Study of Management of Hydrocephalus Secondary to Infective Meningitis by Ommaya Reservoir and its Conversion Rate in Ventriculoperitoneal Shunt

Jayant Jain[1], Himanshu Bansod[2], Devendra Mahor[3], Vijay Kumar Gupta[4] Sanjeev Attry[4]

[1.]Senior Resident, Department of Neurosurgery, NIMS Medical College, Jaipur

[2.]Assistant Resident, Department of Neurosurgery, NIMS Medical College, Jaipur

[3.]Professor, Department of Neurosurgery, NIMS Medical College, Jaipur

[4.]Professor, Department of Neurosurgery, NIMS Medical College, Jaipur

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Abstract

Introduction: A common and lethal infection of the central nervous system is meningitis, which can be bacterial (including tubercular) or non-bacterial in origin. Even while meningitis mortality has dropped due to the introduction of contemporary medical facilities, the number of individuals who survive with sequelae like hydrocephalus has significantly grown.

Materials and Methods: A Non-Randomized, prospective, single institute study, conducted in Neurosurgery Department of a tertiary center between January 2023 and June 2024. The study protocol was approved by the Institutional Ethics Committee and written informed consent was obtained from all participants. 50 patients who underwent surgical management were informed about complications associated with surgery and anesthesia and written consent was taken from their parents/guardians/relatives.

Results: Majority of the patients in this study who had hydrocephalus secondary to infective meningitis were adults with age more than 14 years (62 %) and remaining (38%) were of pediatric age group. Mean age of patients with hydrocephalus secondary to infective meningitis was 21.12±14.79 years. Majority of the patients with hydrocephalus secondary to infective meningitis had Modified Vellore grade III (40%) followed by grade II (32%).

Conclusion: Ommaya reservoir placement and daily aspiration from the reservoir leads to reduction in CSF total protein and cell count back to normal range. This provides us an alternative surgical approach to avoid VP shunt surgeries and its associated complications.

INTRODUCTION

A common and lethal infection of the central nervous system is meningitis, which can be bacterial (including tubercular) or non-bacterial in origin. Even while meningitis mortality has dropped due to the introduction of contemporary medical facilities, the number of individuals who survive with sequelae like hydrocephalus has significantly grown.[1] This requires Neurosurgeons to intervene and manage the pathology surgically. Placement of a ventriculo-peritoneal (V-P) shunt is still the standard for management of hydrocephalus; yet shunt infection and failure are common problems.[2] Potential risks and complications exist with shunt surgery especially among infants during their first year of life. Shunt being often ineffective due to abnormal CSF biochemistry, OMMAYA is a safe and reliable alternative for these patients.[3,4,5] It was invented by Pakistani Neurosurgeon Dr. Ayub Khan Ommaya in 1963. This device consists of intraventricular catheter connected to a reservoir implanted beneath the scalp. It is used for aspiration as well as for the delivery of drugs into the CSF.

Prognosis of patients with hydrocephalus secondary to infective meningitis depends on a number of factors, including the underlying condition, its duration and degree, as well as response to treatment. The mortality rate in shunt-treated patients with hydrocephalus remains high, dependent on the underlying cause for shunt insertion and the subsequent development of infection and other complications related to shunt apparatus.[6]

Hence, the aim of study was to treat hydrocephalus secondary

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Address for correspondence:

Jayant Jain
Senior Resident, Department of Neurosurgery, NIMS Medical College
Jaipur, India
Email: jainjayantjain@gmail.com

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to meningitis of infective etiology by placement of OMMAYA reservoir to resolve the hydrocephalus and to establish the role of OMMAYA reservoir in the management of hydrocephalus secondary to infective meningitis by this study and obviate the need for a shunting procedure.

MATERIALS AND METHODS

A Non-Randomized, prospective, single institute study, conducted in Neurosurgery Department of a tertiary center between January 2023 and June 2024. The study protocol was approved by the Institutional Ethics Committee and written informed consent was obtained from all participants. 50 patients who underwent surgical management were informed about complications associated with surgery and anesthesia and written consent was taken from their parents/guardians/relatives.

Inclusion criteria: -

1. Patients diagnosed with hydrocephalus secondary to infective meningitis were included in the study.

Exclusion criteria: -

1. Patient/Attendants not willing for surgery.
2. Patients with Glasgow Coma Scale (GCS) score 3 and/or dilated and fixed pupils at the time of presentation.
3. Patients of less than one-year age were treated by the repeated tapping of ventricle through open coronal sutures and were excluded from the study.
4. Patients with intra and extra cranial pathologies not associated with meningitis.

METHODOLOGY

Based on the history, clinical examination and radiological findings of the patients a clinical diagnosis of hydrocephalus secondary to infective etiology was made and CSF study was done to establish the diagnosis.

The criteria used for selection of cases were as follows: -

1. Clinical and radiological picture consistent with hydrocephalus associated with infective meningitis.
2. CSF examination, Culture positive for causative organism/s and raised cell counts or protein levels in CSF study.

Radiological criteria used in the diagnosis of hydrocephalus:

1. Ventriculomegaly (Evans' index >0.3)
2. Enlargement of the third ventricular recesses and lateral ventricular horns
3. Decreased mamillopontine distance and frontal horn angle
4. Thinning and elevation of the corpus callosum
5. Normal or narrowed cortical sulci
6. Periventricular white matter hyperintensities (interstitial oedema and acute hydrocephalus)
7. Aqueductal flow void phenomenon in T2W images

Glasgow Coma Scale was used for assessment of patients. Modified Vellore grading system was applied in the study, on a broader aspect, as it is applicable even in cases of hydrocephalus caused by other infective etiology.

Surgical Procedures:

Ommaya reservoir insertion and Ventriculoperitoneal shunt placement were performed in the study.

Reservoir Aspiration

The scalp was prepared with antiseptic scrub. The dome of the reservoir was palpated and ascertained. Using a 25 gauge or thinner needle, the reservoir was pierced in an oblique fashion and then aspirated. Proper aseptic measures were taken while performing aspiration and site was dressed with betadine soaked gauge after procedure

Post-Operative Management

After surgical placement of Ommaya reservoir CSF tapping through reservoir was done twice daily, till CSF examination show normal values of cell count, glucose and proteins. Patients were discharge from hospital based on CSF and clinical signs of improvement and improvement in GCS. Patients were followed-up to notice for symptoms and signs of hydrocephalus. If hydrocephalus reoccurred or if it does not get resolved, patient were planned for conversion of Ommaya reservoir into ventriculo-peritoneal shunt.

Outcome Measure-

1) Primary outcome measure is improvement in signs and symptoms after placement of Ommaya reservoir.
2) Secondary outcome measures assessed during follow up in out-patient department (OPD) visits or telephonically at 1, 3 and 6 months.

Data Analysis-Data obtained from the study was analysed by using appropriate statistical test or methods. Data was entered in Microsoft Word and analyzed using SPSS version 16.0 and EPI INFO version 7.0. Appropriate statistical test was applied to analyze the data.

RESULTS

Table 1: Baseline characteristics

Gender	No. of cases	Percentage
Female	11	22.0
Male	39	78.0
Age Groups		
≤14 years	19	38.0
>14 years	31	62.0
Chief complaint		
Altered sensorium	30	60%
Headache	28	56%
Vomiting	19	38%
Fever	15	30%
Visual Disturbance	12	24%
Gait disturbance	5	10%
Seizure	3	6%
Sphincter disturbance	3	6%
Hemiparesis	2	4%
Excessive Crying	1	2%
Modified Vellore Grade		
I	0	0
II	16	32.0
III	20	40.0
IV	14	28.0

Majority of the patients with hydrocephalus secondary to infective meningitis were males (78%) compared females (22%). Majority of the patients in this study who had hydrocephalus secondary to infective meningitis were adults with age more than 14 years (62 %) and remaining (38%) were of pediatric age group. Mean age of patients with hydrocephalus secondary to infective meningitis was 21.12±14.79 years, which ranged from 1 to 60 years in our study. Out of 50 patient majority of patients (60%) presented in altered sensorium. Followed by complaint of headache in 56% patients.38 % Patients had episodes of vomiting. 30% Patient had history of fever at the time of admission. While 24% had visual disturbance and 10 % had gait disturbance. Only 6% patient presented with seizure as their main complaint. 6% patient had bladder incontinence and 4% patient had unilateral weakness of body whereas 2% had complaints of excessive crying. Majority of the patients with hydrocephalus secondary to infective meningitis had Modified Vellore grade III (40%) followed by grade II (32%). There were 28% patients who had Grade IV.

Table 2: Comparison of CSF color distribution at admission and at time of discharge

Color	Proportions (%)		Z statistic	P Value
	At Admission	At Discharge		
Colorless	62.0	80.0	-1.983	0.047*
Pale Yellow	10.0	4.0	1.176	0.238
Reddish	6.0	0.0	1.759	0.078
Straw	22.0	16.0	0.765	0.447

Majority of the patients were found to have colorless CSF at discharge (80%) compared to the proportion of patients at admission (62%) as revealed by the significant p value of 0.047. However, no significant difference was obtained in proportion of patients with pale yellow (p=0.238), reddish (p=0.078) and stray (p=0.447) color between admission and discharge.

Table 3: Comparison of Total Protein, Glucose and cell count at time of admission and at time of discharge

Variables	At Admission	At Discharge	P value #
	Median (IQR)	Median (IQR)	
Total Protein (mg/dl)	195.15 (87.00-302.45)	46.50 (26.45-65.0)	<0.01
Glucose (mg/dl)	47.30 (25.37-62.00)	40.0 (31.75-54.00)	0.492
Cell count (cells/cumm)	110.0 (55.0-200.0)	20.0 (0.0- 40.0)	< 0.01

A significantly lower median total protein level was reported at discharge (46.50 mg/dl) compared to at the time of admission (195.15 mg/dl) (p<0.001). Median cell count was significantly lower in patients at the time of discharge (20.0 cells/cumm) compared to admission (110.0 cells/cumm) with p value of <0.01. No significant difference in median glucose level was observed at discharge compared to admission (p=0.492).

Table 4: Distribution of cases according to their Diagnosis

Diagnosis	No. of cases	Percentage
Pyogenic Meningitis	**8**	**16.0**
Tubercular Meningitis	42	84.0
Total	50	100.0

Majority of the patients were diagnosed with Tubercular Meningitis (84%) followed by Pyogenic Meningitis (16%).

Table 5: Frequency Distribution of cases during follow up period

	Stable	Expired	Conv ersion	Imp roved	Total
At time of Dicharge	**32**	**18**			**50**
Follow-up 1st month	30		1	1	32
Follow-up 3rd month	28	2	1	1	32
Follow-up 6th month	25	0	0	5	30

At the time of discharge, out of 50 patients, 18 patients expired whereas 32 were stable. On 1st month follow up, out of 32 patients, 30 were found stable whereas 1 was improved and 1 conversion was observed. On 3rd month follow up out of 32 patients, 28 were found stable whereas 2 expired, 1 improved and 1 required conversion. On 6th month follow up, out of 30 alive patients 25 remained in same state where as 5 improved.

Table 6: Outcome assessed by Modified Vellore Grade on Discharge

Modified Vellore Grade	No Conversion from Ommaya	Conversion to VP Shunt	Expire
I	**0**	**0**	**0**
II	11	5	0
III	3	10	7
IV	0	1	13
Total	14	16	20

Modified Vellore grading system was first proposed by Mathew et al. in 19987 . Of the 20 patients who expired majority had Modified Vellore grade IV (n=13) whereas those showing conversion majority had Modified Vellore grade III.

DISCUSSION

Bacterial (including tubercular) or a non-bacterial meningitis is a common and lethal infection of the central nervous system. Although the use of modern medical facilities and antibiotics, has reduced the mortality rate of meningitis, the number of individuals living with problems such as hydrocephalus has substantially grown.[1]

This necessitates the intervention of neurosurgeons to surgically manage the pathology. Despite the fact that a ventriculo-peritoneal (V-P) shunt is currently the gold standard for hydrocephalus treatment, shunt infection and failure are prevalent issues.[2]

Shunt surgery has the potential for hazards and consequences. Due to the ineffectiveness of shunts in the individuals due to aberrant CSF biochemistry, Ommaya reservoir is a safe and effective alternative.[3]

In the present study, the majority of the patients were diagnosed with Tubercular Meningitis (84%) followed by Pyogenic Meningitis (16%). Similarly, In the Patel MN et al study, the most common main diseases in patients undergoing ventriculoperitoneal shunt surgery were tuberculous meningitis and pyogenic meningitis, with percentages of 35.86 percent and 29.41 percent, respectively[8].

In the present study, at the time of discharge, out of 50 patients, 18 patients expired whereas 32 were stable. On 1st month follow up, out of 32 patients, 30 were found stable whereas 1 was improved and 1 conversion was observed. On 3rd month follow up out of 32 patients, 26 were found stable whereas 2 had expired, 1 was improved and 1 conversion was observed. On the 6th month follow-up, out of 30 were stable, 5 were improved. In a study by Sharma RM et al outcome at follow-up was available in 26 tubercular meningitis with hydrocephalus patients. [8] of the 26 patients had died (30.7%). In the 1st month following shunt placement, there was high mortality with 6 of 8 deaths occurring within the first 30 days. Two patients died within 1–6 months of shunt placement. No death after 6 months[9].

In the present study, GCS score was significantly increased in patients at the time of discharge (14.31±1.06) compared to GCS at the time of admission (13.41 ±2.12). Similarly, In the Garlicki A et al study, 32 (80%) patients improve whereas 8 (20%) patients did not show any change after 3weeks at the time of discharge10-11. In Sharma A et al no patient became worse and 7 out of 40 cases who did not improve had GCS less than 83. According to the research of Schutte et al and Garlicki et al, GCS at admission is a good predictive indication for adult patients with bacterial meningitis10-11. In Lucas MJ et al study, 30 patients presented with a minimal GCS score on admission. Although the majority of these patients had an unfavorable outcome (77%) and many patients died (60%), the number of patients who recovered completely was substantial[12].

In the current study of 50 patients, mortality was reported in 40% patients. Similarly, in the Fang CT et al trial, 40% of the patients died13. In Sunwoo JS et al study, 40% of patients died in hospital and 40% were severely disabled at 3 months[14]. Amaya –Villar et al also reported significant mortality and morbidity rates associated with infective meningitis[15].

In the present study of the 20 patients who expired, the majority had a Modified Vellore Grade IV. Singh and Kumar examined the results of VP shunt surgery in 140 children who had TBM and hydrocephalus. They discovered a strong link between the Vellore grade at the time of shunt surgery and the result. All of the deaths (43/87) occurred in patients in grade IV16. In the Lucas MJ et al study, 12 of 30 patients (40%) survived, and 7 patients (23%) had a satisfactory functional result, characterised as a Glasgow Outcome Scale score of 512.

As per the data collected from previous studies on hydrocephalus associated with meningitis report the poor outcome in a proportion of patients. In Fang CT et al study most of the expired patients had a GCS score <813. Bhagwati et al study reported mortality in 43% patients undergoing shunt surgery17. 55% patients died following shunt surgery in the study conducted by Chitaleet al18. Palur et al reported mortality rate of 42% in their study6.

In present study 13 patients (26%) who expired belonged to Grade IV of Modified Vellore grading. Rajshekhar et al reports mortality on long-term follow up to vary from 10.5% to 57.1% in those with altered sensorium prior to surgery and concludes that surgery for patients in Vellore grade IV is usually associated with a poor outcome and high mortality2.

In our study 16 patients (32%) during the course of their admission and follow up required conversion of the Ommaya reservoir into the Ventriculo peritoneal shunt.

Out of 16 patients, 14 patients underwent conversion into the shunt during the time of their initial admission period. During the admission patients were kept under strict clinical monitoring and underwent repeated CSF routine microscopic examination. This was done to study the course of illness and to detect improvement in parameters. Those who did not show any improvement with serial tapping of Ommaya reservoir were selected to undergo VP shunt procedure once their CSF study showed values within normal range. Two of the patients who improved during course of stay in hospital were discharged with advice to follow up. These 2 patients presented with deteriorating clinical condition during the follow up. 1 in first month and the other one after 3 months. They were readmitted and Ommaya reservoir was converted into Ventriculo peritoneal shunt.

Fourteen patients among all, who underwent Ommaya reservoir and shown improvement in their initial course of hospital stay were discharged from hospital after achieving normal range of values in their CSF study. Out of 14 patients 13 patients had achieved GCS score of 15/15 and had stayed stable during the follow up period of 6 months. Regarding the data achieved from the study it is significant that Ommaya reservoir gives neurosurgeons an alternative surgical approach to manage Post meningitis hydrocephalus patients. Similarly, in Sharma A et al 65.6% cases did not require V-P shunt after placement of OMMAYA reservoir and it obviated the need for shunting procedure.3.

CONCLUSION

According to the results obtained from our study, majority of patients presenting with hydrocephalus secondary to meningitis were male adults mostly presenting in altered sensorium. Based on CSF study almost all the patients had predominantly lymphocytes and were diagnosed with tubercular meningitis. Ommaya reservoir placement and daily aspiration from the reservoir leads to reduction in CSF total protein and cell count back to normal range. This provides us an alternative surgical approach to avoid VP shunt surgeries and its associated complications. And in those patients, who required V-P shunt procedure after the placement of Ommaya reservoir, the reservoir allowed the shunt to be placed in clear CSF which reduced the risk of shunt blockage. Also, prognosis of patients was seen better who presented with disease in low grades of modified Vellore grading for hydrocephalus.

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