

Complications of Lumboperitoneal Shunts for Normal Pressure Hydrocephalus

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Abstract

For the past half century, the mainstay of cerebrospinal fluid shunting for normal pressure hydrocephalus (NPH) has been ventriculoperitoneal shunt surgery. Lumboperitoneal (LP) shunt has been used occasionally and seemed to be associated with higher failure rates compared to ventriculoperitoneal shunts. There is no uniformity in the reporting of complication and surgical revision rates.

Goals of this study were to understand better the complications and the causes of surgical revisions post-LP shunt insertion in NPH patients.

Nine patients with NPH undergoing lumboperitoneal shunt surgery for the first time by the senior author at an academy tertiary-care institution were retrospectively reviewed. Presence of complications and surgical revisions were the two main outcome variables. Logistic regression analysis was used first to assess if there was a correlation between preoperative patient characteristics and complications and second to evaluate if there was any association between postsurgical complications and surgical revision.

Primary shunts were inserted into nine patients and 44% required revision surgery. Median time to surgical revision was nine (two to 16) months. Multivariate logistic analysis showed no statistical significant association between preoperative patient characteristics and postoperative complications as well as no relationship between preoperative characteristics or complications and surgical revisions.

While minimizing risks of intracranial complications, high rates of postoperative complications as well as the frequent need for multiple shunt revisions are significant disadvantages for lumboperitoneal shunt in NPH. Our Japanese colleagues ascribe lower complication rates to an overall lower BMI. Prospective studies with stronger statistical power are needed to clarify this question.

Categories: Neurology, Neurosurgery

Keywords: complication, normal pressure hydrocephalus, follow-up, lumboperitoneal shunt, postoperative morbidity, reoperation, surgical revision

Introduction

For the past half century, the mainstay of treatment for normal pressure hydrocephalus (NPH) has been ventriculoperitoneal shunt surgery [1-4]. However, in Japan, normal pressure hydrocephalus is not infrequently managed with lumboperitoneal (LP) shunt surgery [5]. In some institutions, the LP shunt comprises up to 40% of all CSF shunting procedures [6]. The main reason LP shunt is considered when treating patients with NPH is the avoidance of the risk of intracranial hemorrhage while passing a catheter through the brain parenchyma. Nevertheless, the LP shunt has been associated with higher failure rates compared to ventriculoperitoneal shunts [3-4, 7-13]. However, the literature is characterized by lack of uniformity in reporting complication and surgical revision rates after LP shunting [4, 13-15]. Difference in the size of previous cohort studies as well as the tendency to under-report poor outcomes may at least in part explain this finding [3, 16-32]. We conducted the present study with the intention to understand better the complications and causes of surgical revisions following LP shunt insertion in NPH patients.

Materials And Methods

Institutional Review Board (IRB) approval (#44584) was obtained prior to the start of this study

All adult patients (age > 18) that received primary placement of LP shunt with horizontal-vertical (H-V) lumbar valve systems as treatment of NPH by the senior author were included. Exclusion criteria comprised: conditions other than NPH treated with LP shunts, non-primary-placed LP shunts, and pediatric patients.

From 1994 to 2013, there were a total of 41 adult patients who underwent lumboperitoneal shunt surgery for the first time by the senior author at a single academic tertiary-care institution. Patients (n=32) with idiopathic intracranial hypertension, Crouzon, preoperative CSF leak, multiple sclerosis, and syringomyelia were excluded. In total, nine patients met the inclusion criteria.

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The clinical records of the included patients were retrospectively reviewed. The information collected from clinical notes included: demographics, body mass index (BMI), presenting symptoms (gait problems, incontinence, cognitive impairment), etiology (hemorrhagic, infectious, traumatic), opening pressure in mmHg, follow-up time in months, and valve characteristics.

The two main outcomes included presence of complications and surgical revisions. Data was collected on the number of surgical revisions per patient, time to revision in months, conversion to other type of shunt, reprogramming, and if there was a change in the type of valve. Missing data was documented.

Summary data is presented as frequencies and percentage for categorical variables and median and interquartile range (IQR) for continuous variables. Logistic regression analysis was used to assess if there was a correlation between preoperative patient characteristics and complications. This same analysis was used to evaluate if there was any association between preoperative patient characteristics or postsurgical complications and surgical revision. Statistically significant differences were considered when $p < 0.05$.

Overall, time required for surgical revision was plotted using the Kaplan-Meier method (R statistic software (version 3.0.1)) [33].

Results

Nine patients with NPH underwent lumboperitoneal shunting over the 20-year study period. Patient characteristics are shown in Table 1.

	NPH n=9 (%)
Age (years)	76 (69-78)
Female: Male	4/5 (0.8:1)
White	6 (67%)
African-American	0 (0%)
BMI	28 (25-31)
Obesity	2 (22%)
Morbid Obesity	0 (0%)
Gait and balance problems	8 (89%)
Incontinence	7 (78%)
Cognitive impairment	6 (67%)
Optic neuropathy	1 (11%)
Papilledema	0 (0%)
Etiology	
Unknown	7 (78%)
Hemorrhagic	1 (11%)
Infectious	1 (11%)
Traumatic	0 (0%)
Previously shunted	3 (33%)
Opening pressure (mm H ₂ O)	286 (272-375)
Follow up time (years)	3 (2-6)

TABLE 1: Patient characteristics

Median follow-up (IQR) was three (two to six) years. Median age (IQR) was 76 (69-78) years old. Female/male ratio was 0.8:1, and median body mass index (IQR) 28 (25-31) with a 22% rate of obese patients. The most common presenting symptoms included gait and balance problems (89%), incontinence (78%), and cognitive impairment (67%). Median opening pressure (IQR) was 286 (272-375) mm H₂O.

We found that four patients (44%) developed at least one complication. Complication characteristics are shown in Figure 1 and Table 2.

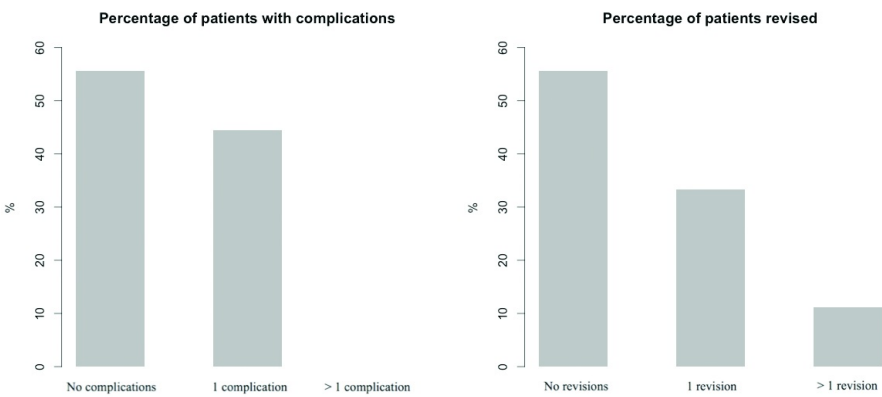


FIGURE 1: Barplots showing: A. Percentage of LP shunt patients with no complications, one complication, or more than one complication. B. Percentage of LP shunt patients with no surgical revisions, one surgical revision, or more than one surgical revision.

	NPH n=9 (%)
Obstruction	1 (11%)
Infection	1 (11%)
Hearing loss	1 (11%)
Pseudomeningocele	1 (11%)
Overdrainage	0 (0%)
Mechanical failure	0 (0%)
CSF leak	0 (0%)
Abdominal pain	0 (0%)
Wound dehiscence	0 (0%)
Tinnitus	0 (0%)
Total # of patients with complications	4 (44%)

TABLE 2: Lumboperitoneal shunt related complications in NPH patients.

They include obstruction, shunt infection, pseudomeningocele, and hearing loss. On the other hand, we did not find any of the following known postoperative complications after LP shunt placement in our patients, such as seizure, pneumocephalus, subdural collection, venous sinus thrombosis, catheter malposition, ileus, gastrointestinal perforation, abdominal hemorrhage, myelopathy, syringomyelia, scoliosis, lumbar hyperlordosis, tonsillar herniation or acquired Chiari I malformation, preterm delivery in pregnancy, spontaneous abortion in pregnancy, and hydrocele.

Furthermore, four patients (44%) required revision surgery, detailed in Figure 2 and Table 3.

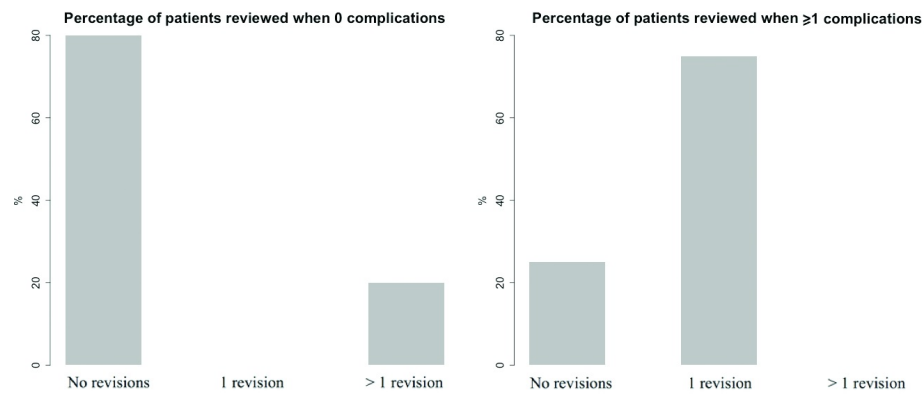


FIGURE 2: Barplots showing: A. Percentage of LP shunt patients with no complications that get no surgical revisions, one surgical revision, or more than one surgical revision.

B. Percentage of LP shunt patients with one or more complications that get no surgical revisions, one surgical revision, or more than one surgical revision.

	NPH n=9 (%)
Num. of patients surgically revised	4 (44%)
Patients that required multiple revisions	1 (11%)
Time to revision (months)	9 (2-16)
Conversion to other type of shunt	2 (22%)
Change of type of valve	0 (0%)
Reprogramming	0 (0%)

TABLE 3: Surgical revisions of lumboperitoneal shunt in NPH patients

Among subjects requiring a shunt revision, three (75%) had one revision, while one (25%) required multiple revisions. Primary shunts were therefore inserted into nine patients, and five revision surgeries were required. Median time to surgical revision was nine (two to 16) months.

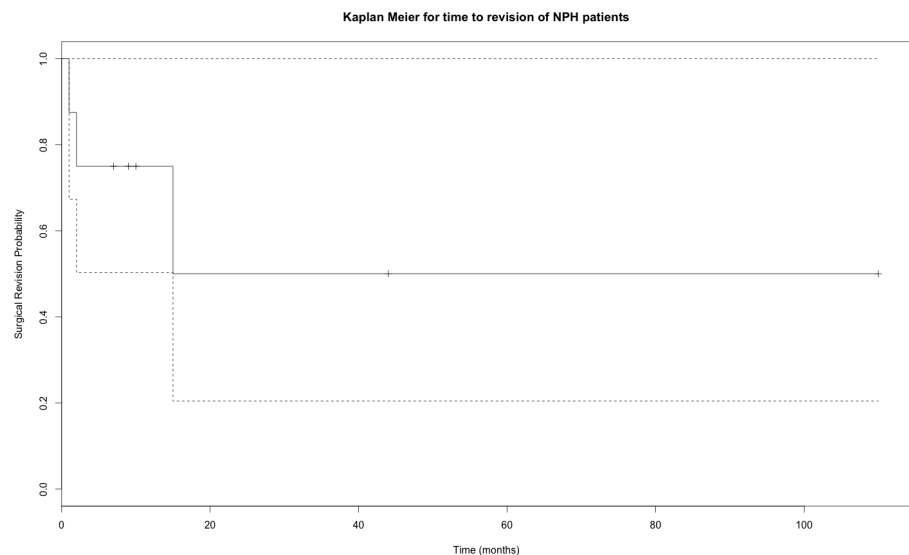


FIGURE 3: Kaplan Meier curves of time to surgical revision

Half of the revisions occurred within the first three months after surgery.

Univariate and multivariate logistic regression did not show any correlation between any of the preoperative factors and the risk of post-LPS complication. Likewise, we did not find any correlation between preoperative factors and risk of surgical revision.

Discussion

Lumboperitoneal shunting is considered in the treatment of NPH in order to minimize the intracranial risks associated with ventricular shunting systems [13, 34-36]. However, since the early days of shunt insertion, shunt complications have been considered a serious problem [2, 27, 37]. During the initial attempts of this technique, there was a very high perioperative mortality [10, 16]. Substitution of polyethylene catheters by Silastic catheters in 1967 lead to a dramatic decline in obstruction and shunt fracture rate [38]. However, complication and surgical revision rates for LP shunting have continued to be reported in the literature [4, 13-15]. Of note, the LP shunt has been associated with higher failure rates compared to ventriculoperitoneal shunts [3, 7-9, 11]. As a consequence of this, ventriculoperitoneal shunts have been the prevalent treatment modality for NPH. The lack of clear data regarding the complication and revision rates of LP shunts in NPH may perpetuate this situation [5-6]. Our data suggests that some of the previously reported complications (seizure, pneumoencephalus, subdural collection, venous sinus thrombosis, catheter malposition, ileus, gastrointestinal perforation, abdominal hemorrhage, myelopathy, syringomyelia, scoliosis, lumbar hyperlordosis, tonsillar herniation or acquired Chiari I malformation, preterm delivery in pregnancy, spontaneous abortion in pregnancy, and hydrocele) are no longer occurring. However, mechanical complications of lumboperitoneal shunts seem to remain high. Nevertheless, hearing impairment may be due to overdrainage and can be addressed with an increment in the valve pressure setting [17].

Japanese authors explain their lower complication and revision rates by lower BMI [6]. In our experience, obstruction and mechanical complication rates were lower than previously reported. That could be explained by the fact that our cohort had a median BMI (IQR) of 28 [25-31]. Unfortunately, we did not find any correlation between BMI and the complication rates or surgical revision rates. This could be due to the fact of weak statistical power because of a small cohort. Thus, it is not clear if the Japanese theory may be supported by our data.

We acknowledge limitations of our study that may influence our results and that may reduce the generalizability or extrapolation of its conclusions to patients from other centers. Our study was not controlled or prospectively designed; it looked at data over a very long period of time; and had a low statistical power due to a small sample. However, this series, being limited to a single surgeon experience, reduced the variability of indication and technique derived from it. Stronger scientific evidence is necessary and requires prospective studies to better assess the current risk and benefits of LP shunting in NPH patients.

Conclusions

While minimizing risks of intracranial complications, the high rate of postoperative complications as well as

the frequent need for multiple shunt revisions are significant disadvantages for lumboperitoneal shunting in NPH. Our Japanese colleagues, reporting lower complication rates, ascribe this fact to an overall lower BMI. Further prospective studies with stronger statistical power are needed to further clarify this question.

Additional Information

Disclosures

Human subjects: All authors have confirmed that this study did not involve human participants or tissue.

Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue.

Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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