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Comparative Study of Ventriculoperitoneal Shunt Versus Lumboperitoneal Shunt in Patients Presenting with Idiopathic Normal Pressure Hydrocephalus

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ABSTRACT

Objective: To compare ventriculoperitoneal shunt versus lumboperitoneal shunt in the treatment of patients presenting with idiopathic normal pressure hydrocephalus.
Study Design: Quasi experimental study.
Place and Duration of Study: Department of Neurosurgery, Combined Military Hospital, Rawalpindi Pakistan, from Aug 2024 to Feb 2025.
Methodology: A total of 60 patients with idiopathic normal pressure hydrocephalus were divided into two equal groups of 30 patients each. Patients in Group A underwent ventriculoperitoneal shunting while patients in Group B underwent lumboperitoneal shunting. The operative time of both group of patients was documented. Both group of patients were monitored for resolution of symptoms and complications at 2, 4 and 12 weeks intervals. Data analysis was done using SPSS version 25 taking p value of <0.05 as statistically significant.
Results: The mean age of patients was 70.2±4.9 years. There were 35 male patients (59.3%) and 25 female patients (41.7%). The mean operative time was 57.0±6.7 minutes in Group A versus 63.7±8.3 minutes in the Group B (p=0.001). Twenty-six patients (86.7%) reported improvement in symptoms at 3 months follow up in the Group A versus 22 patients (73.3%) in Group B, the difference being insignificant (p=0.197).
Conclusion: Both procedures are effective treatment modalities for the management of patients presenting with idiopathic normal pressure hydrocephalus. Ventriculoperitoneal shunt group had a lesser mean operative time while lumboperitoneal shunt was safer in terms of complications like intracranial hemorrhage albeit the higher risk of shunt blockade.

Keywords: Lumboperitoneal shunt, Normal pressure hydrocephalus, Ventriculoperitoneal shunt.

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INTRODUCTION

Idiopathic normal pressure hydrocephalus (INPH) is a common pathological condition of unknown etiology that results in dilatation of the ventricles but the cerebrospinal fluid (CSF) pressure remains normal. Clinically it presents as the triad of Hakim-Adams syndrome which includes dementia, gait disturbance, and urinary incontinence.[1] It was first described in 1965 as a type of shunt responsive communicating hydrocephalus.[2] Clinically, INPH is not an uncommon phenomenon. The global incidence of INPH is estimated to be around 10 to 22 per 100,000 individuals, with 1.30% occurring among people aged ≥65 years and 5.9% in those above the age of 80 years.[3]

The gold standard treatment for INPH is CSF diversion with VP, LP or ventriculoatrial shunts. The main reason behind CSF diversion's therapeutic efficacy is postulated to be the correction of aberrant CSF dynamics.[4] In individuals with INPH, draining extra CSF directly makes up for inadequate CSF absorption and returns CSF pulsatility to normal.[5] Moreover, endoscopic third ventriculostomy (ETV) has recently been introduced as a minimally invasive management option for the management of patients with INPH.[6] In this study of ours, we compared the treatment modalities that are most commonly employed.

VP shunting had been widely used as the most frequent procedure to treat INPH. It is generally a safe procedure in expert hands and has been reported to provide symptomatic relief in 70-91.3% patients in various studies. The long term effects are however the topic of debate.[7,8] LP shunt being an extra-cranial surgery has recently become more popular among Asian neurosurgeons because of the lower incidence of complications. With a better safety profile, avoidance of intracranial hematoma, less incidence of seizures, and similar post-operative outcomes, it is increasingly being employed to treat

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INPH but still carries its own risks of shunt blockade and need for revision etc.[9]

There is scarcity of data in the Pakistani literature on this subject. To the best of our knowledge there is no study in the national literature comparing the two treatment modalities for management of patients with INPH. In the modern era of evidence based practices, the findings of this research protocol will not only help to determine the better option for our subset of patients but will also serve to generate interest for further research protocols on this important topic.

METHODOLOGY

We conducted a quasi experimental study in the Department of Neurosurgery, Combined Military Hospital (CMH) Rawalpindi on a total of 60 patients with idiopathic normal pressure hydrocephalus after approval from Institutional Review Board (IRB) of CMH Rawalpindi IRB No. 820 dated 6 Aug 2024. All patients signed an informed consent before inclusion in the study. The sample size was determined by using the WHO sample size calculator taking the study by Xie et al as the parent study.[10] The confidence level was taken as 95%, absolute precision as 0.10, anticipated population proportion in VP shunt group of tube blockade as 2.5% and anticipated population proportion in LP shunt group as 5.56%. The sample size came out to be 30 patients in each group. The total sample size was 60 patients. Non-probability consecutive sampling technique was employed. The study was a prospective study.

Inclusion Criteria: All patients presenting to neurosurgery department above the age of 45 years belonging to both genders with the diagnosis of INPH having an Evan's index of >0.3 and normal CSF opening pressure of 70-180 mmHg were included in the study.

Exclusion Criteria: Patients with obstructive hydrocephalus, secondary hydrocephalus, other causes of dementia like Alzheimer disease, Parkinsonism, coagulopathies and those unfit for anesthesia were excluded from the study.

The patient's demographics were documented on a proforma. A detailed history was taken followed by clinical examination and investigation. All patients who had all three symptoms including dementia, gait abnormality and urinary incontinence and had an Evan's index of more than 0.3 with no apparent cause of hydrocephalus were labeled as cases of INPH. Patients were divided into two equal groups of 30 patients each by lottery method. Follow up of patients was ensured by taking the contact numbers of patients as well as their attendants/guardians.

Patients in Group A underwent VP shunting under general anesthesia. Strict aseptic measures were ensured. Prophylactic antibiotic was given at the time of induction of anesthesia. The skin of the scalp, neck, chest and abdomen was prepared and draped. The ventricular catheter of the shunt was inserted through a burr hole at the right Keen's point. In all of our patients included in the study, we used the medium pressure VP shunt. A subcutaneous tunnel was made by careful dissection through the neck and chest and the peritoneal catheter was brought out through an incision in the right upper abdomen. The abdominal cavity was opened and peritoneal catheter was inserted. Abdominal wall was then sutured in layers.

Patients in Group B underwent LP shunt under general anesthesia. After administration of prophylactic antibiotics at the time of induction, the patient was positioned in left lateral position with knees and hips flexed and strapped. The L3-4 and L4-5 intervertebral disc spaces were identified and marked. A small 0.5 cm incision was given and the needle was inserted till a loss of resistance feeling was achieved with drainage of clear CSF. The LP shunt tube was then placed into the lumbar cistern along the puncture needle guard and advanced 5 cm inside. A tunnel was created above the right iliac crest and abdominal portion of the shunt was advanced in it. An incision was given in the right iliac fossa and after opening the abdomen near the right McBurney's point, the catheter was placed in the peritoneal cavity. The abdominal wall was closed in layers.

Patients in both the groups were followed at 2 weeks, 4 weeks and 12 weeks intervals. The outcomes measured have been explained as follows. The operative time was measured in minutes from the time of skin incision till application of last stitch. Getting it right first time for both groups was taken as the number of procedures that were successfully completed from start to finish in first attempt. The improvement in the three symptoms of dementia, urinary incontinence and gait disturbance was also documented at 3 months follow up. Complications including shunt blockage, intracranial hematoma, seizures, surgical site infection (SSI) and readjustment of shunt were documented in both groups (Figure).

Data of all patients was entered in and analyzed by using Statistical package for social sciences (SPSS)

version 25.0. Mean and standard deviation were determined for quantitative variables like age, and operative time while qualitative variables like gender, symptomatic improvement and complications were expressed as frequency and percentages. Quantitative variables in both groups were compared by applying the independent samples t test while qualitative variables were compared using the chi square test/ fisher exact test taking p value of less than 0.05 as statistically significant.

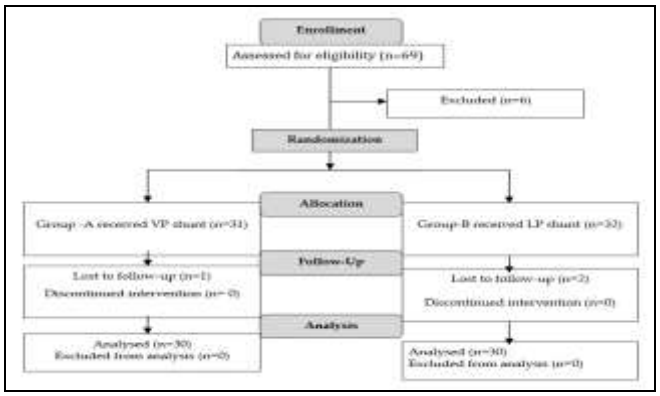

Figure: Patient's Flow Diagram

RESULTS

A total of 60 patients were divided into two equal groups of 30 patients each. The overall mean age of patients included in the study was 70.2±4.9 years. The mean age was 69.9±5.5 years in Group A while it was 70.4±4.3 years in Group B, the difference being non-significant (p=0.694). There were 35 male patients (59.3%) while 25 patients (41.7%) were female. The distribution of patients according to gender is shown in Table-I.

Table-I: Distribution of Patients According to Gender and Age (n=60)

Gender	Group A VP Shunt (n=30)	Group B LP Shunt (n=30)	*p*-value
Male	18(60.0%)	17(56.7%)	0.793
Female	12(40.0%)	13(43.3%)	
Mean age in years	69.9±5.5	70.4±4.3	0.694

The overall mean operative time of all patients included in the study was 60.4±8.2 minutes. The mean operative time was 57.0±6.7 minutes in the VP shunt group versus a mean operative time of 63.7±8.3 minutes in the LP shunt group respectively. The difference between the two groups was statistically significant (p=0.001). Both the group of patients reported improvement in symptoms at 3 months follow up. The results of the study in terms of getting the procedure right first time and improvement in symptoms is shown in Table-II. Overall 52 out of 60 procedures (86.7%) were successfully accomplished in the first go. Moreover, there was improvement in symptoms in 48 out of 60 patients (80.0%) at 3 months follow up.

Table-II: Comparison of both groups in terms of outcomes (n=60)

Variables	Categories	Group A VP Shunt (n=30)	Group B LP Shunt (n=30)	*p*-value
Right first time	Yes	28(93.3%)	24(80.0%)	0.129
	No	2(6.7%)	6(20.0%)	
Improvement at 3 months	Yes	26(86.7%)	22(73.3%)	0.197
	No	4(13.3%)	8(26.7%)	

The various complications reported are expressed in Table III below. Overall both group of patients didn't differ by a statistically significant difference in term of complications. Intra cranial hematoma was reported in 2 patients (6.7%) in VP shunt group vs none of the patients in LP shunt group. Both patients had sub-galeal hematoma which was managed conservatively. Similarly seizures were reported in 3 patients (10.0%) in VP shunt group versus none of the patients in LP shunt group. On the contrary shunt blockade was oberved in none of the patients in VP shunt group versus 2 patients (6.7%) in the LP shunt group respectively.

Table-III: Comparison of both groups according to Complications (n=60)

Variables	Categories	Group A VP Shunt (n=30)	Group B LP Shunt (n=30)	*p*-value
Shunt blockade	Yes	0(0.0%)	2(6.7%)	0.150
	No	30(100.0%)	28(93.3%)	
Readjustment	Yes	1(3.3%)	5(16.7%)	0.085
	No	29(96.7%)	25(83.3%)	
Intracranial hematoma	Yes	2(6.7%)	0(0.0%)	0.150
	No	28(93.3%)	30(100.0%)	
Post-operative Seizures	Yes	3(10.0%)	0(0.0%)	0.076
	No	27(90.0%)	30(100.0%)	
SSI	Yes	0(0.0%)	1(3.3%)	0.313
	No	30(100.0%)	29(96.7%)	

DISCUSSION

INPH is a disease of geriatric age group with the prevalence reported to range from 1.4 to 5.9% among various studies. Shunting remains the main stay of management of patients with INPH. Both VP shunt and LP shunt are effective treatment options with the VP shunt being favoured by western neurosurgeons while the recent Japanese studies seem to be favoring the later technique of LP shunt.[12,13] To the best of our knowledge, this study is the first of its kind comparing

the two treatment modalities in the Pakistani population.

The mean age of patients in our study was 70.2±4.9 years with a male predominance, 35 out of 60 total patients (59.3%). A study by Zulfiqar et from Karachi published in 2022 only studied patients of INPH who underwent VP shunting and reported a comparable mean age of 70.4±7.2 years. Their study had a higher percentage of male patients (75%). Comparable results were reported by Xie *et al*., who reported a mean age of 72.94±7.03 years and 72.12±7.06 years for VP shunt group and LP shunt groups respectively (p=0.613). Similarly, the frequency of male patients was 53.9%, 41 out of 76 patients.[10] Another study from Taiwan reported a mean age of 54.9 years for patients undergoing shunting for INPH.[13]

The mean operative time for VP shunt group in our study was 57.0±6.7 minutes as compared to a mean operative time of 63.7±8.3 minutes for the LP shunt group with the difference being statistically significant (p=0.001).One study compared LP shunt versus VP shunt for hydrocephalus after aneurysmal subarachnoid hemorrhage and reported a mean operative time of 62.5±9.0 minutes versus a mean operative time of 86.2±9.2 minutes for both groups respectively, the difference being statistically significant (p<0.001).[14] However a study 15 reported a mean operative time of 44.0±11.4 minutes for patients undergoing VP shunting for INPH while another study by Li *et al.,* 16 reported a mean age of 70.6±12.7 minutes for patients undergoing LP shunt for INPH.

In our study the first time success rate of VP shunt group was 93.3% as opposed to 80% for LP shunt group (p=0.129). Contrary to our result, Xie *et al*., reported a higher right first time success rate of 95% for LP shunt group versus 77.8% for VP shunt group, the difference also being significant (p=0.026).10 A study reported that shunt revision was required in 3.9% patients in VP shunt group versus 7.0% patients in LP shunt group with a significant difference (p<0.001).[17] One study compared VP shunt and LP shunt for treatment of post-hemorrhagic communicating hydrocephalus and reported that revision of VP shunt was required in 6.7% patients while only 3.57% patients required revision in the LP shunt group with the difference being statistically non-significant (p=0.621).[18]

Coming over to the complications, shunt blockade and readjustment was required slightly higher in the LP shunt group while hematoma and seizures were only reported in the VP shunt group respectively. The difference between the groups remained statistically insignificant as shown in Table III. SSI was only documented in 1 patient in LP shunt group which was managed successfully with antibiotics. The results of our study are in agreement to the findings reported by Xie et al in their study published in 2021.[11] Wang et al reported a significantly higher rate of complications especially intraventricular hemorrhage in the VP shunt group (p=0.009).[18]

The findings of our study are also comparable to the results reported by Li *et al*., Li *et al.,* also reported a higher frequency of intracranial hemorrhage in the VP shunt group (12.2%) versus the LP shunt group (2.4%) but the difference was insignificant (p=0.09). However their study reported a higher frequency of shunt blockade (14.6%) in the LP shunt group versus a frequency of 2.4% in the VP shunt group, the difference being statistically significant (p=0.048). The study also reported that VP shunt was more successful than LP shunt by a significant difference (p=0.047).[15]

The findings of our research protocol show that both the modalities did prove to be effective options in managing INPH. Although VP shunt group had a lesser mean operative time but LP shunt was safer in terms of complications like intracranial hemorrhage albeit the higher risk of shunt blockade. Our findings are comparable to those reported in International literature. There a very few randomized controlled trials on the topic with a few currently ongoing.[19] The limitations of this study was its small sample size and the early follow up results. As it is an under researched topic, in this current era of evidence based practices, future prospective comparative studies are needed to study the long term outcomes which will help to achieve the goal of improving the standard of care for these patients.

CONCLUSION

Patients presenting with idiopathic normal pressure hydrocephalus can be effectively managed with both the treatment modalities. Although lumboperitoneal shunt carried an increased risk of shunt blockade, it was safer in terms of other serious complications such intracranial hemorrhage and seizures. The mean operative time of ventriculoperitoneal shunt group was however less as compared to lumboperitoneal shunt.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

WA & MA: Study design, drafting the manuscript, data interpretation, critical review, approval of the final version to be published.

ZH & TY: Data acquisition, data analysis, approval of the final version to be published.

BS & MU: Critical review, concept, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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