Natural History of Subarachnoid Hemorrhage - A Case Report in Developing Country

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ABSTRACT

Stroke is the second leading cause of death and a significant factor in global disability. Its incidence is highest in developing nations, with ischemic strokes being the most prevalent. Only about 10% to 15% of first-time strokes are Intracerebral Hemorrhages (ICH). Primary hemorrhages make up the majority of strokes, while secondary hemorrhages account for roughly 10–25%. Hydrocephalus is a common complication of aneurysmal subarachnoid hemorrhage (aSAH). Additionally, the presence of hydrocephalus can indicate a greater likelihood of poor outcomes following an ICH. This case explains the natural history of subarachnoid and its management outside of developing countries. VP shunts are often used to treat post-hemorrhagic hydrocephalus, as was done in this case. Rebleeding after VP shunt placement is common. Therefore, appropriate management is needed to prevent increased mortality. Although proper management requires high costs in developing countries.

Keywords: VP shunt, obstructive hydrocephalus, subarachnoid hemorrhagic

Introduction

Stroke ranks among the top three causes of death and disability worldwide. While only about 10% to 15% of initial strokes are intracerebral hemorrhages (ICHs), they result in

notably higher rates of disability and mortality. Hydrocephalus can develop in over 50% of patients who experience intraventricular hemorrhage (IVH), a condition often secondary to ICH[1].

Hydrocephalus can be an indicator of poor outcomes following an ICH. VP shunt helps lower the rates of morbidity and mortality associated with post-hemorrhagic conditions[2]. complications such as rebleeding in VP Shunt often occur. Therefore, proper management is needed to prevent rebleeding. However, the management that should be done to prevent rebleeding is expensive in developing countries. In this case, the management that should be done to prevent rebleeding is explained.

Case Illustration

A 43-year-old man came with decreased consciousness since 4 pm on September 9, 2024, which suddenly occurred after his daily activities. the patient suddenly fell down. Previously the patient complained a very severe headaches and nausea with vomiting. The patient also complained of tingling in the right side of the body in the past two days ago. There was no history of trauma. The patient had a history of hypertension, gout, cholesterol and GERD.

Then the patient went to Leuwiliang Hospital and underwent physical examination, hematology and CT scan. The result of the physical examination showed that GCS 8 (E2V2M4), blood pressure 160/89. The patient's heart rate is 109 bpm, respiratory rate is 20 breaths per minute, temperature is 36.0°C, and oxygen saturation is 100% on room air. Neurological assessment revealed equal, round pupils measuring 2 mm in both eyes, with positive direct and indirect light reflexes on both sides. Motor examination showed right-sided hemiparesis, and sensory testing indicated that the patient still responded to pain stimuli. The hematology results showed an increase in leukocyte, an increase in neutrophils, a decrease in lymphocytes, and an increase in SGPT results. The CT scan results were shows there is a diffuse hemorrhage pattern throughout the basal cistern and bilateral sylvian fissures and hyperdens shadow that indicate subarachnoid hemorrhage (figure 1). Then he was consulted with a neurosurgeon and referred to Cileungsi Hospital to undergo a VP shunt procedure.

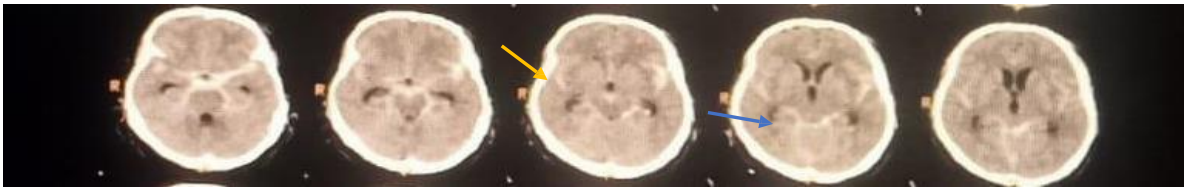

Figure 1. CT scan non contras (blue arrow = diffuse hemorrhage pattern throughout the basal cistern, yellow arrow = bilateral sylvian fissures).

VP Shunt was performed one day after the patient came to the hospital. After the VP shunt surgery, the vital signs showing blood pressure: 90/56 mmHg, pulse: 69x/min, respiratory rate: 20x/min, temperature: 36^0C. The patient still had a headache one day after surgery. The headache was worsened by coughing. Then a CT scan was performed again on the patient after surgery. The CT scan shows intraparenchymal hemorrhage in the left temporal lobe with perifocal edema causing obstructive hydrocephalus and intraventricular hemorrhage (yellow arrow).

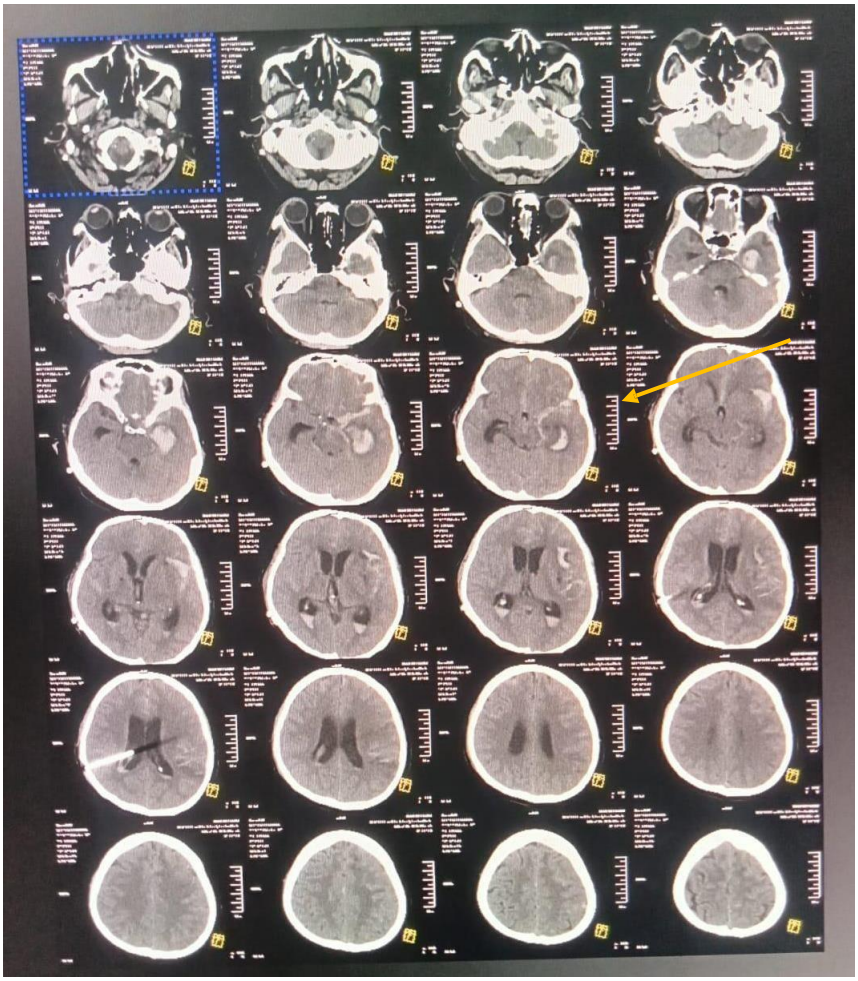

Figure 2. CT scan non contras after VP Shunt procedure (yellow arrow = intraparenchymal hemorrhage).

Then the patient's condition worsened on September 17 (7 days post operative), when the patient became unconscious and was then taken to the ICU. The patient GCS was 4 (E2M1V1). During the ICU the patient did not experience much progress, then the patient was declared dead 9 days later

Table 1. Clinical Symptoms after VP Shut procedure.

Day 1	Headache, GCS 15
Day 2	Headache, GCS 15
Day 3	Headache, GCS 15
Day 4	Headache, GCS 15
Day 5	No complaints, GCS 11 (E3V3M5)
Day 6	No complaints, GCS 11
Day 7	No complaints, GCS 11
Day 8	GCS 4 (E1V2M1)
Day 9	GCS 4
Day 10	GCS 4
Day 11	GCS 4
Day 12	GCS 4
Day 13	GCS 4
Day 14	GCS 3
Day 15	GCS 3
Day 16	GCS 3

Discussion

Hydrocephalus is frequently linked to ICH. As many as 50% of patients with IVH resulting from ICH could develop hydrocephalus. The most prevalent modifiable risk factor for ICH is hypertension[3]. About 85% of ICH cases are primary, caused by the rupture of small penetrating arteries and arterioles, which are typically weakened by chronic hypertension. The mortality rate of ICH is about 40% within the first 30 days, making it one of the most fatal acute medical conditions[1].

Hydrocephalus can cause brain damage through various mechanisms, such as inflammation, ventricular enlargement that affects periventricular fibers, and increased intracranial pressure, which decreases cerebral perfusion[4].

The VP shunt is frequently used in the management of post-hemorrhagic hydrocephalus. Despite significant progress in shunt technology and treatment techniques, a definitive, optimal approach to managing hydrocephalus has not yet been established. Consequently, VP shunting remains the preferred and widely used method for managing hydrocephalus, especially in post-hemorrhagic cases in adults, due to its efficiency in urgent treatment needs and cost-

effectiveness[5-6].

The pathogenesis of subarachnoid hemorrhage (SAH) and the decision to perform a ventriculoperitoneal (VP) shunt involves several stages[7].

Initiation of SAH

Rupture of a cerebral aneurysm often begins with hemodynamic stress, which is a key factor in the formation of intracranial aneurysms (IA). Large, enraptured aneurysms can compress surrounding brain tissue, leading to neurological symptoms. Elevated blood pressure and other risk factors increase hemodynamic stress on vessel walls, which promotes both the formation and rupture of IAs. Research consistently highlights inflammation as a primary factor in IA development; hemodynamic stress triggers an inflammatory response that activates matrix metalloproteinases (MMPs), leading to degradation of the extracellular matrix and apoptosis of smooth muscle cells (SMCs)—the main matrix-producing cells in the vascular wall. This process weakens the arterial wall, causing dilation, aneurysm formation, and eventual rupture.

Trauma: Alternatively, SAH can result from head trauma, which causes direct damage to blood vessels.

Hemorrhagic stroke causes bleeding in the subarachnoid space and causes obstruction of cerebral spinal fluid flow and absorption at subarachnoid granulation then causes hydrocephalus obstructive and decreased consciousness. In addition, bleed into subarachnoid space it can also cause an increase in blood volume causing vessels and meninges to stretch suddenly, causing thunderclap headache Then it can cause reduced cerebral blood flow and increased dilation of cranial blood vessels and cause an increase in internal carotid arteries and increased intracranial pressure, if it affects the middle cerebral artery it can cause motor strip ischemia and cause hemiparesis. Unilateral hemiparesis occurs when one side of the body experiences weakness, typically due to disruption in the neural pathways that control motor function[8].

Middle cerebral artery is one of the major arteries that branches from the internal carotid artery and travels laterally to the brain. It primarily supplies[9].

- Lateral Surface of the Cerebral Hemisphere: This includes parts of the frontal lobe, parietal lobe, and temporal lobe.
- Frontal Lobe Areas: The MCA supplies the lateral portions of the frontal lobe, including regions involved in motor control, language (in the dominant hemisphere), and higher cognitive functions.

Blood in the subarachnoid space triggers both local and systemic inflammatory responses. Acute brain injury leads to the release of pro-inflammatory cytokines, and the resulting stress response raises catecholamine levels, further stimulating immune activation. An elevated WBC count, one of the earliest indicators, is closely associated with a higher risk of vasospasm and cerebral ischemia after SAH and has been confirmed as an independent risk factor[7].

When blood enters the subarachnoid space, it prompts a systemic inflammatory response, leading to an increase in neutrophils and a decrease in lymphocytes. These changes are associated with the severity of tissue inflammation and hemorrhagic irritation. This response is triggered by the rapid release of significant amounts of endogenous catecholamines, corticosteroids, and other cytokines. Neutrophils contribute to the inflammatory response, while lymphocytes are key in anti-inflammatory and endothelial protective roles[10].

Elevated serum SGPT (also known as ALT or alanine aminotransferase) levels in the context of subarachnoid hemorrhage (SAH) may occur due to several reasons, one of which is: Hepatic Hypoxia: During SAH, there may be decreased blood flow or oxygen supply to the liver due to systemic changes, leading to liver cell damage and increased SGPT levels. Subarachnoid hemorrhage causes ischemia in the posterior hypothalamus and can cause decreased blood flow and oxygen, output and causes syncope (loss of consciousness due to decreased blood flow)[11].Ventriculoperitoneal shunt (VPS) is an effective treatment for hydrocephalus that is generally well tolerated by patients. The greatest benefits from surgery are typically seen within the first six months, particularly in improving gait disturbances. Long-term control of the Hakim triad is largely sustained, highlighting the significant positive effects of VPS treatment. However, one drawback of VPS is the need for shunt revision due to shunt failure. The overall incidence of shunt revision in adult patients with hemorrhage-related hydrocephalus is 51.9%, with most revisions occurring within the first six months post-procedure. When a VP shunt fails in adults, it necessitates neurosurgical intervention.

Delayed cerebral ischemia (DCI) typically occurs three days after an event and can persist for up to 21 days. It is attributed to factors such as vasospasm, increased apoptosis, breakdown of the blood-brain barrier (BBB), microthrombosis, microcirculatory dysfunction, and cortical spreading depression (CSD). DCI is primarily associated with the narrowing of cerebral arteries that begins days after an aneurysmal subarachnoid hemorrhage (aSAH), a phenomenon known as cerebral vasospasm. Clinical deterioration due to DCI is characterized by focal neurological deficits or a reduction of at least 2 points on the Glasgow Coma Scale (GCS). Following hemorrhage, the toxicity of free hemoglobin, along with transient global ischemia, contributes to vasoconstriction and neuronal dysfunction. Modulation of the nitric oxide pathway is a key

aspect of DCI, marked by decreased nitric oxide production and increased scavenging, which connects vascular dysfunction to inflammation and cortical spreading ischemia[12].

A decrease in the Glasgow Coma Scale (GCS) after a ventriculoperitoneal (VP) shunt in a patient with subarachnoid hemorrhage (SAH) can occur due to several reasons, include Rebleeding, which can exacerbate symptoms and lead to a decline in neurological status. The cumulative incidence of rebleeding following subarachnoid hemorrhage (SAH) in the first 72 hours is estimated to be between 8% and 23%. Research indicates that 50% to 90% of rebleeding incidents take place within the first 6 hours after the initial hemorrhage[13]. Rebleeding following the start of cerebrospinal fluid (CSF) drainage may occur due to abrupt fluctuations in transluminal pressure affecting the already compromised and sensitive wall of the aneurysm. This disruption can destabilize the previously stable local anatomical environment after aSAH. Alongside a larger aneurysm size, other previously identified risk factors can also contribute to this risk[3].

Patients with aneurysmal subarachnoid hemorrhage (aSAH) who have had their aneurysms repaired should receive imaging around the time of surgery to detect any residual or recurrent aneurysms, as these can lead to rebleeding. Although major randomized clinical trials like ISAT have examined rebleeding, intraoperative and postoperative imaging was only necessary for endovascular procedures. While imaging has been studied for surgically clipped aneurysms, it has not specifically focused on assessing the risk of rebleeding in cases of ruptured aneurysms[2].

The approach to preventing bleeding is informed by high-quality randomized controlled trials (RCTs), notably the ULTRA trial (Ultra-Early Tranexamic Acid After Subarachnoid Hemorrhage), which evaluated ultra-early, short-term antifibrinolytic therapy in patients with aSAH. However, the ULTRA trial did not demonstrate a significant decrease in rebleeding rates and showed no improvement in functional outcomes for patients treated with tranexamic acid compared to those who did not receive antifibrinolytic therapy. Treatment with tranexamic acid began a median of 185 minutes after symptom onset and continued until aneurysm repair, lasting up to 24 hours. The rebleeding rates were 10% in the tranexamic acid group and 14% in the control group[2].

Early intervention for ruptured aneurysms reduces the risk of rebleeding and helps manage delayed cerebral ischemia (DCI). The timing of treatment for ruptured aneurysms has been directly examined in just one small randomized prospective trial involving patients with good grade aSAH during the precoiling era. This study, which included 159 patients, found that early surgery (within 0–3 days post-SAH) resulted in lower rates of death and dependency at

three months compared to surgery performed at intermediate (4–7 days) or late (≥8 days) stages. Meta-analyses of these studies and individual case series support the benefits of early treatment, even for high-grade aSAH patients. Overall, the data suggest no significant difference in long-term functional outcomes between patients who underwent primary coiling and those who had clipping[2].

Acute subarachnoid hemorrhage (aSAH) accompanied by acute symptomatic hydrocephalus requires prompt management through cerebrospinal fluid (CSF) diversion, such as external ventricular drainage (EVD) or lumbar drainage, to enhance neurological status. Studies have demonstrated that lumbar drainage of CSF following aSAH can decrease the incidence of delayed cerebral ischemia (DCI) and lead to improved early clinical outcomes[2].
Persistent or chronic shunt-dependent hydrocephalus associated with acute subarachnoid hemorrhage (aSAH) occurs in 8.9% to 48% of patients. However, the literature outlining the criteria for the placement of a permanent ventriculoperitoneal (VP) shunt is limited. Important predictors of shunt dependency include poor neurological status at admission, advanced age, acute hydrocephalus, high Fisher grades, intraventricular hemorrhage, rebleeding, ruptured aneurysms in the posterior circulation or anterior communicating artery, surgical clipping, endovascular coiling, cerebral vasospasm, meningitis, and a prolonged period of external ventricular drainage (EVD)[2].

Conclusion

The placement of a ventriculoperitoneal (VP) shunt is the most commonly employed treatment for hydrocephalus. complications such as rebleeding in VP Shunt often occur. However, the management that should be done to prevent rebleeding is expensive in developing countries. Management should include endovascular procedures such as coiling or clipping for management of subarachnoid hemorrhage which is usually caused by ruptured aneurysm but this cost expensive. An EVD should be performed for hydrocephalus treatment. Chronic hydrocephalus requires permanent cerebrospinal fluid (CSF) diversion through a ventriculoperitoneal shunt (VPS), but certain criteria must be met.

Ethical Approval

Institutional board approval not required.

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Conflict of Interest

There are no conflicts of interest.

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