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Outcome of Lumbar Drain in Delayed Communicating Hydrocephalus Secondary to Traumatic and Aneurysmal Subarachnoid Hemorrhage

Abstract

Introduction: Delayed hydrocephalus is one of the common complications in traumatic subarachnoid hemorrhage and post aneurysmal subarachnoid hemorrhage. This study aims to study the role of lumbar drain in its management.

Methods: This is a retrospective study of cases of delayed hydrocephalus which were managed with lumbar drain between March 2009 to February 2019. Computed tomogram or Magnetic Resonance Imaging was used in the diagnosis of delayed hydrocephalus and lumbar drain was inserted. A repeat Computed tomogram scan was performed, and the absence of delayed hydrocephalus was the indication for removal.

Results: A total of 40 cases of delayed hydrocephalus were managed with lumbar drain during the study period. Traumatic subarachnoid hemorrhage was the cause of delayed hydrocephalus in 16 cases and the remaining 24 cases were due to post aneurysmal subarachnoid hemorrhage. The most common Fischer grade was III in aneurysm and II in trauma. Delayed hydrocephalus occurred within two to four weeks in aneurysm cases and after four weeks in traumatic cases. All aneurysm was managed with clipping whereas craniotomy or decompressive craniectomy was done in traumatic cases. 92.5% of cases improved after lumbar drainage of the hydrocephalus.

Conclusion: This study reports the use of lumbar drain to treat delayed post subarachnoid hemorrhage hydrocephalus in a clinically-cost-effective way with minimal complications. Randomized studies to compare methods to treat delayed hydrocephalus will overcome the limitations of this study. Till then lumbar drain remains a safe alternative in communicating delayed hydrocephalus secondary to subarachnoid hemorrhage.

Key words: Cerebrospinal fluid, External ventricular drain, Hydrocephalus, Lumbar drain, subarachnoid hemorrhage, Traumatic brain injury

Introduction

Delayed hydrocephalus (DH) is one of the common complications in both traumatic subarachnoid hemorrhage (tSAH) and post aneurysmal subarachnoid hemorrhage (aSAH). The incidence is around 11 to 20% for aSAH and 19 to 40% for tSAH.[1-4] Increasing age, intraventricular hemorrhage, decompressive craniectomy, Fischer grade and aneurysms located in the basal cisterns are factors leading to DH.[4-11]

Management of DH is either by inserting external drains or Ventriculo-peritoneal (VP) shunt.[6-8] Lumbar drain (LD) is one of the simplest, fastest, effective, economical methods that removes the blood and helps in the circulation of cerebrospinal fluid to reduce hydrocephalus.[6,12,13] LD although simple can cause complications which include infection, dislodgement, neurogenic pain, tentorial herniation, syringomyelia, headache and pneumocephalus.[2,9]

This study aims to study the outcome of lumbar alone in DH and the author believes that this is the first study to be reported from Nepal. The outcome of LD and the benefit is discussed further.

Methods and Materials

This is a descriptive cross-sectional study of all cases who underwent LD for DH secondary to aSAH or tSAH in this center from February 2009 to February 2019. The case records and discharge reports were searched and eligible cases were included. The age, type of SAH, sex, Fischer grade, clinical features, location of aneurysm, Glasgow Coma Scale (GCS) at admission and discharge and week of development of DH were analyzed. Computed tomogram (CT) or Magnetic Resonance Imaging (MRI) was used in the diagnosis of DH using Bicaudate or Evans Index.

Inclusion criteria:

Cases that presented with hydrocephalus at presentation were excluded from the study. Presence of DH with abnormal Bicaudate or Evans Index, and radiological features of communicating hydrocephalus, with one or more of the following was a definitive indication for LD.

- Radiological periventricular hypo-density or hyper-intensity
- Fall in consciousness level
- New onset-seizure
- Bladder incontinence
- Change in gait or personality along with DH

Ethical clearance from the hospital board, informed consent was taken from patients, LD inserted and cerebrospinal fluid (CSF) drained at rate equal to 15-20 ml/hour by monitoring in a closed graduated drainage system. CSF study was done every third day to rule out infection. Secure taping and fixation of the LD was done to avoid inadvertent displacement. A repeat CT scan was performed on the fourth day. If reduction in the DH was noticed using the Bicaudate or Evans Index, the LD was kept at bed level for 24 hours followed by clamping for another 24 hours and CT repeated. LD was kept for an average of six days. Absence of DH was an indication for removal. The cases were then followed at one, three and six months. Data was calculated using Statistical Package for the Social Sciences (SPSS) version 21 (IBM corporation).

Results

A total of 40 cases of DH were managed with LD during the study period. LD was successful in treating the DH in 37 cases (92.5%), except for three postoperative cases which underwent VP shunt. The GCS was 15 in all cases at discharge. There was no complication associated with LD and neither was there a need for serial LD insertion. tSAH was the cause of DH in 16 cases and the rest 24 cases were due to aSAH (Table 1).

The commonest complaint at diagnosis was headache followed by decompressive defect bulge, drop in GCS, lethargy, decreased appetite, gait imbalance, increased drowsiness and three cases having seizure and bladder incontinence each.

Aneurysmal SAH: In cases with aSAH the majority were female (M:F=7:17), and the age ranged from 22 to 56 years. Most cases were in Fischer grade III (present in 15 cases) and the rest in grade I and IV. The occurrence of DH was maximum within two to four weeks (13 cases) followed by <2 or >4 weeks in the remaining. At diagnosis majority had GCS>8 score (18 cases). All aneurysms were in the anterior circulation (anterior communicating-10, posterior communicating-4, internal carotid-7 and middle cerebral-3) and they were all managed with microsurgical clipping. Lamina terminalis was opened in eight cases. One case underwent VP shunting.

Traumatic SAH: In cases secondary to tSAH the age ranged from 18 to 45 years. The commonest case of injury was road traffic accident. Trauma was more common in males (M:F=13:3). The left side was more common (11 cases) than right. At admission GCS was <8 in 10 cases and 6 had >8. Majority had Fischer grade of II (6 cases) followed by other grades. DH was present after four weeks in majority (9 cases) followed by two to four weeks and <2 weeks in the remaining. Acute subdural hematoma and fronto-temporal contusion was associated in seven cases and the rest were in decompressive craniectomy for severe brain injury. Two cases underwent VP shunting and the remaining cases underwent cranioplasty at a later follow-up date after the DH had subsided.

Follow-up ranged from three months to five years with no recurrence of DH. In this study there was only one failure of LD necessitating the use of EVD in a postoperative case of acute subdural hematoma. The patient had features of meningitis which was managed by EVD first followed by VP shunt.

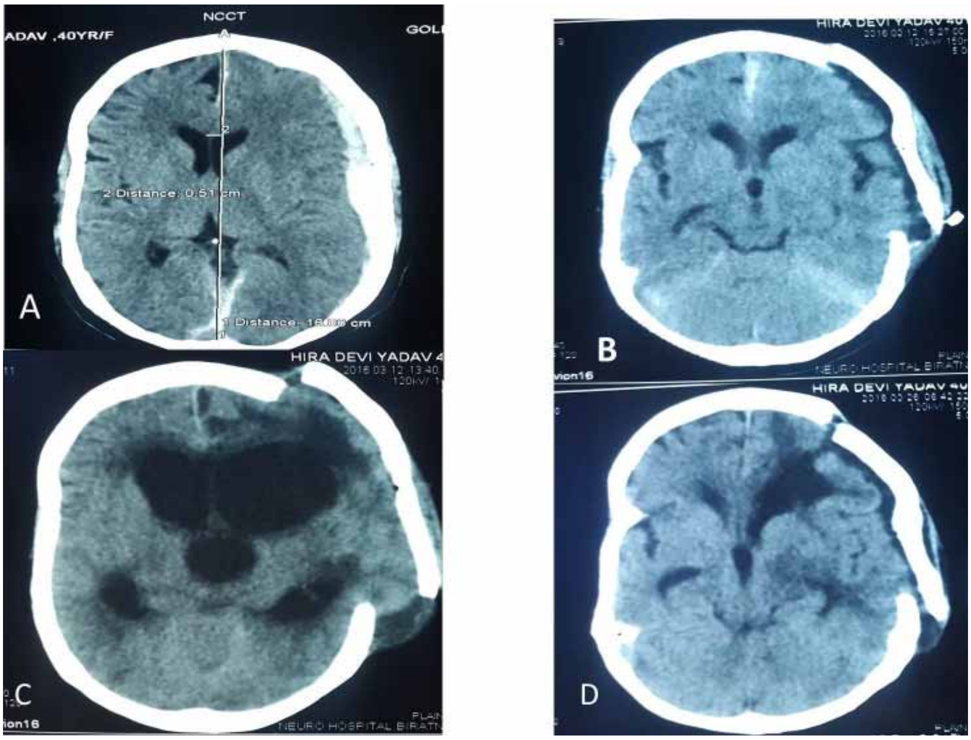

Figure 1: Sequential development of DH in a postoperative case of acute subdural hematoma
(A- preoperative scan showing acute left subdural hematoma; B- postoperative scan at 72 hours; C- DH at four weeks; D- post LD showing absence of DH)

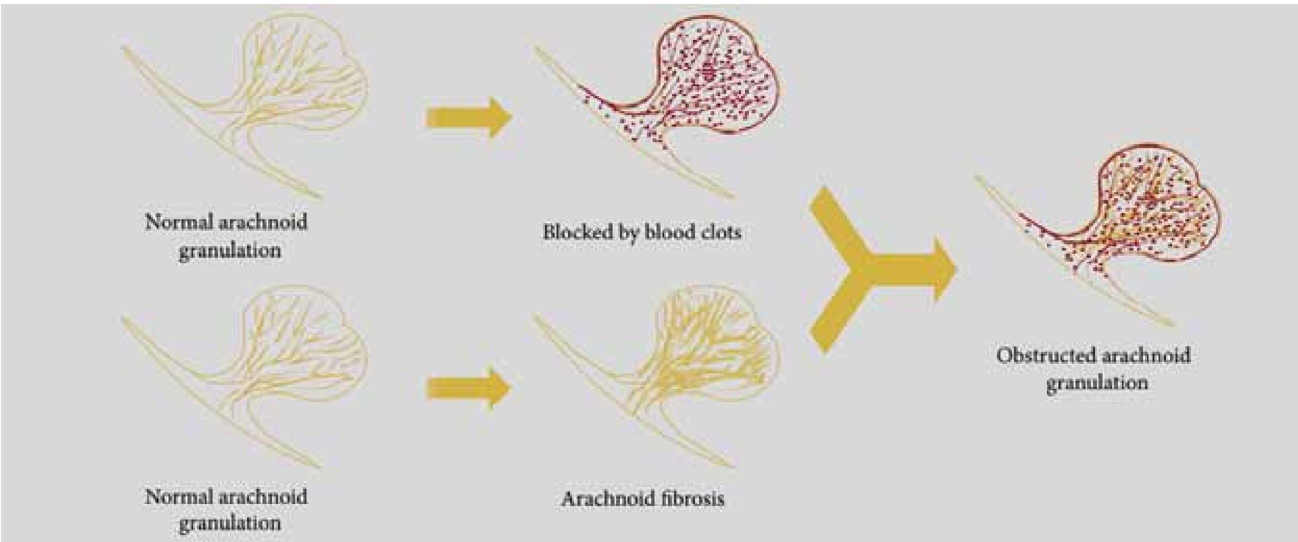

Figure 2: Diagram showing how the SAH can block the arachnoid granulation by either clots or fibrosis [15]

Variable	Aneurysmal SAH	Traumatic SAH
Age (years)		
0-20	1	1
20-40	9	12
40-60	10	3
60-80	4	0
Sex		
Male	7	13
Female	17	3
Side		
Left	11	11
Right	13	5
GCS		
<8	6	10
>8	18	6
Fischer Grade		
1	4	3
2	0	6
3	15	4
4	5	3
Delayed hydrocephalus		
<2 weeks	5	3
2-4 weeks	13	4
>4 weeks	6	9
TOTAL	**24**	**16**

Table 1: Table showing demographic pattern of presentation in aSAH and tSAH cases and the occurrence of DH at diagnosis

Discussion

Etiology of DH:

Hydrocephalus leading to permanent CSF diversion is a well-known risk of SAH, with an incidence ranging from 11 to 27%. Post-traumatic hydrocephalus was first reported by Dandy in 1914 and the incidence of symptomatic hydrocephalus ranges from 0.7 to 29%.[14] The incidence may be more in cases with higher Fischer (>3), WFNS and Hunt & Hess grades.[6] Chronic hydrocephalus requiring CSF diversion usually develops after two weeks of ictus. The mechanisms causing DH is mainly due to the obstruction of CSF pathways with blood clot, blood products, fibrosis of arachnoid membrane, leptomeningeal proliferation and adhesions of the arachnoid granulations leading to prevention of CSF drainage or absorption. The release of iron from blood products leads to cell death secondary to its oxidation (ferroptosis) and thereby disrupting the blood brain barrier.[15] Fibrosis and adhesions of the arachnoid could be attributed more to communicating DH. Increasing age (>50 years), low GCS score on admission, intraventricular hemorrhage, acute hydrocephalus, interhemispheric subdural hygroma, decompressive craniectomy, interhemispheric subdural hematoma and severity of SAH could be other risk factors for facilitating the development of hydrocephalus.[15,16] Aneurysms located in the basal cisterns, anterior communicating aneurysm, posterior circulation aneurysm, severity of aSAH, higher Fischer grade, use of EVD and non-opening of lamina terminalis are some of the other factors leading to DH in aSAH cases .[9-11]

Decompressive craniectomy in association with low GCS, CSF infection, higher Fischer grade, advanced age and time of cranioplasty is related with increased chances of DH. The cause of DH may be secondary to CSF flow blockage around the convexity. Another study showed that if the craniectomy bone was <25 mm from midline there is statistically significant increased chances of DH.[17,18]

Clinical features and diagnosis of DH: Neurological deficits including headache, vomiting, seizures, altered consciousness, motor or sensory deficits, visual changes and even sudden death are linked with DH and thus the latter needs treatment to improve the outcome. The diagnosis of DH is either by a postoperative CT or MRI with diffusion tensor image, fluid attenuated inversion recovery or diffusional kurtosis image scan which will show the status of the aqueduct, increase of the Bicaudate Index more than the age adjusted 95th percentile or greater than 0.3 Evans Index.[19,20] CT scan along with neurological deterioration is more effective to diagnose DH.

Management of DH: A third of SAH cases may need permanent CSF diversion procedure. Intraoperative washing of the blood products, lamina terminalis fenestration or use of external temporary cisternostomy are some of the ways to reduce DH. The lamina terminalis fenestration may have a limited role as it does not prevent fibrosis of the arachnoid as observed by some studies.[22]

VP Shunt: The options for treatment are medical with use of Acetazolamide or surgical, like lumbar drain (single or repetitive), VP shunt or lumbo-peritoneal shunt. Initial EVD followed by VP shunt has remained the standard for treatment of DH while carrying some possible risks like malfunction, infection, stroke and seizure. VP shunt also has a failure rate of 50% at one year which may need revision surgery and a cumulative 32% complication at five years.[23] By shunting the CSF to the abdomen, VP shunt only helps to remove the collected CSF without improving the natural CSF circulation.

Lumbar Drain: Since the blood and its products are heavier than CSF they tend to sediment in the basal cistern and the ventricle floor thus avoiding drainage through the EVD.[8,21] Use of the latter has also been shown to increase the chances of VP shunt due to obstruction by the basal cistern blood. LD remains an alternative to permanent CSF diversion by removal of the bloody CSF, increasing circulation of CSF, reducing vasospasm, infection and allowing reduction in intracranial pressure. LD will also remove the basal cistern sedimented blood products, blood from the lumbar component and thus ease CSF circulation. In trauma cases, it also helps to reduce the decompressive site swelling thus aiding in cranioplasty. There remains a theoretical possibility of downward trans-tentorial herniation or CSF over drainage but careful selection of cases and treating only communicating type of DH alone will avert these complications. The advantages of LD in these DH cases have been well studied in literature.[2,6,9-11,15,17,24-27] In aSAH as shown by the LUMAS study in 2012 there is a reduction of prevalence of delayed ischemic neurological deficit and improves early clinical outcome.[28] LD has also been shown to be beneficial in post aneurysm coil embolization associated DH.[29] Another systematic review in 2017 substantiated the findings by showing LD reduced the rate of vasospasm and improved clinical outcomes.[29]

In this study there was only one failure of LD necessitating the use of EVD in a postoperative case of acute subdural hematoma due to features of meningitis which was managed by EVD followed by VP shunt. Two cases which did not improve with LD underwent VP shunt. Majority of the DH presented within four weeks in aSAH group compared with tSAH which presented after four weeks in this study. Rupture of an aneurysm could have multiple intracerebral effects on blood circulation including vasospasm, infarction, rise of intracerebral pressure and venous return hampering that could lead to early hydrocephalus. In comparison post traumatic hydrocephalus usually presented after four weeks indicating the mechanism following trauma may be different than aSAH. Trauma not only can cause the above-mentioned complications but also lead to arachnoid granulation's blockage due to shifting of the blood products, leading to DH. Surgery for trauma will release some of the SAH and relieve the increased intracranial pressure but could also change the cerebrovascular dynamics that affects the flow of CSF. Although this needs to be studied experimentally it could explain the delayed presentation in tSAH cases.

A maximum of 10 days of admission was needed for complete resolution of the DH with no LD related complications in majority of cases while in the remaining the average stay was six to seven days. In developing countries, LD (catheter cost USD 30 and procedure cost USD 70) remains a cheaper alternative to VP shunt (shunt cost USD 80 and surgery cost USD 500) with the bed charges remaining same and thus for eligible DH cases this could be the primary modality of treatment.

Conclusion

This study reports the use of LD to treat delayed post SAH hydrocephalus in a clinically-cost-effective way with minimal complications. The limitation is that it is not being compared with EVD or VP shunt to study the true benefits of LD alone in DH. Intraoperative opening of the lamina terminalis could also affect the outcome which has to be studied in the future. Randomized studies that compare all three methods to treat DH will overcome this limitation. Until then LD remains a safe alternative in management of communicating DH secondary to SAH. It avoids the need for a VP shunt and is safe, fast, easy and economically cheaper for the patients.

Conflict of interest: None

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