Original Article

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Comparison of Duration of Cerebrospinal (CSF) Leak in Post-Traumatic Patients Managed by Early Lumbar Drain vs Conservative Treatment

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Author`s Contribution

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ABSTRACT

Objective: To compare the duration (in days) of cerebrospinal fluid (CSF) leakage among post-traumatic patients managed with early lumbar drain (LD) placement versus conservative treatment.

Methodology: This study was conducted in the Department of Neurosurgery, Rawalpindi Medical University, Rawalpindi, from 23rd October 2023 to 23rd April 2024. Patients presenting with post-traumatic or post-surgical CSF leakage through the emergency department or outpatient department (OPD) were included. Patients were randomly divided into two groups. In Group A, a lumbar drain (LD) was inserted, while Group B patients were managed conservatively. If CSF leakage persisted after 10 days of drainage, the lumbar drain was removed, conservative treatment was discontinued, and surgical repair was performed. Patient data were collected using a pre-designed proforma.

Results: A total of 60 patients were included in the study. Data were entered and analyzed using SPSS version 21.0. Patients were randomly allocated to two groups using a computer-generated randomization method. The mean age of the patients was 37.30 ± 11.76 years, with 50 (83.3%) males and 10 (16.7%) females. The frequency of CSF leakage cessation in the lumbar drain group versus the conservative group was 29 (96.7%) and 21 (70.0%), respectively. The mean duration of CSF leakage cessation was significantly shorter in the lumbar drain group (5.23 ± 1.67 days) compared to the conservative group (6.40 ± 1.35 days) ($p < 0.05$).

Conclusion: The study concludes that early lumbar drain placement is superior to conservative management for CSF leakage in terms of reducing the duration of leakage. By providing an alternative pathway for CSF drainage, the fistula site remains dry, reducing CSF pressure at the leakage site and thereby promoting earlier wound healing.

Keywords: Cerebrospinal Fluid Leak. Lumbar drain, skull.

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Introduction

Communication between the subarachnoid space and the air-filled spaces of the middle ear or paranasal sinuses, and occasionally the skin, causes cerebrospinal fluid (CSF) leakage. CSF leakage may be categorized into two types: traumatic and non-traumatic. CSF leaks may be further subdivided into accidental and iatrogenic (post-surgical).[1,2]

CSF leakage may be managed by the placement of a lumbar drain (LD), which is commonly recommended in patients with skull base fractures. However, the indications for LD placement remain controversial, and its effect on the early cessation of CSF leakage is still debatable.[2,3] Our research will be particularly useful at the tertiary care level, especially in public hospitals, where we aim to document the advantages of early lumbar drain (LD) placement in patients with traumatic CSF leakage and its impact on hospital stay. This will

also help minimize the existing ambiguity regarding the protocol for early lumbar drain (LD) placement.

The scarcity of both local and international data on early lumbar drain placement and its effect on the duration of CSF leakage prompted us to compare it with conservative treatment. By providing CSF with an alternative pathway for drainage, the fistula site remains dry. The leaking skin or wound site is not exposed to continuous CSF pressure, which facilitates early healing.

Methodology

After obtaining approval from the Ethical Review Committee, a randomized controlled trial was conducted at the Department of Neurosurgery, Rawalpindi Medical University hospitals. Patients presenting with post-traumatic or post-surgical CSF leakage through the emergency department or outpatient department (OPD) were included in the study.

Simple random sampling using computer-generated numbers was used for patient allocation. Patients were randomly divided into two groups. A total of 60 cases (30 in Group A and 30 in Group B) were enrolled, calculated using the WHO sample size calculator. The sample size calculation was based on the following parameters: level of significance = 5%, power of test = 80%, pooled standard deviation = 1.39, test value of the population mean = 4.83, and anticipated population mean = 7.03.

In Group A, a lumbar drain (LD) was inserted, while in Group B, patients were treated conservatively. Patients were randomly allocated by a statistician within 24 hours prior to LD insertion. Randomization was carried out using computer-generated numbers, with 0 assigned to Group A and 1 to Group B.

Inclusion criteria included patients aged 15–60 years of both genders. Patients with craniospinal post-traumatic or post-operative CSF leakage persisting for more than 24 hours were included. CSF leak sites were confirmed on MRI. Exclusion criteria included patients with comorbid conditions such as cardiovascular disease, chronic kidney disease, chronic obstructive pulmonary disease (COPD), coagulopathies, and pregnancy. Patients with a previous history of chest or abdominal surgery, as well as any prior lumbosacral surgery, were also excluded.

Cerebrospinal fluid (CSF) leakage results from defects in the dura mater secondary to craniospinal trauma or surgery. Patients usually present with rhinorrhea or otorrhea. CSF leakage may also be observed from the wound site in craniospinal post-traumatic or post-surgical patients.[3] The duration (in days) of CSF leakage was measured as the number of days required for complete cessation of leakage. Lumbar drain (LD) placement was continued for a maximum of 10 days, or until cessation of CSF leakage, in post-traumatic patients.[1]

Lumbar drains (LDs) are typically placed by neurosurgeons, anesthesiologists, or interventional radiologists. The most common indication for LD placement is the prevention or management of CSF leakage by providing a path of least resistance and diverting CSF flow away from the leakage site.[5]

In cases where CSF leakage did not resolve within the first 24 hours in post-traumatic or post-surgical patients (emergency or elective), lumbar drain placement was considered. For both groups, the maximum duration of treatment was 10 days. Once CSF leakage ceased, the lumbar drain was clamped for 24 hours; if no recurrence occurred, the LD was removed.[48] Antibiotics were not used in either treatment group.

If CSF leakage persisted after 10 days of CSF drainage, the lumbar drain was removed, conservative treatment was discontinued, and surgical repair was performed. Patient data were collected by the principal investigator using a pre-designed proforma. The collected data were entered and analyzed using SPSS version 21.0 (Statistical Package for the Social Sciences).

Quantitative variables, such as age and duration (days) of CSF leakage, were expressed as mean ± standard deviation (SD). Qualitative variables, including gender and CSF leakage cessation, were expressed as frequencies and percentages. An independent-sample t-test was used to compare the mean duration (days) of CSF leakage between the two groups. An independent-sample t-test was also used to compare the mean duration (days) of hospital stay between the two groups. A p-value < 0.05 was considered statistically significant.

Results

Data were entered and analyzed using SPSS version 21.0 (Statistical Package for the Social Sciences). Patients presenting with post-traumatic or post-surgical CSF leakage through the emergency department or outpatient department (OPD) were included in the study. Patients were randomly divided into two groups. In Group A, a lumbar drain (LD) was inserted, while in Group B, patients were treated conservatively. Randomization was carried out using computer-generated numbers.

The mean age ± standard deviation of the study population was 37.30 ± 11.76 years, whereas the mean age (years) in Group A and Group B was 36.33 ± 12.71 and 38.27 ± 10.85, respectively. The majority of patients were male (50; 83.3%) compared to female patients (10; 16.7%).

Table II shows a comparison between the lumbar drain group and the conservative management group, demonstrating a significantly higher rate of CSF leakage cessation among patients who received lumbar drainage. Specifically, 96.7% of patients in the lumbar drain group achieved cessation of CSF leakage, compared to 70.0% in the conservative group; this difference was statistically significant ($p < 0.05$). This finding indicates that lumbar drainage is markedly more effective in controlling CSF leaks than conservative treatment alone.

Table II: Comparison of CSF Leakage Cessation & Diagnosis among Groups.

		Two groups		Total
		Lumbar Drain	Conservative	
CSF leakage cessation	yes	29 (96.7)	21 (70.0)	50 (83.3)
	no	1 (3.3)	9 (30.0)	10 16.7)
Diagnosis				
Cervical spine trauma		0 (0.0)	1 (3.30)	1 (1.70)
Cervical spine tumor		3 (10.0)	1 (3.30)	4 (6.70)
Post-traumatic Epidural hematoma		3 (10.0)	1 (3.30)	4 (6.70)
Fire arm injury to head		1 (3.30)	1 (3.30)	2 (3.30)
Fire arm injury to spine		1 (3.30)	2 (6.7)	3 (5.00)
Frontal bone fracture		1 (3.30)	0 (0.0)	1 (1.70)
Frontal temporal fracture		1 (3.30)	0 (0.0)	1 (1.70)
Temporoparietal bone fracture		1 (3.30)	1 (3.30)	2 (3.30)
Head trauma		5 (16.70)	14(46.70)	19 (31.70)
ICB (intracranial cerebral haemorrhage)		2 (6.70)	2 (6.70)	4 (6.70)
Pituitary adenoma		2 (6.70)	0 (0.0)	2 (3.30)
SDH (subdural hematoma)		5 (16.70)	1 (3.30)	6 (10.00)
SOL brain (space occupying lesion)		4 (13.30)	4 (13.30)	8 (13.30)
Thoracic spine tumor		1 (3.30)	2 (6.70)	3 (5.00)
Total		30	30	60

Regarding underlying diagnoses, both groups exhibited a wide range of etiologies, including traumatic, neoplastic, and postoperative conditions, with no statistically significant difference in diagnostic distribution between the two groups ($p > 0.05$). Common diagnoses included head trauma, space-occupying brain lesions, subdural hematoma, and cervical or thoracic spine pathologies. The similar distribution of these diagnoses suggests that the observed difference in CSF leak cessation is attributable to the treatment modality rather than baseline diagnostic variability. Overall, lumbar drainage was associated with superior clinical outcomes.

Table III presents a comparative analysis between the lumbar drain and conservative groups and demonstrates no statistically significant difference in the proportion of trauma-related cases (56.7% vs 70.0%, $p > 0.05$) or surgery-related cases (83.3% vs 66.7%, $p > 0.05$), indicating that both groups were comparable with respect to underlying causes. Complication rates were also comparable, with meningitis occurring infrequently in both groups and no statistically significant difference observed ($p > 0.05$), while the majority of patients in each group experienced no complications.

The timing of CSF leakage onset following trauma or surgery was similar between the two groups ($p > 0.05$). However, statistically significant differences were observed in clinical outcomes. Patients treated with lumbar drainage experienced earlier CSF leakage cessation, with a mean duration of 5.23 days compared to 6.40 days in the conservative group ($p < 0.05$). Additionally, the lumbar drain group had a significantly shorter hospital stay (10.20 vs 12.40 days, $p < 0.05$).

These findings suggest that, despite similar baseline characteristics, lumbar drainage results in faster CSF leak resolution and reduced duration of hospitalization compared with conservative management.

Table III: Comparison of Outcomes among groups.

		Two groups		p-value
		Lumbar Drain	Conservative	
Trauma	yes	17 (56.7)	21 (70.0)	0.284[a]
	no	13 (43.3)	9 (30.0)	
Surgery	yes	25 (83.3)	20 (66.7)	0.136[a]
	no	5 (16.7)	10 (33.3)	
Complications	Meningitis	3 (10.0)	2 (6.7)	0.529[a]
	Blockage	1 (3.3)	0 (0.0)	
	Nil	26 (86.7)	28 (93.3)	
Post-Operative Day or Post-Traumatic Day of Leakage		2.30±0.74	2.23±0.85	0.750[b]
Day of CSF leakage Cessation		5.23±1.67	6.40±1.35	0.004[b]
Hospital Stay		10.20±4.14	12.40±3.71	0.035[b]

Discussion

A five-year prospective evaluation of spontaneous cerebrospinal fluid (CSF) leaks reported the findings of 46 patients with a total of 56 spontaneous CSF leaks treated over a 5-year period. Opening pressures measured

by lumbar puncture increased significantly by 8 cm H_2O after closure of the skull base defect. Consequently, 24 patients (52%) were started on acetazolamide therapy following surgery. However, 2 of the 24 patients developed intolerance to acetazolamide (Diamox) and ultimately required long-term CSF diversion with ventriculoperitoneal (VP) shunt placement. Notably, 22 of the 24 patients (92%) responded favorably to acetazolamide, with bottom-up lumbar puncture used as a salvage treatment for iatrogenic CSF leaks following transsphenoidal tumor resection. The average hospital stay following lumbar puncture was two nights, after which patients were discharged. This duration was considerably shorter than the prolonged hospital stays associated with lumbar drainage. Moreover, these patients did not experience the common complications of lumbar drainage, including subdural hematoma or hygroma, meningitis, and debilitating low-pressure headaches, which are frequently reported with lumbar drain use.[10,11]

Lumbar drains (LDs) are commonly used after various skull base surgeries to prevent CSF leakage. In retrospective transcranial studies,[12] postoperative CSF leakage rates were reported to be 35% in patients who did not receive perioperative lumbar drains, compared with 12% in those who did receive LDs. In another study including CSF fistulae resulting from spinal surgery, cranial surgery, and traumatic causes,[13] the incidence of CSF leakage was reported as 6% with the use of a lumbar drain; however, CSF leak incidence in patients without lumbar drainage was not evaluated.Only a limited number of prospective studies have assessed the utility of lumbar drains in skull base surgery, and none have evaluated their use in endoscopic endonasal surgery (EES).[14] A major confounding factor in evaluating outcomes is the ability to differentiate between high-flow and low-flow CSF leaks.

Several risks associated with lumbar drain placement must be weighed against its potential benefits. Headache, nausea, and vomiting are the most common complications, occurring in 13%–63% and 4%–10% of cases, respectively.[15] More serious complications, including meningitis and other infections, have also been reported. Prolonged use of lumbar drains (LDs) beyond a few days after surgery is potentially dangerous, as the longer the duration of LD use, the greater the risk of infection. Other infrequent but serious complications include neurological impairment due to excessive drainage, such as tonsillar herniation, acute or delayed intracranial hypotension, intracranial venous thrombosis,[16] lumbar nerve root irritation, pneumocephalus, and retained catheters. These risks are further compounded by systemic complications associated with relative patient immobilization, which is often required for the safe use of LDs. CSF leakage and pneumocephalus were also considered indications for surgical intervention, as were intracranial complications, including meningitis, extradural or subdural abscess, and/or hemorrhage. Decompensation warning signs included injury to the optic and facial nerves. Comatose patients were excluded from the study, as accurate assessment of rhinorrhea is difficult in unconscious patients.

In addition, Yilmazlar et al.[17] reported that a considerable proportion of patients with Glasgow Coma Scale (GCS) scores ≤8 at admission experienced multiple complications and unfavorable outcomes. Conversely, patients admitted with GCS scores >8 demonstrated high success rates with conservative management. The use of strict inclusion and exclusion criteria allowed the generation of a homogeneous study population.Lumbar drain insertion was initiated after 48 hours of persistent rhinorrhea. This threshold was selected because most traumatic CSF leaks seal spontaneously within the first 24–48 hours.[18]

During follow-up, the incidence of recurrent CSF leakage did not differ significantly between the two treatment arms. Furthermore, the incidence of meningitis during follow-up was not statistically significant, occurring in 10% of patients with lumbar drains compared to 14% of patients without lumbar drains. Thus, if the primary treatment goal is the prevention of meningitis, lumbar drain diversion does not appear to be superior to conservative management. Bernal-Sprekelsen et al.[19] reported a 29% incidence of meningitis in patients treated conservatively following traumatic CSF leaks. In a subsequent study, Bernal-Sprekelsen et al.[20] demonstrated that closure of CSF leaks prevented the occurrence of meningitis. Yeo et al.[21] reported meningitis incidences of 10% in patients without lumbar drains and 7% in patients managed with lumbar drainage.

In our study, the mean age of patients was 37.30 ± 11.76 years, with a male predominance (83% males vs 17% females). CSF leakage cessation occurred in 29 patients (96.7%) in the lumbar drain group compared to 21 patients (70.0%) in the conservative group, a difference that was statistically significant ($p = 0.006$). The mean post-traumatic day of CSF leakage onset did not differ

significantly between the lumbar drain and conservative groups (2.30 ± 0.74 vs 2.23 ± 0.23 days; p = 0.750).

The mean duration of CSF leakage was significantly shorter in the lumbar drain group (5.23 ± 1.67 days) compared to the conservative group (6.40 ± 1.35 days; p = 0.004). Additionally, the mean duration of hospital stay was significantly reduced in the lumbar drain group (10.20 ± 4.14 days vs 12.40 ± 3.71 days; p = 0.035).

Conclusion

The study concluded that early lumbar drain placement is superior to conservative treatment for CSF leakage in terms of reducing the duration of leakage (in days). By providing CSF with an alternative drainage pathway, the fistula site remains dry. Reduced CSF pressure at the leakage site facilitates earlier wound healing.

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