Thai J Neurological Surg 2026: 17(1): 1 - 7

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Efficacy of a Rapid External Ventricular Drain (EVD) Weaning Protocol in Preventing EVD Associated Complications

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Abstract

Background: External ventricular drainage (EVD) is a temporary management in patients with acute obstructive hydrocephalus from various causes. However, prolonged EVD placement is associated with significant risk of EVD-associated complications. To mitigate these risks and expedite the weaning process, a rapid external ventricular drainage weaning protocol has been proposed as a potential solution. This research aims to evaluate the efficacy of such a weaning protocol in preventing EVD-associated complications and improving patient outcomes.

Methods: Between January 2020 and December 2023, a prospective cohort study was conducted in patients who underwent EVD placement. The rapid EVD weaning protocol was assigned in the cohort group. The rate of EVD-associated complications was compared to the historical control group.

Results: Sixty patients were divided into rapid or gradual EVD-weaning groups (n = 30 each). EVD-related infection and complications occurred in 3.3% vs 10%; p=0.612 and 23.3% and 40.0%: p=0.258 in the rapid and gradual groups, respectively. Secondary outcomes—VP shunt rate, hospital length of stay, ICU stay, and EVD duration—did not differ significantly between groups. Only EVD-weaning duration was shorter with rapid weaning (4.4 vs 7.61 days; p=0.002).

Conclusion: The results indicate that rapid EVD weaning may shorten the weaning process without adversely affecting clinical outcomes or increasing complication rates. Confirmation in larger, adequately powered studies with extended follow-up is needed to define its role in neurocritical care.

Keywords: External ventricular drainage; Hydrocephalus; Neurosurgical patients; Infection

Received: September 8, 2025 | Revised: November 5, 2025 | Accepted: November 8, 2025

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Introduction

External ventricular drainage (EVD) is a standard intervention for the management of acute neurosurgical conditions, including obstructive hydrocephalus, aneurysmal subarachnoid hemorrhage (SAH), intraventricular hemorrhage (IVH) or traumatic brain injury (TBI). Although effective for intracranial pressure (ICP) control and cerebrospinal fluid (CSF) diversion, prolonged EVD placement increases the risk of complications—including EVD-related infection and EVD-related complications (CSF leakage, occlusion, displacement, and overdrainage)—which may extend hospitalization, escalate healthcare costs, and worsen clinical outcomes.[1]

Following resolution of the primary indication for EVD placement, the catheter should be weaned and removed as early as feasible, as the risk of ventriculostomy-associated infection (meningitis/ventriculitis) and other complications increase with dwell time.[2,3] To mitigate these risks and improve outcomes, rapid EVD-weaning protocols have been adopted to facilitate timely catheter removal, thereby reducing dwell time and associated complications.

This study aims to investigate the efficacy of a rapid EVD weaning protocol in reducing EVD-associated complications compared with standard (gradual) weaning. By comparing patient outcomes across protocols, thereby delineating the clinical utility of structured EVD weaning strategies.

Materials and Methods

Patient population

This prospective cohort study was conducted in the neurosurgical critical care unit of a tertiary referral hospital. The protocol was approved by the Research Ethics Committee of Chiang Mai University Hospital (Study code: SUR-256408108). Adults (≥18 years) treated between January 2020 and December 2023 were included in the rapid EVD-weaning cohort if they met all of the following criteria: diagnosis of acute obstructive hydrocephalus; placement of an external ventricular drain (EVD); no history of prior brain surgery; and no clinical evidence of central nervous system infection. A matched historical control cohort managed with gradual EVD weaning was constructed by matching on age, diagnosis, and Glasgow Coma Scale score

Intervention

The rapid EVD-weaning protocol entailed immediate clamping with continuous ICP monitoring once the indication for EVD placement had resolved, as determined by senior neurosurgical staff. If ICP exceeded 20 mm Hg for more than 5 minutes, the EVD was opened at 10 cm above the external acoustic meatus (EAM) for 5 minutes or until 10 mL of CSF had drained, whichever occurred first. A maximum of three releases per day was permitted; if additional releases were required, continuous drainage at 10 cm above the EAM was maintained until the following day. The protocol was implemented as individualized 2- or 5-day plans. At completion, a head CT was obtained to exclude hydrocephalus.

In contrast, the gradual EVD-weaning protocol consisted of stepwise elevation of the drainage height in 5-cm increments to 20 cm above the EAM, followed by clamp trials with ICP monitoring to assess readiness for removal. Decisions to continue or discontinue the EVD were based on clinical judgment, with head CT obtained selectively to confirm suitability for removal. (Table 1)

Table 1 A comparison between the rapid and gradual EVD weaning protocol.

Rapid EVD weaning	Gradual EVD weaning
Immediate clamping of EVD	Progressive increase in drainage levels at 5 cm intervals until reaching a level 20 cm above the EAM.
If ICP ≥ 20 mmHg for more than 5 minutes, the EVD is released for 5 minutes at a level 10 cm above the EAM or if drainage ≥ 10 ml.	Clamping was initiated for ICP monitoring and decision regarding EVD discontinuation or VP shunt were relied upon clinical judgment and expert opinions.
If released exceeded 3 times/day, continuous releasing was carried out.	
Tailored to each patient, the rapid EVD weaning protocol encompassed 2 and 5-day plans, if the weaning failed, VP shunt was indicated.	

Data Collection and Statistical Analysis

General demographic characteristics, primary diagnoses, and outcomes—including EVD-related complication rates (which include CSF leakage, occlusion, displacement, and overdrainage), hospital and ICU length of stay, shunt placement rate, EVD dwell time, and EVD weaning duration—were collected. Medical records were systematically reviewed on an individual basis to ensure data accuracy and appropriate matching of demographic variables. Analyses were performed using Stata version 16, with statistical significance defined as two-sided $p<0.05$. Baseline characteristics were summarized using descriptive statistics: categorical variables as counts (percentages) and continuous variables as mean±SD for normally distributed data or median (interquartile range) otherwise. Between-group differences were assessed using Student's t test or Wilcoxon rank-sum test for continuous variables and the chi-square test for categorical variables.

Results

Baseline characteristics

Sixty patients were enrolled, comprising 30 in the rapid EVD-weaning group and 30 matched controls. The groups were comparable at baseline, with no significant differences in age, sex, admission Glasgow coma score, or indication for EVD placement. (Table 2)

Outcomes

The primary outcome were the rates of EVD-related infection and EVD-related complications. EVD-related infection occurred in 1/30 patients (3.3%) in the rapid-weaning group and 3/30 (10.0%) in the gradual-weaning group; the difference was not statistically significant ($p=0.612$). EVD-related complications occurred in 7/30 (23.3%) versus 12/30 (40.0%), respectively, also without a significant difference ($p = 0.258$).

Secondary outcomes included VP shunt placement, hospital and ICU length of stay, total EVD dwell time, and EVD weaning duration. Hospital

Table 2 Baseline characteristics of the patients in both group.

Parameters	Rapid EVD weaning Group (N=30)	Gradual EVD weaning group (N=30)	p-value
Age (years), Mean (±SD)	57.97 (15.97)	59.10 (15.08)	0.779
Sex, N(%)			
Male	10 (33.3)	12 (40.0)	0.789
Female	20 (66.7)	18 (60.0)	
GCS Admission Mean (±SD)	7.79 (2.67)	7.80 (2.77)	0.969
Indication for EVD placement, N(%)			
Ruptured intracranial aneurysm	12 (40.0)	13 (43.3)	0.885
Hemorrhagic stroke	4 (13.3)	5 (16.7)	
Brain tumor	14 (46.7)	12 (40.0)	

and ICU length of stay and EVD dwell time did not differ significantly between groups. EVD weaning duration was significantly shorter in the rapid-weaning group (4.40 vs 7.61 days; p=0.002). VP shunt rates were equal in both groups (23.3% vs 23.3%; p=1.00). (Table 3)

Discussion

An external ventricular drain (EVD) is a valuable intervention for neurosurgical patients with acute obstructive hydrocephalus arising from various etiologies, particularly brain tumors and hemorrhagic stroke (SAH or IVH). It is also indicated in traumatic brain injury patients who require intracranial pressure monitoring. However, prolonged EVD placement may result in adverse events, notably EVD-related infection and complications.[4,5] Efforts to reduce these risks are highly valuable, particularly in resource-limited settings. In a study by Poblete et al., the EVD-related infection rate among patients with aneurysmal SAH was 7.3%, with an associated mortality rate of 19.8%.6 Holloway et al. demonstrated a positive association between EVD dwell time and infection risk, which increased over the first 10 days, leading to recommendations for removing EVD catheters as soon as clinically feasible.[7]

There is no consensus on a standard EVD weaning protocol, and practice frequently depends on individual clinician preference. Several groups have proposed rapid weaning protocols with variable efficacy.[8–12] Although prior studies have explored rapid weaning, our protocol is uniquely tailored to local clinical practices and resource constraints, and provides a reproducible framework for low-resource settings. In our study, the EVD-related infection rate was lower in the rapid weaning group compared with the gradual weaning group (3.3% vs 10.0%; p = 0.612), although this difference was not statistically significant, the lower infection rate in the rapid weaning group may be due to reduced EVD exposure time. This finding is consistent with results from Rao et al., who reported infection rates of 1.3% versus 8.8% (p = 0.315) for rapid versus gradual weaning, respectively. Although the overall rate of EVD-related complications

Table 3 A comparison of outcomes between the rapid and gradual EVD weaning protocol.

	Rapid EVD weaning protocol (N=30)	Gradual EVD weaning protocol (N=30)	*p-value*
EVD-related infection, N(%)			0.612
Yes	1 (3.3)	3 (10.0)	
No	29 (96.7)	27 (90.0)	
EVD-related complication, N(%)			
Yes	7 (23.3)	12 (40.0)	0.258
No	23 (76.7)	18 (60.0)	
Length of hospital stay (day) (±SD)	21.34 (3.97)	25.86 (4.53)	0.188
ICU stay (day) (±SD)	16.50 (5.52)	15.30 (6.28)	0.718
Total EVD dwell time (day) (±SD)	12.45 (4.43)	12.36 (4.97)	0.899
EVD weaning duration (day) (±SD)	4.40 (2.26)	7.61(3.81)	0.002
Rate of VP shunt, N(%)	7 (23.3)	7 (23.3)	1.000

* p <0.05

did not differ significantly between the groups (23.3% vs 40.0%; p = 0.258), subgroup observation suggested higher frequencies of cerebrospinal fluid leakage and catheter occlusion in the gradual weaning group. These trends warrant further investigation.

Prior studies have reported that rapid weaning is associated with shorter hospital and ICU lengths of stay and reduced mean EVD dwell time. In our cohort, however, none of these outcomes differed significantly between groups. Consistent with previous study[8,11] the EVD weaning interval was significantly shorter with rapid weaning (4.40 vs 7.61 days; p = 0.002). Some studies have also reported lower ventriculoperitoneal (VP) shunt placement rates with rapid weaning[11,12], whereas we observed no between-group difference. Taken together, these findings suggest that strict implementation of a rapid-weaning protocol may reduce healthcare provider workload, minimize invasive monitoring, and lower healthcare costs without increasing the risk of clinical deterioration.

This study has several limitations. First, the relatively small sample size reduced the statistical power to detect between-group differences. Second, heterogeneity in the primary indications for EVD placement, peri- and postoperative care, and the criteria for obtaining pre-discontinuation CT imaging between the prospectively enrolled rapid-weaning cohort and the historical control group may have introduced bias. Finally, long-term follow-up to determine the incidence of late shunt dependence was not available. Therefore, larger, multicenter RCTs with blinded outcome assessment, standardized complication criteria, and cost-effectiveness analyses are warranted.

Conclusion

Our study found that rapid EVD weaning shortened the weaning period by more than 3 days without evidence of worse outcomes compared with gradual weaning and showed trends toward lower infection and complication rates. Larger studies with longer follow-up are needed to confirm efficacy; evaluations of cost-effectiveness and healthcare provider satisfaction may further inform standardized EVD management guidelines.

Disclosure Statement

The author(s) have no competing interests to disclose.

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