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Utility Of Lumbar Drain In Achieving Brain Relaxation In Patients Undergoing Intracranial Vascular Aneurysmal Surgeries

KEYWORDS: aneurysmal surgery ,lumbar drain ,SAH

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ABSTRACT *Background:The study was designed to ascertain the utility of lumbar drain in achieving brain relaxation intraoperatively in patients undergoing intra cranial vascular aneurysmal surgeries. Materials and methods: This prospective non-randomized study was conducted on 40 patients. After standard intravenous induction and securing the airway with endotracheal tube, patient was placed in lateral decubitus position and lumbar puncture was performed, usually at L4-5 interspace .The lumbar drain (LD) was attached to an external CSF drainage bag and ICP transducer. After placement of lumbar drain, the patient was placed in surgical position and MAP, HR, ICP, CPP, ETCO2 were recorded. Mannitol 20% was started immediately after positioning the patient in the dose of 1 gm/kg slowly within half an hour and MAP, HR, ICP, CPP and ETCO2 were again noted at interval of 10, 20, 30, 60, 120 minutes. Lumbar drain was closed for 120 minutes after the infusion of mannitol. Then lumbar drain was opened and was kept at the level of operating table. CSF drainage was carried out continuously and MAP, HR, ICP, CPP and ETCO2 were noted at every 10 min interval for half an hour. Duramater was opened after half an hour of opening the lumbar drain. Surgeon's intraoperative impression of the fullness of the brain was recorded. Brain relaxation was assessed by surgeon on a four point scale as Relaxed, Satisfactory, Firm and Bulging. Results: In this study, 21% decrease in ICP was observed during two hours after giving mannitol whereas 43 % decrease in ICP was found following CSF drainage two hour after giving mannitol. CPP was decreased by 3 % within first 2 hours of giving mannitol infusion, though this decrease was not significant (p value >0.05) whereas CPP improved by 8 % (p value< 0.000) after lumbar drain. Brain was fully relaxed in 22 patients and was satisfactory in 16 patients. In only one patient firm brain was observed Conclusion: We conclude from this study that taking the help of lumbar drain for intracranial vascular surgery not only improves cerebral hemodynamics,but also provides better intraoperative surgical exposure.*

Introduction

Aneurysmal Subarachnoid Hemorrhage (SAH) is associated with significant mortality and morbidity. The cause is the primary damage to the brain at the time of SAH and secondary damage due to rebleeding, vasospasm, and intracranial hypertension with other contributing factors like hypercarbia, arterial hypertension, hypoxemia, hyperglycemia, and hyperthermia[1, 2]. The best way to prevent these complications is early intervention to occlude the aneurysm – either surgical or endovascular. The introduction of early surgery and microscopic surgical techniques has improved the outcome of the patients[3, 4]. Surgical treatment of ruptured intracranial aneurysm is far more difficult in the presence of hydrocephalus and significant cerebral edema as exposure is difficult due to edematous brain and it can lead to significant retraction that can lead to secondary cerebral damage. By altering intracranial hemodynamics, timely intracranial pressure (ICP) management can effectively protect against secondary brain damage, improve functional status, and facilitate operative exposure during aneurysmal surgery[5].

To improve cerebral exposure and minimize cerebral damage various non pharmacological methods like head end elevation, controlled hyperventilation and pharmacological methods like mannitol, furosemide infusion, hypertonic saline infusion are employed. Mannitol was introduced in 1960 and has since remained the major osmotic agent of choice for reducing brain edema [6].

However, studies done to evaluate the effect of lumbar drain in reducing ICP in patients of refractory or malignant intracranial hypertension not responding even to mannitol have found significant reduction in intracranial hypertension and good neurological outcome with lumbar drainage [7, 8, 9]. To decrease intracranial tension and retraction injury due to edematous brain, direct cerebrospinal fluid (CSF) drainage by ventriculostomy is also employed by neurosurgeons. Studies have shown a good correlation between ventricular and lumbar CSF pressures, implying a free communication of the CSF between the ventricles and the lumbar subarachnoid space[10].

Lumbar drainage has been shown to be associated with a reduced rate of rebleeding and associated with more gradual decrease in CSF pressure as compared with ventriculostomy. Spinal drainage also allows a slightly fuller ventricular space than ventricular drainage which, in turn, facilitates initial arachnoidal dissection and minimizes epidural bleeding. Moreover, it provides access to a larger reservoir of CSF than ventriculostomy (130 cc versus 20 cc), permitting a greater degree of relaxation [11].

We have observed that many a times, intraoperative brain relaxation was not sufficient even after mannitol administration. Few studies have been done showing the utility of lumbar drain in preoperative and postoperative management of patients with ruptured intracranial aneurysm [12, 13]. This study was conducted to assess the utility of lumbar drain intraoperatively in conjunction with mannitol in patients undergoing ruptured aneurysmal surgeries. We have employed intraoperative lumbar CSF drainage in patients of SAH due to ruptured aneurysm to evaluate the effect of lumbar drainage on brain relaxation along with other methods - head up position, controlled hyperventilation and mannitol infusion.

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MATERIAL AND METHODS

This was a prospective non-randomized study. Protocol for the proposed study was presented before the institutional ethics committee and approval was obtained. The study was conducted on 40 patients after excluding two patients. One patient refused to give the consent and another patient was excluded from the study because of associated coronary artery disease (CAD). Written informed consent was taken either from the patient or the relative. Pre-anesthetic checkup of all the patients was done. Routine preoperative investigations in the form of complete blood count, blood urea, serum creatinine, serum electrolytes (Na K), routine and microscopic examination of urine, chest X-ray, ECG were done in all the patients.

Inclusion Criteria

- Age group between 16– 60 years of either sex.
- ASA grade I to III.
- CT scan showing discernible basal cistern.
- WFNS grade I to III.

Exclusion criteria

- Patient with severe cardiac, pulmonary, or renal compromise.
- Coagulation disorder.
- Contraindication to lumbar puncture like infection at local site, obstructed hydrocephalus.
- WFNS grade IV and V.

After standard intravenous induction and securing the airway with endotracheal tube, patient was placed in lateral decubitus position and lumbar puncture was performed, usually at L4-5 interspace. The lumbar drain (LD) was attached to an external CSF drainage bag and ICP transducer. After placement of lumbar drain, the patient was placed in surgical position and MAP, HR, ICP, CPP, $ETCO_2$ were recorded. Mannitol 20% was started immediately after positioning the patient in the dose of 1 gm/kg slowly within half an hour and MAP, HR, ICP, CPP and ETCO2 were again noted at interval of 10, 20, 30, 60, 120 minutes. Lumbar drain was closed for 120 minutes after the infusion of mannitol. Then lumbar drain was opened and was kept at the level of operating table. CSF drainage was carried out continuously and MAP, HR, ICP, CPP and $ETCO_2$ were noted at every 10 min interval for half an hour. Duramater was opened after half an hour of opening the lumbar drain. Surgeon's intraoperative impression of the fullness of the brain was recorded. Brain relaxation was assessed by asking the surgeon on a four point scale:Relaxed, Satisfactory, Firm, and Bulging

Statistical Analysis

For the statistical analysis the parameters (MAP, ICP, CPP, $ETCO_2$, HR) were recorded at following time interval:

- Baseline parameters before starting mannitol - MAPb, ICPb, CPPb, HRb, $ETCO_2$b.
- 120 minutes after giving intravenous mannitol (before opening the lumbar drain) -MAPm120, ICPm120, CPPm120, HRm120, $ETCO_2$m120.
- 30 minutes after opening the lumbar drain - MAPd30, ICPd30, CPPd30, HRd30, $ETCO_2$d30.

The analysis has been done using the software SPSS version 15.0. The repeated measure ANOVA test has been used to compare effects of Mannitol and CSF drainage over the above time interval. Paired t - test was conducted for the significant parameters to see the paired differences. Three groups were made to study for each variable and paired t – test was applied on each group:

Before starting mannitol (baseline) and 120 minutes after giving mannitol (To know the effect of mannitol).

After 120 minutes of mannitol infusion and 30 minutes after opening the lumbar drain (To know the effect of CSF drainage).

Before starting mannitol and 30 minutes after opening the lumbar drain (To know the combined effect of mannitol and lumbar CSF drainage).

A probability value of less than 0.05 was considered statistically significant.

OBSERVATION AND RESULTS

Patient characteristics

Table 1- provides a summary of demographics data obtained in patients with aneurysmal SAH.

Table 1: Demographic Values

Mean Age (in years)		47
Sex ratio (M:F)		18:22
ASA grade (I:II:III)		16:16:8
Pre co- existing illness	DM	12
	HTN	8

Table2: Effect of Mannitol and CSF drainage on Intracranial Pressure (ICP) and Cerebral Perfusion Pressure(CPP)

		ICP Mean (mm Hg)	CPP Mean (mm Hg)	MAP Mean (mm Hg)	$ETCO_2$ Mean (mm Hg)
Pair 1	b	16.70 (3.658)	72.30 (5.850)	89.15 (5.254)	30.80 (1.152)
	m120	13.20 (3.412)	70.15 (5.214)	83.35 (4.913)	28.95 (0.759)
Pair 2	m120	13.20 (3.412)	70.15 (5.214)	83.35 (4.913)	28.95 (0.759)
	d30	6.00 (1.919)	76.00(3.839) (3.839)	82.10(4.424) (4.424)	28.85 (0.671) (0.671)
Pair 3	b	16.70 (3.658)	72.30 (5.850)	89.15 (5.254)	30.80 (1.152)
	d30	6.00 (1.919)	76.00 (3.839)	82.10 (4.424)	28.85 (0.671)

(b- before starting mannitol infusion; m120- 120 minutes after mannitol infusion; d30 – 30 minutes after opening the lumbar drain)

Figures in parenthesis are standard deviation

Changes in ICP and CPP with mannitol infusion and lumbar CSF drainage

Table 2- shows significant decrease in ICP during 2 hours

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of giving mannitol infusion and 30 minutes after opening the lumbar drain. Therefore total decrease in ICP was significant before starting mannitol and 30 minutes after lumbar CSF drainage. However maximum drop in the ICP was after 30 minutes of opening the lumbar drain.

There was a decrease in CPP within 120 minutes of giving mannitol. But this decrease was not significant (p value 0.081). Subsequently, after opening the lumbar drain there was significant increase in CPP (p value < 0.000). Overall comparing with baseline values at d30 there was significant increase in CPP (p value 0.014).

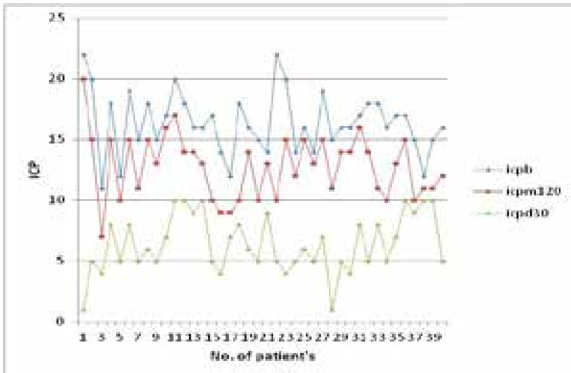

Fig 1: Effect of Mannitol and CSF drainage on Intracranial Pressure (ICP)

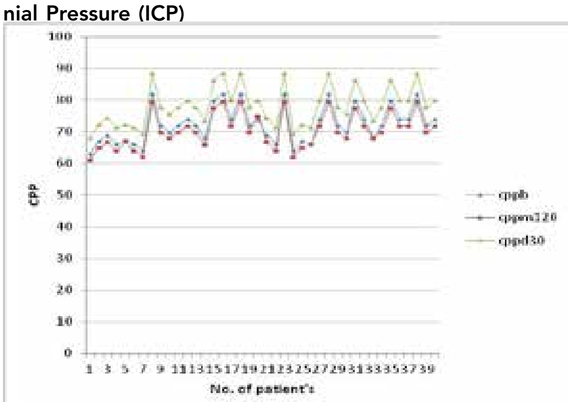

Fig2 – : Effect of Mannitol and CSF drainage on CPP

Brain relaxation and postoperative events

As in Table 3 surgeon found relaxed and satisfactory brain and surgical exposure on opening the duramater (38 out of 40 patient). Only 2 patient had firm brain on opening the duramater and no case of bulging of the brain was observed.

Table – 3: Surgeon's impression of status of brain

Brain relaxation	No. of patients	%
Relaxed	22	55
Satisfactory	16	40
Firm	2	5
Bulging	0	0
Total	40	100

DISCUSSION

Intracranial hypertension and diminished cerebral perfusion pressure accounts for the initial neurologic deficit in a considerable portion of patients of aneurysmal SAH. Intraoperative cerebral swelling and poor postoperative GCS score are significantly associated with a raised intracranial pressure. By altering intracranial hemodynamics, timely ICP management can effectively protect against secondary brain damage and facilitate operative exposure during aneurysm surgery. This study evaluates the utility of lumbar CSF drainage intraoperatively as a treatment modality to reduce intracranial hypertension.

Maximum decrease in ICP of 21% was observed during two hours after giving mannitol(Table 2). The same finding was observed by Kirkpatrick etal[14]. They assessed the influence of mannitol on cerebral hemodynamics in comatose patients with head injury and found fall in intracranial pressure by 21 % (p value 0.001).

A significant decrease in ICP (43 %) was found following CSF drainage two hour after giving mannitol(Table 2). The effect was immediate. Munch EC etal[9] evaluated the effect of controlled lumbar CSF drainage in adult patients with refractory intracranial hypertension and found that ICP decreased by 53.5 % (p value <0.0001). Tomosvari etal[7] found an immediate 62 % decrease in ICP after initiation of CSF drainage in 10 head injured patients with medically refractory intracranial hypertension. Similarly, Murad A etal[15] found 66 % decrease in ICP and advocated controlled lumbar drainage as a standard part of ICP control protocols.

Subsequently, the combined effect of Mannitol and CSF drainage was evaluated. Significant decrease in mean ICP (by 64%) of the pretreatment level was seen after the combined effect of Mannitol and opening the lumbar drain for half an hour before opening the duramater. The significant fall in ICP was used as a surgical aid for achieving better brain relaxation. Fearnside and Adams in 1980[13]. postoperatively studied the effect of intravenous Mannitol infusion and withdrawal of CSF in 26 patients with raised intracranial pressure and found decrease in the mean intracranial pressure by about 60 % of the pretreatment level.

Brain relaxation was assessed by the operating neurosurgeon after opening the duramater in all the patients. Brain was fully relaxed in 22 patients and was satisfactory in 16 patients(Table 3). In only 2 patient firm brain was observed. Intraoperatively none of the patients had bulging brain as observed by the surgeon. This correlated with significant fall in ICP in all these patients and thus helped in good intraoperative surgical exposure and reduced brain insult.

Overall decrease in MAP was about 8 % of the pretreatment level. Out of this, 81% decrease was within first 2 hours after giving mannitol and 19 % decrease was seen after opening the lumbar drain for half an hour. Thus maintenance of MAP near pretreatment level was better during CSF drainage as compared with mannitol. Ochiai and Yamakawa[12] analyzed continuous lumbar drainage and found the mean systolic blood pressure was 143±32 mm of Hg before drainage and 132±19mm of Hg after drainage showing a significant decrease of 7.6 % (p value 0.0226).

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In this study, CPP was decreased by 3 % within first 2 hours of giving mannitol infusion, though this decrease was not significant (p value >0.05). This decrease in CPP could be due to greater decrease in MAP initially within 2 hours of mannitol infusion or due to hypocapnia. However, Kirkpatrick etal[14] showed improvement in CPP with Mannitol infusion (+10 %, p < 0.003) in patients with diffuse head injuries.

Opening the lumbar drain after two hours of Mannitol and withdrawing the CSF for 30 minutes improved CPP by 8 % (p value< 0.000). This improvement was probably due to better maintenance of MAP and significant decrease in ICP during CSF drainage. Similar finding was observed by Munch EC etal[9].They found significant 19 % improvement in CPP from 72.9 ± 10.3 to 87 ± 11.6 mm of Hg during controlled CSF drainage in patients with severe traumatic brain injury or delayed ischemia after SAH.

Overall there was improvement in CPP by 5 % of the pretreatment level with the combined effect of mannitol and CSF withdrawal before opening the duramater by the surgeon. Thus, CSF drainage by lumbar drain resulted in immediate and significant fall in ICP and better cerebral perfusion pressure intraoperatively. Initially, $ETCO_2$ was decreased from the mean value of 30.80 to 28.95 (p value <0.05) in the first two hours after giving mannitol but later during CSF drainage the decrease was not significant (28.95 to 28.85). Thus decrease in ICP with improvement in CPP during CSF drainage could not be contributed to controlled hyperventilation and was thus mainly due to CSF drainage. However, changes in $ETCO_2$ may have contribution in slight decrease in CPP with in two hours of giving mannitol. Soustiel JF etal[16] found CBF was significantly reduced following hyperventilation. In contrast, Mannitol resulted in significant moderate improvement of cerebral perfusion. Schneider GH etal[17] also found hyperventilation significantly reduced ICP and improvement in CPP but led to reduction of brain tissue PO_2 However conflicting results were found by Adrian WG etal[18] who found that hyperventilation (25±2 mm of Hg) decreased the risk of increased brain bulk by 45 %. The mean ICP during hyperventilation, 12.3±8.5 mm of Hg, was lower than that during normoventilation ($PaCO_2$ 37±2 mm Hg), 16.2±9.6 mm of Hg (p value < 0.001).

There was no significant change in the heart rate (HR) during intraoperative period (p value > 0.05).

Thus, simple technique of draining the CSF via lumbar catheter causes significant reduction in ICP with improvement in CPP and maintenance of MAP near pretreatment value.

CONCLUSION

In this study it was observed that insertion of a lumbar drain has multiple advantages in patients undergoing intracranial vascular surgeries. Although the medical agents are being practiced for years together for the purpose of brain relaxation and intracranial pressure reduction, it has been observed with this study that a simple procedure in the form of lumbar drain insertion after induction and draining the CSF before opening the duramater by the surgeon helps not only in providing appropriate surgical field but also directly helps in brain protection by preserving CPP and MAP during intracranial vascular aneurysmal surgeries. Hence we conclude from this study that taking the help of lumbar drain for intracranial vascular surgery not only improves cerebral hemodynamics, provides better intraoperative surgical exposure Further large studies, however, are required to make controlled lumbar drainage as a standard part of ICP control protocols.

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