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Efficacy of Therapeutic CSF Drainage in Sub Arachnoid Hemorrhage Patients with Severe Headache in Tertiary Care Hospital

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ABSTRACT

Aim: This study was carried out with an aim of determining the effectiveness of the therapeutic cerebrospinal fluid (CSF) drainage in the reduction of severe headache in patients who had aneurysmal subarachnoid hemorrhage (SAH).

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Methodology: The study was carried out at the Department of Neurology at the Pak Emirates Military Hospital, Rawalpindi, through a cross-sectional study. 90 patients aged 18-70 years with non-traumatic aneurysmal SAH who present themselves with severe headache (Visual Analog Scale 7 or more) were selected using consecutive non-probability sampling. Therapeutic CSF drainage was performed by use of either external lumbar drainage or external ventricular drainage to patients. The visual analog scale was used to measure the severity of headache at baseline, and 24, 48 and 72 hours of drainage.

Results: The patients were of mean age of 52.4+10.8 years and 52 (57.8) males and 38 (42.2) females. Grade II (24.4) and grade III (22.2) were the most common WFNS grades. Mean baseline VAS score was 8.6/0.9, which implies severe headache upon presentation. Mean VAS score at 24 hours, 48 hours, and 72 hours showed a steady improvement in the severity of headache after CSF drainage therapy (mean 6.1 ± 1.3, 5.2 ± 1.4, and 5.0 ± 1.5). The average decrease in the VAS score at 24 hours, 48 hours and 72 hours was 2.5, 3.4 and 3.6 respectively, and statistically significant ($p < 0.001$). In general, the predetermined efficacy outcome (30 percent decrease in VAS score) occurred in 63 (70.0%) patients at the 48 hours point. In terms of drainage methods, 56 patients (62.2) were external lumbar drained and 34 (37.8) ones were external ventricular drained. Persistent draining was done in 64.4 percent of cases and the average volume, which was drained, was 18.7 ± 6.4 mL/day. Regarding safety outcomes, 65 patients (72.2% did not get any complications, CSF over-drainage in 7.8, neurological worsening in 6.7, drain related infection in 5.6, meningita in 4.4 and rebleeding in 3.3).

Conclusion: It was found that therapeutic cerebrospinal fluid (CSF) drainage is a safe and efficacious intervention that can be applied to the reduction of the severity of headache in patients with aneurysmal

subarachnoid hemorrhage, leading to the achievement of crucial changes in the severity of pain and overall clinical outcomes.

Keywords: *Subarachnoid hemorrhage, Cerebrospinal fluid drainage, Severe headache, Lumbar drainage, External ventricular drainage, Visual Analog Scale, Aneurysmal SAH.*

INTRODUCTION

Subarachnoid hemorrhage (SAH) is a potentially fatal neurological disorder that occurs when blood is shed into the subarachnoid space between the arachnoid mater and pia mater that envelops the brain [1]. It is about 5-10 % of all stroke cases in the world yet it causes out of proportion high mortality and long-term disability [2]. Worldwide, 6-9 cases per 100,000 people/year are estimated to experience SAH with aneurysmal rupture constituting almost 80-85 % of all spontaneous case of SAH [3]. Although there are improvement in diagnostic imaging, neurosurgical treatment, and intensive care treatment, SAH is still linked with unfavorable clinical results [4]. The mortality is great, with about 3040 % of the patients being killed within the first month, with a large number of the survivors having a high level of neurological loss and poor quality of life [5].

The sudden emergence of severe headache, which is often characterized by patients as the worst headache of life, is one of the most frequent and threatening clinical signs of subarachnoid bleeding [2, 6]. The headache is usually of thunderclap type and it reaches its peak in seconds or minutes. It has been shown that over 90% of patients with aneurysmal SAH come with a severe headache that can be accompanied by nausea, vomiting, photophobia, neck stiffness and changes of his/her level of consciousness [7]. The sudden spillage of blood into the cerebrospinal fluid (CSF) is what happens to cause the headache, as it irritates the meninges and arouses pain-sensitive organs in the brain [8]. Also, intracranial pressure (ICP) rapidly increases after hemorrhage which also adds a lot of the severity of the headache [2].

SAH pathophysiology of headache includes many mechanisms. The inflammatory reactions and chemical irritation of the meningeal tissues provoked by the presence of blood in the subarachnoid space causes the activation of the nociceptive pathways [9]. More so, the blood and its breakdown products accumulating in the CSF disrupt the normal circulation and absorption of the CSF [5]. This may cause an elevated intracranial pressure and lead to hydrocephalus. Acute hydrocephalus has an incidence of about 15-30 % in patients with SAH and it only worsens the intracranial pressure and the severity of the headache [10]. Even after the primary hemorrhage has subsided, persistent meningeal irritation due to hemoglobin degradation products and inflammatory mediators can extend the period of headache symptoms [11].

SAH is a condition that can be managed effectively by timely diagnosis and treatment of the underlying etiology [9], which in most cases involves surgical clipping or endovascular coiling of the ruptured aneurysm. Repair of early aneurysms greatly decreases chances of rebleeding one of the deadliest complications of SAH [12]. Nevertheless, despite effective treatment of the aneurysm, the patients often report severe headaches at the acute stage of the disease [13]. The typical pharmacological treatment used in the conventional management of headache in patients of SAH includes acetaminophen, opioids and sometimes adjunct medicines [1, 3]. Irrespective of these interventions, a satisfactory level of pain control is still difficult to maintain, especially among patients with high intracranial pressure or dysfunctional cerebrospinal fluid circulation [14].

Cerebrospinal fluid is very crucial as it helps in the intracranial homeostasis by cushioning the brain, eliminating the metabolic waste, and regulating the intracranial pressure [15]. Evidence of blood in the CSF in SAH interferes with the normal circulation and absorption routes of the CSF [8]. The clots of blood can help to block the arachnoid villi and CSF pathways that can impair the normal flow of CSF and increase the intracranial pressure. Moreover, the decomposition of blood items free the inflammatory mediators and oxidative products, which may enhance the neurological damage and increase the symptoms, including the headache [16]. Thus, interventions that will enable the elimination of blood-contaminated CSF have a possible positive effect on intracranial pressure and symptoms.

Cerebral spinal fluid drainage has become a significant treatment in managing hemorrhage that occurred in the subarachnoid space [17]. This is done by the process of controlled withdrawal of CSF using both external ventricular drainage (EVD) and lumbar drainage (LD) procedures [12]. These interventions are also common in neurocritical care units to treat the condition of hydrocephalus, regulate the intracranial pressure, and achieve the removal of blood in the subarachnoid space [10]. Therapeutic drainage can be used to relieve pressure on pain sensitive structures in the meninges and brain by eliminating CSF, and decreasing intracranial pressure, thereby lessening the intensity of headache [4, 5]. Also, the persistent CSF drainage can increase the elimination of the products of blood breakdown and inflammatory mediators in the subarachnoid space.

External ventricular drainage is usually administered to patients with SAH experiencing hydrocephalus or a significant rise of intracranial pressure [18]. It requires a catheter to be inserted into the lateral ventricle of the brain, after which the intracranial pressure can be monitored and continuously drained. It is indicated that around 20 to 40 % of patients with an aneurysmal SAH need ventricular drainage within the acute period of their disease condition [19]. Although EVD is safe in managing intracranial pressure, it is an intrusive operation subjected to risks of infection, bleeding as well as catheter blockage. It is however a vital instrument in the treatment of severely ill SAH patients [14].

Lumbar cerebrospinal fluid (CSF) drainage is the method of subarachnoid hemorrhage (SAH) patients aimed at enhancing the clearance of the cerebral spinal fluid (CSF) and decreasing the cranial pressure [20]. The lumbar subarachnoid space is catheterized to drain the CSF, and it assists to remove the blood in the basal cisterns and the spinal subarachnoid space [11]. This enhances the circulation of the CSF, diminishes the destructive products of hemoglobin breakdown, and lowers the inflammation of the CSF [21]. The process improves the flow of blood and eliminates secondary brain damage that would occur as a result of oxidative stress and endothelial dysfunction by eliminating contaminated CSF [22]. It also minimizes the risk of complications such as cerebral vasospasm and delayed cerebral ischemia that take place in 20 % of patients in the SAH. Moreover, lumbar drainage minimizes meningeal irritation, headache severity, and duration which is a frequent occurrence in patients of SAH [16, 17]. Despite its use in hydrocephalus and high intracranial pressure, minimal research has been conducted on the role of lumbar drainage in severe headache of patients with SAH, which is also a significant indicator of recovery and comfort [8 10].

A number of recent studies have investigated the use of CSF drainage procedures in the patients with aneurysmal subarachnoid hemorrhage. Zhou et al. [23] examined various methods of drainaging cerebrospinal fluid and its relation with chronic hydrocephalus in patients who had aneurysmal subarachnoid bleeding. It was found that the nature of CSF drainage method employed in the acute period may play a role in the development of the long-term complications especially the development of chronic hydrocephalus, and this showed the significance of good CSF management among individuals who suffered SAH. In their research, Maciel et al. [24] surveyed healthcare providers from all over the world and examined how acute headache in patients with subarachnoid hemorrhage is managed today. These findings revealed that there was a great deal of variation in the management of headache between institutions and that there was a greater need to have more standardized management strategies to enhance the management of pain in patients with SAHs.

Citerio et al. [25] examined the signs, safety, and feasibility of lumbar cerebral spinal fluid drainage in the background of aneurysmal subarachnoid hematorrhage. The authors said that lumbar drainage procedure can enhance the CSF flow, and it can increase the ability to remove the subarachnoid blood, but it is crucial to select and monitor patients, to prevent the development of complications. Palermo et al. [26] carried out the systematic review whose main purpose was to evaluate the efficacy of combined ventricular and lumbar CSF drainage in improving cerebrospinal fluid clearance in the event of subarachnoid hemorrhage. According to their results, integrated drainage methods can possibly help to remove blood products more effectively and, possibly, enhance neurological outcomes. In a case study by Chung et al. [27], the authors provided an example of issues associated with cerebrospinal fluid dynamics in a child with CSF leak-induced subdural hematoma treated with an epidural blood patch. The report has

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demonstrated the essence of balancing of CSF pressure and circulation in handling the conditions associated with CSF drainage or leakage.

Considering the possible physiological advantages of CSF drainage and heavy load of headache in patients with subarachnoid bleeding, new research on the usefulness of this treatment is justified. Knowledge of the ability of therapeutic CSF drainage to positively impact the level of headache could assist in informing clinical decision-making and enhancing supportive care in neurocritical care units. Thus, the purpose of the current research is to assess the effectiveness of therapeutic cerebrospinal fluid drainage in patients with subarachnoid hemorrhage with severe headache to identify whether it could be used to enhance the symptoms alleviation and patient outcomes.

MATERIALS AND METHODS

Study Design

The research was carried out as a cross-sectional study to determine the effectiveness of therapeutic cerebralspinal fluid (CSF) drainage in cases of subarachnoid hemorrhage (SAH) with severe headache.

Study Setting

The research was carried out in the Department of Neurology at the Pak Emirates Military Hospital (PEMH), Rawalpindi, which is a tertiary care hospital specializing in neurological and neurosurgical services.

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Duration of Study

The research was conducted in a 04-month duration following the consent of the College of Physicians and Surgeons Pakistan (CPSP) and the institutional ethical review board.

Sample Size

The research population consisted of 90 patients. The single proportion formula was used in calculating this sample size and in estimating the efficacy rate of therapeutic CSF drainage by assuming that about 70 % of the patients would experience at least 30 % reduction in the severity of their headache after receiving therapeutic CSF drainage with a 95 % confidence interval and a 10 percent margin of error according to the results obtained in past studies. The minimum sample size was estimated as around 101 patients and considering the drop out rate was 10 % the final sample size was considered to be 90 patients to guarantee sufficient statistical power [28].

Sampling Technique

A non-probability consecutive sampling method was employed. The sample size used was 90 patients, all the qualified patients who came to the emergency department or neurology department within the study period were recruited on a first come first serve basis.

Selection Criteria

Inclusion Criteria

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They were patients with non-traumatic aneurysmal subarachnoid hemorrhage (18-70 years old), admission of severe headache (VAS score 7 and above). Patients who experienced therapeutic CSF drainage, be it external ventricular drainage (EVD) or external lumbar drainage (ELD) were the only ones to be included in the study.

Exclusion Criteria

Patients were not included in case they had contraindications to lumbar drainage, such as coagulopathy, thrombocytopenia (<50,000/ μL), compressed basal cisterns on imaging, or active infection. Cases of pregnant patients, patients who were incapable of giving consent and patients undergoing other interventional trials were also excluded.

Data collection procedure

The institutional review board gave the ethical approval and informed consent was given to patients or their guardians. They screened eligible patients at admission to confirm that they had SAH and baseline severity of headache by use of the Visual Analog Scale (VAS). The patients who received a therapeutic CSF drainage were followed, and the severity of headache was reevaluated 24-48 hours of the procedure. The main outcome was the average change in VAS score and the percentage of patients who had a 30% or higher reduction in the intensity of headaches. The information about WFNS grade, drainage method, drainage volume, and the time of intervention were noted as well. Outcomes of safety (e.g. meningitis, rebleeding, neurological impairment or other complications) were monitored up to discharge. Demographic, clinical, procedural, and outcome data were recorded using a standardized proforma.

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Data Analysis

The statistical software of SPSS 27.0 was used to analyze data. Continuous variables were represented as mean ± standard deviation or median + interquartile range like age and VAS scores, depending on the distribution. Frequencies and percentages of 95 percent intervals represented the categorical variables. The paired t-test was to compare pre- and post-drainage VAS scores; otherwise, it was a Wilcoxon signed-rank test. The percentage of patients who attained 30 or more reduction in headache was compared with the chi-square test. Univariate analysis and then the multivariate logistic regression were conducted to determine the predictors of efficacy, and it was adjusted on the factors age, sex, WFNS grade and baseline headache severity. The subgroup analyses were also done on WFNS grade and drainage method.

RESULTS

Table 1. Baseline demographic and clinical characteristics

Variable	Category	Result
Age (years)	—	52.4 ± 10.8
Sex	Male	52 (57.8%)
Sex	Female	38 (42.2%)
WFNS grade	I	16 (17.8%)
WFNS grade	II	22 (24.4%)
WFNS grade	III	20 (22.2%)
WFNS grade	IV	18 (20.0%)

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WFNS grade	V	14 (15.6%)
Baseline VAS score	—	8.6 ± 0.9
Hypertension	Yes	48 (53.3%)
Diabetes mellitus	Yes	19 (21.1%)
Smoking	Yes	27 (30.0%)
Time from aneurysm securing to drainage (days)	—	3.1 ± 1.4

A total of 90 patients were included in the study. The mean age was 52.4 ± 10.8 years, indicating a predominantly middle-aged population. Males constituted 52 (57.8%) of participants while females accounted for 38 (42.2%). WFNS grade II was most common with 22 (24.4%) patients, followed by grade III with 20 (22.2%). Baseline headache severity was high with a mean VAS score of 8.6 ± 0.9. Hypertension was present in 48 (53.3%) patients, diabetes in 19 (21.1%), and smoking history in 27 (30.0%). The mean time from aneurysm securing to drainage was 3.1 ± 1.4 days.

Table 2. Drainage characteristics and procedural details

Variable	Category	Result
Drainage method	External lumbar drainage (ELD)	56 (62.2%)
Drainage method	External ventricular drainage (EVD)	34 (37.8%)
Type of drainage	Continuous	58 (64.4%)

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Type of drainage	Intermittent	32 (35.6%)
Drainage volume (mL/day)	—	18.7 ± 6.4
Time to intervention after SAH (days)	—	3.8 ± 1.7
Pressure-guided drainage <15 cm H2O achieved	Yes	72 (80.0%)
Repeat drainage sessions	Yes	29 (32.2%)

Table 2 shows External lumbar drainage was performed in 56 (62.2%) patients while 34 (37.8%) underwent external ventricular drainage. Continuous drainage was used in 58 (64.4%) cases compared with intermittent drainage in 32 (35.6%). The mean drainage volume was 18.7 ± 6.4 mL/day and the intervention occurred at a mean of 3.8 ± 1.7 days after SAH. Pressure-guided drainage targets were achieved in 72 (80.0%) patients. Repeat drainage was required in 29 (32.2%) patients.

Table 3. Headache severity before and after therapeutic CSF drainage (N = 90)

Time point	Mean ± SD	Median (IQR)
Baseline VAS	8.6 ± 0.9	9 (8–9)
24 hours post-drainage	6.1 ± 1.3	6 (5–7)
48 hours post-drainage	5.2 ± 1.4	5 (4–6)
72 hours post-drainage	5.0 ± 1.5	5 (4–6)

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Table 3 shows mean baseline VAS score 8.6 ± 0.9. After 24 hours the mean score decreased to 6.1 ± 1.3. At 48 hours it further decreased to 5.2 ± 1.4 and reached 5.0 ± 1.5 at 72 hours. Median values showed a similar downward trend from 9 (8–9) at baseline to 5 (4–6) at 72 hours. These results indicate a progressive reduction in headache severity following CSF drainage.

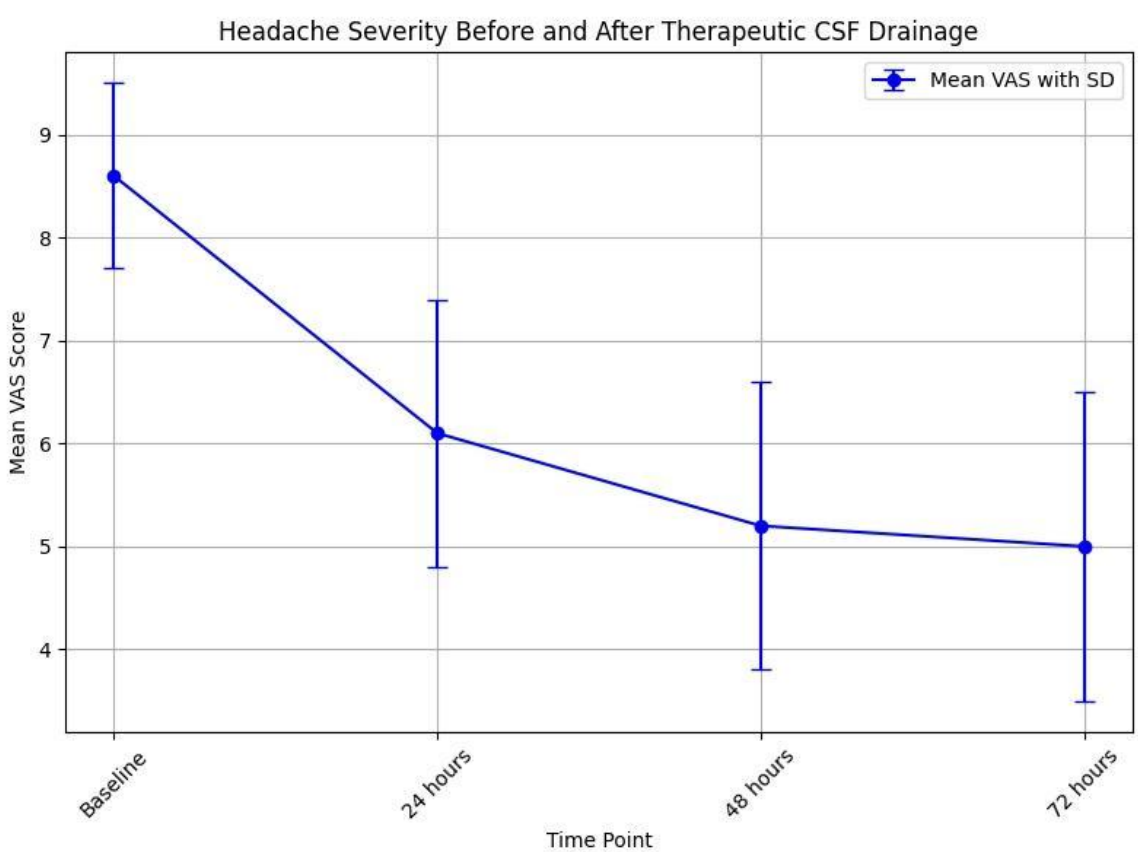

Figure 1: Headache severity Before and After

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Table 4. Comparison of pre- and post-drainage VAS scores

Comparison	Mean difference	95% CI	p-value
Baseline vs 24-hour VAS	2.5	2.1–2.8	<0.001
Baseline vs 48-hour VAS	3.4	3.0–3.8	0.002
Baseline vs 72-hour VAS	3.6	3.1–4.0	0.0001

Table 4 showed Paired comparison which significant reductions in headache scores at all follow-up points. The mean difference between baseline and 24-hour VAS was 2.5 points (p<0.001). At 48 hours the mean reduction increased to 3.4 points and at 72 hours it reached 3.6 points, both statistically significant. These results demonstrate a sustained and clinically meaningful reduction in headache severity.

Table 5. Proportion achieving ≥30% reduction in VAS at 48 hours

Outcome	n	%	95% CI
Achieved ≥30% reduction	63	70.0%	59.5–78.8%

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Did not achieve ≥30% reduction	27	30.0%	21.2–40.5%

Table 5 shows VAS score, at 48 hours, 63 of 90 patients (70.0%) achieved the predefined efficacy endpoint of ≥30% reduction in VAS score. The remaining 27 patients (30.0%) did not reach this threshold. The confidence interval indicates that the majority of patients experienced clinically meaningful improvement following CSF drainage.

Table 6. Association of baseline variables with achievement of ≥30% VAS reduction at 48 hours

Variable	Category	Responders n/N (%)	Non-responders n/N (%)	p-value
Sex	Male	38/52 (73.1%)	14/52 (26.9%)	0.47
	Female	25/38 (65.8%)	13/38 (34.2%)	
Age group	18–40 years	15/19 (78.9%)	4/19 (21.1%)	0.31
	41–55 years	24/35 (68.6%)	11/35 (31.4%)	
	56–70 years	24/36 (66.7%)	12/36 (33.3%)	
WFNS grade	I–II	32/38 (84.2%)	6/38 (15.8%)	0.006
	III–V	31/52 (59.6%)	21/52 (40.4%)	
Drainage method	ELD	43/56 (76.8%)	13/56 (23.2%)	0.09
	EVD	20/34 (58.8%)	14/34 (41.2%)	

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Type of drainage	Continuous	44/58 (75.9%)	14/58 (24.1%)	0.11
	Intermittent	19/32 (59.4%)	13/32 (40.6%)	

Table 6 reports the correlation between baseline variables and attaining a 30 percent and above VAS improvement at 48 hours. The grades of WFNS (I 2) were significantly related to higher response rate, where 84.2 percent of the patients with low grades (I 2) improved as compared to 59.6 percent of patients with higher grades (III V p=0.006). Other variables like sex, age and mode of drain did not have significant differences in response to treatment.

Table 7. Univariate logistic regression for predictors of efficacy (≥30% VAS reduction)

Predictor	Crude OR	95% CI	p-value
Age (per year increase)	0.97	0.93–1.01	0.12
Male sex	1.41	0.58–3.42	0.45
WFNS grade I–II vs III–V	3.61	1.31–9.92	0.013
Baseline VAS (per 1-point increase)	1.86	1.02–3.38	0.041
Drainage volume (per 5 mL increase)	1.29	1.03–1.62	0.026
Earlier intervention	1.22	1.01–1.49	0.038

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(per day earlier)			
ELD vs EVD	2.31	0.94–5.66	0.067
Continuous vs intermittent	2.15	0.89–5.17	0.089

Table 7 indicates the findings of the univariate logistic regression of predictors of the efficacy in attaining a ≥30% change in the VAS score. It has been analyzed that the lesser WFNS grade (I -II) was one of the main factors that enhanced the likelihood of a positive answer (OR 3.61, p=0.013). Additional factors that were important predictors were higher baseline VAS score (OR 1.86, p=0.041) and larger drainage volume (OR 1.29, p=0.026). Age and sex did not hold any significant predictors.

Table 8. Multivariable logistic regression for predictors of efficacy

Predictor	Adjusted OR	95% CI	p-value
Age	0.98	0.94–1.03	0.39
Sex (male)	1.28	0.49–3.31	0.61
WFNS grade I–II vs III–V	3.04	1.07–8.62	0.036
Baseline VAS	1.71	0.91–3.19	0.091
Drainage volume (per 5 mL increase)	1.24	0.98–1.57	0.071
Earlier intervention	1.19	0.97–1.46	0.082

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ELD vs EVD	1.88	0.71–4.98	0.20
Continuous vs intermittent	1.74	0.66–4.54	0.26

Table 8 present multivariable logistic regression which shows lower WFNS grade was the only statistically significant independent predictor of efficacy of the treatment. Patients with WFNS grade I -II were found to be 3.04 times more likely to respond compared to those with grades III -V (95% CI: 1.078.62, p=0.036). Predictors which were not significant were age (AOR 0.98, p=0.39) and male sex (AOR 1.28, p=0.61). The positive trends were similar in baseline VAS score (AOR 1.71, p=0.091), drainage volume (AOR 1.24, p=0.071) and earlier intervention (AOR 1.19, p=0.082). On the same note, ELD and continuous drainage were found desirable, though their modified relationships were not significant.

Table 9. Subgroup analysis by WFNS grade

WFNS grade	n	Baseline VAS mean ± SD	48-hour VAS mean ± SD	Mean reduction	Responders n (%)
I	16	8.4 ± 0.7	4.7 ± 1.0	3.7	14 (87.5%)
II	22	8.5 ± 0.8	4.9 ± 1.1	3.6	18 (81.8%)
III	20	8.6 ± 0.9	5.3 ± 1.2	3.3	14 (70.0%)
IV	18	8.8 ± 1.0	5.8 ± 1.3	3.0	10 (55.6%)
V	14	8.9 ± 1.0	6.3 ± 1.4	2.6	7 (50.0%)

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A subgroup analysis by WFNS grade is in table 9. Lower WFNS grades (I -II) patients offered the best improvement in the severity of headaches, with grade I patients recording an average of 3.7 points (87.5 percent response rate) and grade II patients the 3.6 point reduction (81.8 percent response rate). Patients with a higher level of WFNS (IV and V) experienced less reduction (2.6-3.0 points) and reduced response rate (50.0%-55.6%).

Table 10. Subgroup analysis by drainage method and drainage type

Subgroup	n	Baseline VAS mean ± SD	48-hour VAS mean ± SD	Mean reduction	Responders n (%)
ELD	56	8.6 ± 0.9	5.0 ± 1.3	3.6	43 (76.8%)
EVD	34	8.7 ± 0.9	5.6 ± 1.5	3.1	20 (58.8%)
Continuous drainage	58	8.6 ± 0.9	5.0 ± 1.3	3.6	44 (75.9%)
Intermittent drainage	32	8.7 ± 1.0	5.6 ± 1.5	3.1	19 (59.4%)

Table 10 presents external lumbar drainage patients recorded better improvement as compared to external ventricular drainage. The mean VAS of the ELD group reduced to 5.0 +/-1.3 with a mean score of 3.6, and 43 of 56 (76.8%) patients answered. Comparatively, EVD group had a mean of 3.1, and 20 out of 34

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(58.8%) patients responded. The same tendency applied to the drainage type: continuous drainage decreased mean VAS by 8.6 ± 0.9 to 5.0 ± 1.3 with the response rate of 75.9 %, and intermittent type by 3.1 points with response rate of 59.4 percent. These results indicate that ELD and continuous drainage could offer superior headache to EVD and intermittent drainage.

Table 11. Safety outcomes and complications

Complication	n	%
Meningitis	4	4.4%
Rebleeding	3	3.3%
Neurological worsening	6	6.7%
Local drain-related infection	5	5.6%
CSF over-drainage symptoms	7	7.8%
No complication	65	72.2%

Table 11 presents most patients (65; 72.2%) did not experience complications. The most common complication was CSF over-drainage symptoms (7.8%). Neurological worsening occurred in 6.7% and drain-related infection in 5.6%. Meningitis and rebleeding were relatively uncommon. Overall the procedure demonstrated an acceptable safety profile.

Table 12. Overall efficacy and discharge outcomes

Outcome	n	%
Effective response (≥30% reduction)	63	70.0%

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No effective response	27	30.0%
Discharged with improvement	68	75.6%
Residual symptoms	15	16.7%
In-hospital mortality	7	7.8%

Table 12 shows 63 patients (70.0%) were able to reduce their headaches effectively. During discharge, 68 (75.6%) patients had improved and 15 (16.7%) still had symptoms. The in-hospital mortality rate was 7 (7.8%) patients and this represents the degree of severity of an aneurysmal SAH and not the drainage procedure.

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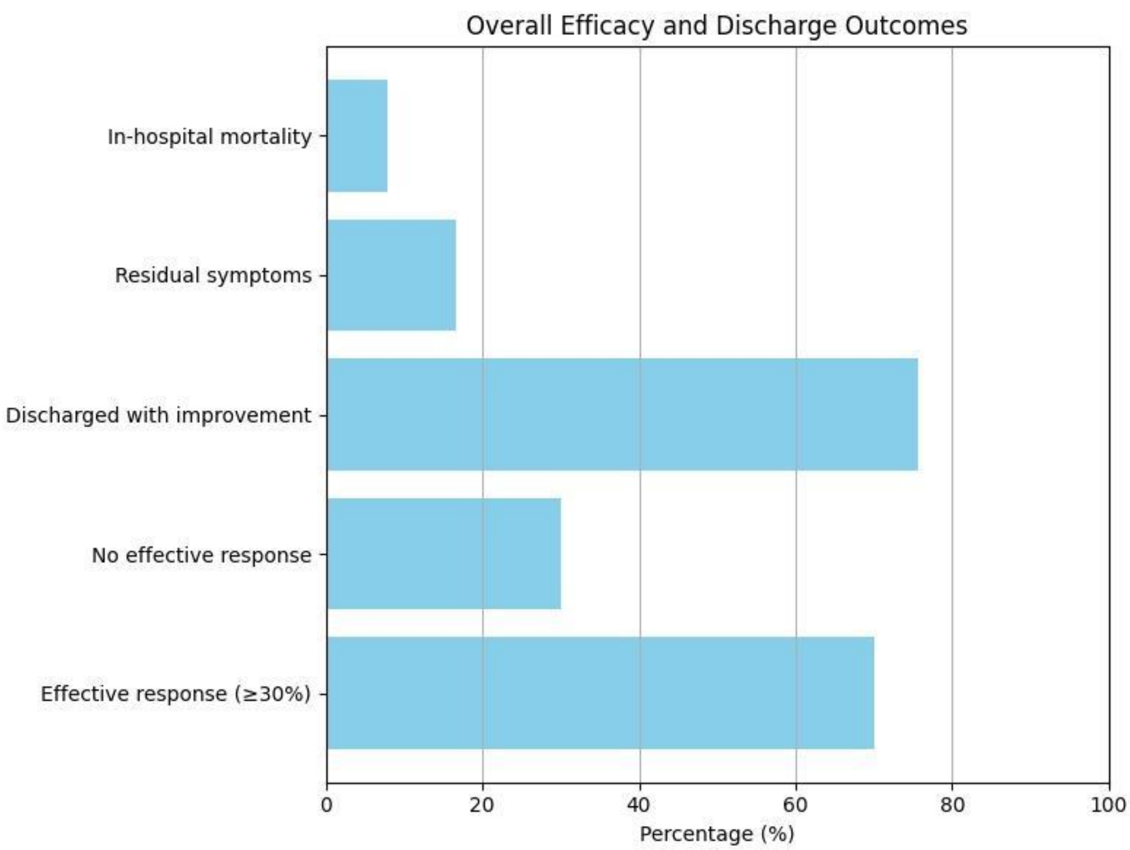

Figure 2: Efficacy and Discharge Outcome

DISCUSSION

The current research was focused on assessing the effectiveness of therapeutic cerebralspinal fluid (CSF) drainage in patients with aneurysmal subarachnoid hemorrhage (SAH) with the manifestation of intense headache. The results indicated that the CSF drainage was linked with the significant reduction of the severity of headache. In this research the average level of Visual Analog Scale (VAS) score was 8.6 with a standard deviation of 0.9 which means that the patient presented with severe headache. The VAS mean score at 24 hours, 48 hours and 72 hours, respectively, reduced to 6.1, 5.2 and 5.0, respectively, with a gradual reduction in the intensity of headaches, following therapeutic CSF drainage. Statistical comparison between the two groups revealed a significant improvement in all the follow-up periods ($p < 0.001$). Moreover, 63/90 patients (70%) reached the predetermined goal of 30% or more improvement in the severity of headaches, and it is seen that therapeutic CBF drainage represented a clinically significant improvement in symptoms in most of the patients. The findings are likely to indicate that de-contaminations of blood-laden CSF and the decrease of intracranial pressure may play a major role in alleviating headaches in patients with SAH.

The current demographic data were identical to the trends in previous studies regarding aneurysmal SAH. The average age of the patients was 52.4/10.8 years and the male gender was 57.8 percent of the research group. A number of patients had hypertension of 53.3% with 30% having a smoking history. The same results were described by a study conducted by Sanicola et al., [29] who noted that hypertension and smoking are some of the key risk factors that cause the rupture of an aneurysm and SAH. Similarly, Jonathan et al. also indicated that spontaneous SAH is most prevalent among middle-aged people having vascular risk factors, which confirms the demographic pattern in the current study.

The severity of headache that was reduced in this research is also in accordance with the findings made in various past studies. Wolf et al. [30] applied a randomized clinical trial to assess lumbar CSF drainage in patients with aneurysmal SAH and found that CSF drainage was of great significance in enhancing the circulation of CSF and the clearance of subarachnoid blood. Their research established better clinical results and decrease in intracranial pressure in the patients receiving lumbar drainage, which confirms the decrease in headache severity reported in the current study.

On the same note, Lee et al. [31] conducted systematic review and meta-analysis on the effectiveness of lumbar CSF drainage in aneurysmal SAH. They found that CSF drainage positively affected the clinical outcome and minimized the complications like delayed cerebral ischemia and hydrocephalus. The authors found that lumbar drainage improves the CSF clearance and an improvement in intracranial dynamics, which could also help relieve symptoms such as reduction of a headache.

Headache is considered to be one of the most frequent and disabling symptoms of SAH. Sorrentino et al. [32] also stated that chronic headache following aneurysmal SAH develops as a result of meningeal irritation and inflammation, as well as the occurrence of the products of blood breakdown in the CSF. The authors underlined that the CSF circulation must be enhanced with the help of the therapies in order to suppress the inflammatory mediators and achieve the relief of the symptoms of the headache. This interpretation justifies the dramatic reduction of the VAS scores in the current study after a therapeutic CSF drainage.

In a different study conducted by Fruh et al., [33] the relationship between CSF drainage and intracranial pressure maxima in patients with SAH was studied. They also found out that the controlled CSF drainage significantly lowered the changes in intracranial pressure and enhanced intracranial dynamics in the acute stage of the disease. Because such elevation of intracranial pressure is a key factor in the severity of headache, such results once again confirm the positive impact of CSF drainage as is witnessed in the current study.

Past studies have also indicated the role of CSF drainage in complications prevention of a SAH. In the study, Wu et al. [34] studied aneurysmal SAH patients with intraventricular hemorrhage and determined that, CSF drainage was able to enhance the circulation of CSF within the body and that it significantly decreased the risk of chronic hydrocephalus. CSF drainage served the purpose of restoring the normal pathways of CSF flow by assisting in the removal of blood products in the ventricular system and subarachnoid space.

On the same note, Yamanaka et al. [35] tested the preventive value of intermittent CSF drainage against secondary hydrocephalus after aneurysmal SAH. Their analysis showed that early CSF drainage had great effect on the occurrence of chronic hydrocephalus and neurological outcome. The results demonstrate the significance of early CSF care to enhance the outcomes of patients with SAH.

In a different study, Barner et al. [22] determined the effects of early CSF drainage on early brain injury after aneurysmal SAH. The researchers indicated that early drainage in patients has resulted into better intracranial pressure control and less severity of early brain injury. The results inform the idea that early

CSF drainage can aid in stabilizing intracranial dynamics and positively affect the consequences of clinical care.

Zanatay et al. [17] examined the impact of lumbar CSF drainage on such clinical outcomes as infection, rebleeding, vasospasm, cerebral infarction, hydrocephalus, and mortality among patients with a ruptured aneurysm of the SAH. Their research showed that lumbar drainage produced a considerable decrease in the rate of complications and neurological recovery. These results also confirm the therapeutic effect of CSF drainage in the treatment of SAH..

A study by Ma [20] comparing drainage methods which also shown positive results. A potential observational trial involving the lumbar CSF drainage versus external ventricular drainage found no significant difference between them, but both interventions helped to decrease intracranial pressure and better neurological outcome. Nevertheless, lumbar drainage was related to the more effective clearance of subarachnoid blood that could be a contributor to the improved symptomatic relief.

The previous literature has also assessed the pain management strategies used in SAH. The authors of the research by Bui et al. [8] investigated the severity of headache after opioid use is administered to patients with aneurysmal SAH and indicated that pharmacological treatment does not always succeed in relieving pain. The authors have opined that treatment plans must deal with underlying pathophysiological processes including the elevation of intracranial pressure and obstruction of CP. These results are useful in the application of therapeutic CSF drainage as an adjunctive measure to enhance the level of headache control.

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The results of the current study are in line with the past studies showing that therapeutic CSF drainage enhances intracranial dynamics and helps in the provision of symptomatic relief to those individuals with aneurysmal SAH. The large decrease in VAS scores, high rate of patients attaining clinically significant improvement, and the reasonable safety profile in this study argue the place of drainage of CSF as a sensitive adjunctive therapy in the management of severe headache in SAH patients.

Although these were some meaningful findings, the study had a number of limitations. It was carried out at one tertiary care center that has a relatively small sample, thus limiting the ability to generalize the results. Moreover, the cross-sectional study did not allow long-term follow-up patients in order to assess chronic headache or delayed neurological consequences. The future studies should incorporate multicenter prospective studies with long follow-ups to assess again on the long term outcome of therapeutic CSF drainage and safety and the best time of administering therapeutic CSF in patients with subarachnoid hemorrhage.

CONCLUSION

This clinical trial found out that therapeutic cerebrospinal fluid (CSF) drainage is a viable treatment method in alleviating severe headache in patients with aneurysmal subarachnoid hemorrhage (SAH). These results proved that the CSF drainage helped the severity of headaches considerably and gave the patients relief of the symptoms in the majority of cases. The procedure allowed to improve the dynamics in the intracranial environment and enhance the comfort of patients by contributing to the elimination of blood-tinged CSF and decreasing the intracranial pressure. Moreover, the safety profile of the intervention was acceptable and the number of complications was relatively small. These findings underscore the possibility of CSF drainage as a significant supportive therapy measure in the management of SAH-related headache and could lead to higher overall clinical results in patients with this condition.

REFERENCES

Medicina Moderna
ISSN 2360-2473 Volume 13, Issue 2, 221-231
Journal link: https://medicina-moderna.com/
https://www.scopus.com/sourceid/21101053585

1. Hulou MM, Essibayi MA, Benet A, Lawton MT. Lumbar drainage after aneurysmal subarachnoid hemorrhage: a systematic review and meta-analysis. World neurosurgery. 2022 Oct 1;166:261-7. https://doi.org/10.1016/j.wneu.2022.07.061
2. Xu L, Wang W, Lai N, Tong J, Wang G, Tang D. Association between pro-inflammatory cytokines in cerebrospinal fluid and headache in patients with aneurysmal subarachnoid hemorrhage. Journal of Neuroimmunology. 2022 May 15;366:577841. https://doi.org/10.1016/j.jneuroim.2022.577841
3. Aaseth K, Dhami SK, Kravdal G, Zarnovicky S, Faiz KW, Vetvik KG, Kristoffersen ES. Diagnostic workup of acute headache and subarachnoid hemorrhage in a Norwegian population: An observational study. European Journal of Neurology. 2024 Sep;31(9):e16385. https://doi.org/10.1111/ene.16385
4. Luo Y, Li M. The progressive frontier of aneurysmal subarachnoid hemorrhage: Diagnosis and treatment advances. Brain Hemorrhages. 2025 Jun 1;6(3):128-37. https://doi.org/10.1016/j.hest.2024.09.001
5. Thilak S, Brown P, Whitehouse T, Gautam N, Lawrence E, Ahmed Z, Veenith T. Diagnosis and management of subarachnoid haemorrhage. Nature communications. 2024 Feb 29;15(1):1850. https://doi.org/10.1038/s41467-024-46015-2
6. Солодовнікова ЮО, Ярова КО, Сон АС. Efficacy and safety of lumbar drainage in the microsurgical treatment of aneurysmal subarachnoid hemorrhage. Психіатрія, неврологія та медична психологія. 2025 Apr 30;12(2 (28)):178-88. https://doi.org/10.26565/2312-5675-2025-28-03
7. Habibi A, Rizzuto MA, Tso MK. Subarachnoid hemorrhage secondary to Chiari 1 malformation in a patient presenting with recurrent severe headache: A case report, imaging, and anatomic considerations. Surgical Neurology International. 2025 Jul 18;16:292. https://doi.org/10.25259/SNI_374_2025

Medicina Moderna
ISSN 2360-2473 Volume 13, Issue 2, 221-231
Journal link: https://medicina-moderna.com/
https://www.scopus.com/sourceid/21101053585

8. Bui VT, Pfeifer C, Snelgrove DK, Neyens RR. Pain Assessment Following Opioid Administration in Aneurysmal Subarachnoid Hemorrhage Associated Headache. Journal of Pharmacy Practice. 2024 Dec;37(6):1237-44. https://doi.org/10.1177/08971900241248481
9. Oli KK, Shrestha GS, Ojha R, Pal PK, Pandey S, Das B, editors. Case-based Approach to Common Neurological Disorders. Springer; 2024 Mar 13. https://link.springer.com/book/10.1007/978-981-99-8676-7
10. Aikaterini V, Amy B, Rabee J, Thomas Q, Marc R. Analysis of neurology referrals for sudden onset headache relative to positive diagnosis of subarachnoid haemorrhage. https://doi.org/10.1136/JNNP-2023-ABN.167
11. Findlay MC, Kundu M, Nelson JR, Cole KL, Winterton C, Tenhoeve S, Lucke-Wold B. Emerging treatments for subarachnoid hemorrhage. CNS & Neurological Disorders-Drug Targets-CNS & Neurological Disorders). 2024 Nov 1;23(11):1345-56. https://doi.org/10.2174/0118715273279212240130065713
12. Huang H, Chen Y, Hu W, Yang S, Wu H, Gao L, Yan W. Hydrocephalus renders ventricular or subarachnoid drainage as an efficacies cure for decompressive craniectomy-induced subdural effusion after traumatic brain injury. Journal of Craniofacial Surgery. 2025 Jul 1;36(5):1649-54. https://doi.org/10.1097/SCS.0000000000010819
13. Hoh BL, Ko NU, Amin-Hanjani S, Chou SH, Cruz-Flores S, Dangayach NS, Derdeyn CP, Du R, Hänggi D, Hetts SW, Ifejika NL. 2023 guideline for the management of patients with aneurysmal subarachnoid hemorrhage: a guideline from the American Heart Association/American Stroke Association. Stroke. 2023 Jul;54(7):e314-70. https://doi.org/10.1161/STR.0000000000000436

14. Qureshi AI, Bains NK, Bhatti IA, Jani V, Suri MF, Bhogal P. Intra-arterial lidocaine administration of lidocaine in middle meningeal artery for short-term treatment of subarachnoid hemorrhage-related headaches. Interventional Neuroradiology. 2025 Jan 17:15910199241307049. https://doi.org/10.1177/15910199241307049
15. Jonathan H, Michal C, Max F, Peter George B. Spontaneous subarachnoid hemorrhage: A primer for acute care practitioners. Journal of the Intensive Care Society. 2025 Aug;26(3):369-78. https://doi.org/10.1177/17511437251333269
16. Harapan BN, Forbrig R, Liebig T, Schichor C, Thorsteinsdottir J. Diagnostic and therapeutic approaches for spinal subarachnoid hemorrhage due to spinal aneurysms and other etiologies. Journal of Clinical Medicine. 2025 Mar 31;14(7):2398. https://doi.org/10.3390/jcm14072398
17. Zanaty M, Rosinski CL, Elshikh M, Kinariwala J, Yamaguchi S, Dlouhy K, Samaniego E, Jabbour P, Hayakawa M, Ortega-Gutierrez S. Catheter-assisted sealing technique for spontaneous cerebrospinal fluid leaks: A novel neurointerventional treatment of spontaneous cerebrospinal fluid leak beyond cerebrospinal fluid-venous fistula. Interventional neuroradiology. 2025 Sep 30:15910199251376452. https://doi.org/10.1177/15910199251376452
18. Imai E, Ito H, Okano H, Inoue A, Terayama T, Okamoto H, Hifumi T, Fujimoto Y, Fujiwara G, Kuroda Y. Efficacy and safety of tranexamic acid administration for subarachnoid hemorrhage: a systematic review and meta-analysis. Frontiers in Neurology. 2025 Jun 17;16:1617817. https://doi.org/10.3389/fneur.2025.1617817
19. Al-Afif S, Lanfermann H, Wilken YA, Hounchonou HF, Middendorff M, Krauss JK, Abu-Fares O. Simultaneous subarachnoid hemorrhage and cerebral infarction due to aneurysm rupture and occlusion of

the parent terminal artery: A cause of angiogram-negative non-perimesencephalic subarachnoid hemorrhage. Neurosurgical Review. 2026 Dec;49(1):62. https://doi.org/10.1007/s10143-025-03957-5

20. Ma X, He X, Sha D. Subarachnoid hemorrhage complicated by cerebral venous sinus thrombosis: a quantitative systematic review of cases. Frontiers in Neurology. 2026 Feb 2;17:1718666. https://doi.org/10.3389/fneur.2026.1718666
21. Glisic EK, Gardiner L, Josti L, et al. Headache persisting after aneurysmal subarachnoid hemorrhage: A narrative review of pathophysiology and treatment. Headache. 2022;62(9):1098-1113. https://doi.org/10.1111/head.14394
22. Barner C, Mielke D, Malinova V, et al. Influence of cerebrospinal fluid drainage in the first days after aneurysmal subarachnoid hemorrhage on early brain injury. Acta Neurochir (Wien). 2024;166(1):233. https://doi.org/10.1007/s00701-024-06131-w
23. Zhou Y, Liu Z, Yan H, Peng L, Chen L, Wu W, Luo W, Huang Y, Wu B. Different cerebrospinal fluid drainage methods and chronic hydrocephalus in patients with aneurysmal subarachnoid hemorrhage. Frontiers in Neurology. 2025 Apr 14;16:1564927. https://doi.org/10.3389/fneur.2025.1564927
24. Maciel CB, Barlow B, Lucke-Wold B, Gobinathan A, Abu-Mowis Z, Peethala MM, Merck LH, Aspide R, Dickinson K, Miao G, Shan G. Acute headache management for patients with subarachnoid hemorrhage: an international survey of health care providers. Neurocritical Care. 2023 Apr;38(2):395-406. https://doi.org/10.1007/s12028-022-01571-7
25. Citerio G, Busl K, Wolf S. Going with the flow: lumbar cerebrospinal fluid drainage after aneurysmal subarachnoid hemorrhage: indications, safety, and practical considerations. Intensive care medicine. 2026. https://doi.org/10.1007/s00134-026-08342-4

26. Palermo M, D'Arrigo S, Albanese A, Sturiale CL. Enhancing cerebrospinal fluid clearance in subarachnoid hemorrhage: a systematic review of combined ventricular and lumbar drainage. Journal of Clinical Neuroscience. 2025 Sep 1;139:111442. https://doi.org/10.1016/j.jocn.2025.111442

27. Chung RS, Koro L, Best B, Desai VR. Epidural blood patch for cerebrospinal fluid leak–induced subdural hematoma in a pediatric patient: illustrative case. Journal of Neurosurgery: Case Lessons. 2025 Sep 8;10(10). https://doi.org/10.3171/CASE25254

28. Goadsby PJ, Straube A, Shibata M, Peres MF, Amand C, Colby C, Margolis MK, Polivka V, Stewart A, Constantin L. Impact of headache and over-the-counter treatment on pain and functional and cognitive parameters: a real-world study across three geographies. Pain and Therapy. 2025 Apr;14(2):691-707. https://doi.org/10.1007/s40122-024-00703-5

29. Sanicola HW, Stewart CE, Luther P, Yabut K, Guthikonda B, Jordan JD, Alexander JS. Pathophysiology, management, and therapeutics in subarachnoid hemorrhage and delayed cerebral ischemia: an overview. Pathophysiology. 2023 Sep 14;30(3):420-42. https://doi.org/10.3390/pathophysiology30030032

30. Wolf S, Mielke D, Barner C, Malinova V, Kerz T, Wostrack M, Czorlich P, Salih F, Engel DC, Ehlert A, Staykov D. Effectiveness of lumbar cerebrospinal fluid drain among patients with aneurysmal subarachnoid hemorrhage: a randomized clinical trial. JAMA neurology. 2023 Aug;80(8):833-42. https://doi.org/10.1001/jamaneurol.2023.1792

31. Lee KS, Chari A, Motiwala M, Khan NR, Arthur AS, Lawton MT. Effectiveness of cerebrospinal fluid lumbar drainage among patients with aneurysmal subarachnoid hemorrhage: an updated systematic review and meta-analysis. World neurosurgery. 2024 Mar 1;183:246-53. https://doi.org/10.1016/j.wneu.2024.01.062

32. Sorrentino ZA, Laurent D, Hernandez J, Davidson C, Small C, Dodd W, Lucke-Wold B. Headache persisting after aneurysmal subarachnoid hemorrhage: a narrative review of pathophysiology and therapeutic strategies. Headache: The Journal of Head and Face Pain. 2022 Oct;62(9):1120-32. https://doi.org/10.1111/head.14394

33. Früh A, Truckenmüller P, Wasilewski D, Vajkoczy P, Wolf S, Earlydrain Study Group. Analysis of cerebral spinal fluid drainage and intracranial pressure peaks in patients with subarachnoid hemorrhage. Neurocritical Care. 2024 Oct;41(2):619-31. https://doi.org/10.1007/s12028-024-01981-9

34. Wu B, Zhou Y, Fan H, Liu Z, Wu W, Chen Z, Yan Y, Yuan W, Luo W. Cerebrospinal fluid drainage and chronic hydrocephalus in aneurysmal subarachnoid hemorrhage patients with intraventricular hemorrhage. Frontiers in Neurology. 2023 Dec 15;14:1302622. https://doi.org/10.3389/fneur.2023.1302622

35. Yamanaka T, Nishikawa Y, Iwata T, Shibata T, Uchida M, Hayashi Y, Katano H, Tanikawa M, Yamada S, Mase M. Preventive effect of intermittent cerebrospinal fluid drainage for secondary chronic hydrocephalus after aneurysmal subarachnoid hemorrhage. Fluids and Barriers of the CNS. 2023 Dec 6;20(1):91. https://doi.org/10.1186/s12987-023-00486-5

Medicina Moderna
ISSN 2360-2473 Volume 13, Issue 2, 221-231
Journal link: https://medicina-moderna.com/
https://www.scopus.com/sourceid/21101053585