flow. Technical difficulty was not related to age, sex, body mass index (BMI), experience of the anesthesiologist, nature of tumor, or suprasellar extension. There were no major patient-related complications fulfilling the criteria for PDPH, meningitis, nerve root irritation, or retained catheter, or intracranial complications causing neurologic decline. There was a 56% incidence of headache and 26% incidence of backache (►**Table 3**). The demographic factors (sex, age, BMI, weight) that may contribute to difficult LD placement were nonsignificant ($p > 0.05$).

►**Table 4** shows that there is a statistically significant correlation between the drainage of higher CSF volumes (>30 mL/hour) and better intraoperative conditions as assessed subjectively by the surgeon based on the absence of arachnoid folds in the surgical field.

The presence of headache was significantly related to the difficulty in tapping the CSF ($p = 0.032$) (►**Table 5**). Backache

Table 3 Analysis of patient-related and technical complications

Variables	*N* (%)	95% confidence interval
Technical complications		
Insufficient CSF drainage	5 (10)	3.3–21.8
Dressing changes for LSAD	7 (14)	5.8–26.7
LSAD system change	7 (14)	5.8–26.7
Patient complications		
Headache	23 (56)	41.2–70
Postdural puncture headache	0	0–7.1
Backache	13 (26)	14.6–40.3
Meningitis	0	0–7.1
Nerve root irritation	0	0–7.1
Retained catheter	0	0–7.1
Skin changes such as erythema/induration	0	0–7.1
Intracranial complications	0	0–7.1

Abbreviations: CSF, cerebrospinal fluid; LSAD, lumbar subarachnoid drainage.

Table 4 Mean CSF volume drained and intraoperative conditions

Intraoperative conditions	Mean volume of CSF		*p*-Value
	Mean	SD	
Unsatisfactory	18.25	16.71	0.0003
Satisfactory	85.31	46.85	
Excellent	91.92	46.93	

Abbreviations: CSF, cerebrospinal fluid; SD, standard deviation.

Table 5 Technical difficulties and their relationship with patient-related complications

		Headache	No headache	*p*–Value	Backache	No backache	*p*-Value
Difficulty in tapping CSF	Yes	19 (90.5%)	6 (54.55%)	0.032	5 (41.7%)	5 (25%)	0.325
	No	2 (9.52%)	5 (45.45%)		7 (58.3%)	15 (75%)	
Number of attempts	1	2 (9.52%)	1 (12.5%)	0.924	2 (15.38%)	22 (59.46%)	<0.001
	2	8 (38.1%)	3 (37.5%)		1 (7.7%)	10 (27.03%)	
	3	11 (52.4%)	4 (50%)		10 (70.7%)	5 (13.51%)	
Number of levels attempted	1	10 (47.62%)	6 (75%)	0.44	5 (38.46%)	32 (86.5%)	0.001
	2	9 (42.86%)	2 (25%)		6 (46.15%)	5 (13.5%)	
	3	2 (9.52%)	0		2 (15.38%)	0	
Mean CSF Volume(mL)		83.71 ± 57.02	66.86 ± 38.45	0.479	57.38 ± 58.35	82.95 ± 45.7	0.004

Abbreviations: CSF, cerebrospinal fluid; LSAD, lumbar subarachnoid drainage.

was significantly related to the number of attempts ($p < 0.001$) and the number of levels attempted ($p < 0.001$) (►**Table 5**). There was a significant decrease in backache in those with higher CSF volumes (p = 0.04). Both headache and backache were not significantly related to age, sex, BMI, experience of the anesthesiologist, nature of tumor, or suprasellar extension. Duration of hospitalization was significantly prolonged in those with CSF leak ($p = 0.03$).

Discussion

In our study, difficult LD placement was observed in 64% with a technical failure rate of 2%.

In a similar study by Qureshi et al,[8] fluoroscopy-guided LD placement was attempted to decrease the incidence of technical difficulties. They used large catheters (14-gauge), prone position, awake patients, and paramedian approach for all procedures, and had a comparable technical failure rate of 2.32%. Most anesthesiologists preferred to perform the procedure in intubated patients through the midline approach, which is similar to the study by Mehta and Oldfield[1] and Ransom and Chiu.[9]

There was a decrease in CSF flow, with final positioning to supine in approximately 33%. There are no studies that have reported on this aspect, although it is a pertinent practical problem intraoperatively since neither manipulations nor repositioning is feasible after final positioning. Since there is a paucity of data, we assume that this may not be a problem with the larger gauge wire reinforced catheters, which are commonly used in high-volume centers, and is probably unique to the smaller gauge nylon catheters which are intended for epidural infusions.

The standard LD system consists of a specifically designed wire reinforced Codman's catheter.[10] Owing to its high cost and unavailability, the 16-gauge epidural Tuohy needle with an 18-gauge catheter is commonly used. Our study demonstrates significant difficulty associated with CSF drainage with the use of nylon catheters, resulting in suboptimal surgical conditions.

Wynn et al has shown that the drain failure rate was 7.8% for small drains (19-gauge) and 1.7% for large silicone drains (16-gauge).[11] In our study, the drain failure rate was 10%, which could be due to the use of small nylon catheters. Silicone catheters have been demonstrated to be superior to nylon catheters.[12] The mean volume of CSF drained was 76.3 mL over 3 to 4 hours. Wynn et al[11] has shown that the mean volume of CSF drained by a small catheter and a large catheter to be comparable.

The complications that usually occur are PDPH, injury to the Lumbosacral nerves, infections, retained catheter fragments and over drainage,[1,6] herniation, intradural hematoma, subdural hematoma, pneumocephalus, and neurologic decline.[12-14] The incidence of headache in our study is comparable to the findings of Kitchel et al[15] (58%) and Shapiro and Scully[12] (63%).

None of our patients presented with PDPH. Wynn et al[11] has shown that the incidence of PDPH was 0.6% in small drains and 2.3% in large drains. In the study by Youngblood et al,[16] the incidence of PDPH was 9.7%. The mean CSF drained was 128 mL, whereas in our study, it was only 76.3 mL. In concordance with this, we found that in the subgroup of patients with headache, there was an insignificant but definite increase in the volume of CSF that was drained. However, we have not considered obstructive hydrocephalus as a cause of a decrease in CSF drainage.

The incidence of backache was 26%. Although this is only a minor complication and is not reported by any other study, it is an important consideration in the quality of care. The presence of CSF leak significantly increased the duration of hospitalization by 4.69 days. This is comparable with the findings of Jung et al[3] and hence the need for a well-functioning LD.

We would like to conclude by affirming with Wynn et al[11] that the rate of difficulty in LD placement is unacceptably high with the use of epidural catheters as LD. Moreover, a drain failure rate of 10% after successful LD placement mandates that large-drain catheters, specifically designed for CSF drainage, must be used. Since the rate of technical failure is only 2% in our study, the use of fluoroscopy as the first line of treatment for the placement of LD is questionable but should definitely be considered as the second line of treatment.

Limitation

Our study was performed for a period of 10 months with a limited sample size (50 patients). Our follow-up lasted for only 48 hours after LD removal. Hence, complications thereafter were not assessed.

Conclusion

The incidence of technical difficulties in LD placement with the use of epidural catheters is high. However, the incidence of major complications is minimal when the procedure is performed using standard protocols by experienced anesthesiologists. With increases in endoscopic approach for skull base procedures, the need for LD with free flow of CSF is of utmost importance for successful surgical outcomes, thus mandating the availability of standard LD catheters and the need for perfection in the placement of a well-functioning LD.

Conflict of Interest
None declared.

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Appendix A

1. *Headache* was defined as pain in the head having no relationship with postural variation and not accompanied by vomiting and is >3 on the numerical rating scale (NRS).
2. *Meningitis* was defined as fever (temperature ≥100°F) with neck stiffness and a positive cerebrospinal fluid culture.
3. *Nerve root irritation* was defined as numbness, tingling, radicular pain, or sensorimotor deficit in the lower extremity.
4. *Retained catheter tip* was defined as a break in the epidural catheter tip noticed on removal of the epidural catheter.
5. *Postdural puncture headache* was defined as pain in the head involving the back and front of the head and spreading to the neck and shoulders, with or without neck stiffness, nausea/vomiting, which is exacerbated by movement, and sitting or standing, relieved to some degree by lying down, and is ≥ 5 on the NRS.
6. *Backache* was defined as pain, with or without stiffness, in the lumbosacral region and is ≥ 5 on the NRS.

