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Complications of Lumboperitoneal Shunts for Idiopathic Intracranial Hypertension

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Disclosures can be found in Additional Information at the end of the article

Abstract

For the past half century, the mainstay of cerebrospinal fluid (CSF) shunting for idiopathic intracranial hypertension (IIH) has been lumboperitoneal (LP) shunt surgery. LP shunts have been associated with higher failure rates compared to ventriculoperitoneal shunts. However, there is no uniformity in the reporting of complication and surgical revision rates.

The goals of this study were to understand better the complications and surgical revision rates associated with LP shunt insertion in IIH patients with the objective of providing better information about the different therapeutical option outcomes when counseling for a better informed consent.

Twenty-six patients with IHH 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 preoperative patient characteristics or postsurgical complications and surgical revision.

Primary shunts were inserted into 26 patients and 58% required revision surgery. Median time to surgical revision was four (3-22) months. Multivariate logistic analysis showed no statistical significant association between preoperative patient characteristics and postoperative complications as well as no relationship between either preoperative characteristics or complications and surgical revisions.

Our data suggests that our revisions were mostly performed to reduce the rate of post-LP shunt tonsillar herniation. The introduction of newer hardware is expected to positively impact the symptoms and signs of overdrainage post-LP shunt placement and the need for revision.

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Keywords: complication, idiopathic intracranial hypertension, follow-up, lumboperitoneal shunt, pseudotumor cerebri, reoperation, surgical revision

Introduction

For the past half century, the mainstay of cerebrospinal fluid (CSF) shunting for idiopathic intracranial hypertension (IIH) also known as pseudotumor cerebri syndrome (PTC) has been lumboperitoneal (LP) shunt surgery [1-2]. In some institutions, the LP shunt comprises up to

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40% of all CSF shunting procedures [3-4]. One of the reasons that LP shunt is used when treating patients with IIH is because of the difficulty placing the proximal catheter in ventricles that are usually quite small [5]. Furthermore, LP shunt eliminates the small risk of intracranial hemorrhage associated with the introduction of a catheter through the brain parenchyma. Nowadays, given the better understanding of the pathogenetic mechanism of IIH, the primary therapeutic intervention aims at curing the condition by reducing patients' weight (diet, bariatric surgery, etc.) and/or eliminating dural sinus stenosis by insertion of a cerebral venous sinus stent [6-7]. LP shunt and optic nerve fenestration (ONF), being palliative treatments, should only be offered when the first two have failed or in an emergency situation. On the other hand, LP shunt has been associated with higher failure rates compared to ventriculoperitoneal shunts [1-2, 8-13]. However, there is no uniformity in the reporting of complication and surgical revision rates [2, 12-15]. Differences in the size of previous cohorts' studies as well as the tendency to under-report poor outcomes may explain this regrettable situation [1, 12, 16-34]. We conducted the present study with the intention to understand better the complications and surgical revision rates associated with LP shunt insertion in IIH patients to help when informing patients about the outcomes of the different treatments with the objective of providing better information about the different therapeutical option outcomes when counseling and a better informed consent.

Materials And Methods

Institutional Review Board (IRB) approval (#44584) was obtained prior to the start of this study. Informed patient consent was obtained from all patients involved in 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 IIH by the senior author were included. Exclusion criteria were comprised of conditions other than IIH, 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=15) with hydrocephalus, preoperative CSF leak, multiple sclerosis, and syringomyelia were excluded. In total, 26 patients met the inclusion criteria.

The clinical records of the included patients were retrospectively reviewed. The information collected from clinical notes included: demographics, body mass index (BMI), presenting symptoms (headache, vision problems, nausea, vomit, photophobia, phonophobia), optic neuropathy, papilledema, etiology (dural venous sinus stenosis, infectious, traumatic, hemorrhagic, unknown), opening pressure in mmHg, follow-up time in months, and valve characteristics.

Presence of complications and surgical revisions were the two main outcomes variables. Data was collected on the number of surgical revisions per patient, time to revision in months, conversion to other type of shunt, reprogramming, change in the type of valve, optic nerve fenestration, subtemporal decompression craniectomy, and suboccipital decompression. Missing data was documented.

Summary data is presented as frequencies, 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) [35].

Results

Twenty-six patients underwent lumboperitoneal shunting to treat IIH over the 20-year study period. Patient characteristics are shown in Table *1*.

	IIH n=26 (%)
Age (years)	34 (30-43)
Female: Male	21/5 (4.2:1)
White	18 (69%)
African-American	5 (19%)
BMI	36 (30-41)
Obesity	17 (65%)
Morbid Obesity	8 (31%)
Headache	22 (85%)
Vision problems	17 (65%)
Nausea	6 (23%)
Vomit	4 (15%)
Photophobia	2 (8%)
Phonophobia	2 (8%)
Cognitive impairment	2 (8%)
Optic neuropathy	16 (62%)
Papilledema	14 (54%)
Etiology	
Unknown	19 (73%)
Sinus stenosis	4 (15%)
Traumatic	2 (8%)
Infectious	1 (4%)
Hemorrhagic	0 (0%)
Opening pressure (mm H_2O)	350 (330-440)
Follow up time (years)	4 (1-8)

TABLE 1: Patient characteristics.

Data is presented as frequencies (percentage) for categorical variables and median (interquartile range) for continuous variables.

Median follow-up (IQR) was four (1-8) years. Median age (IQR) was 34 (30-43) years old. Female/male ratio was 4.2:1 and median body mass index (IQR) 36 (30-41) with 65% of obese

patients and 31% of morbid-obese patients. The most common presenting symptoms were headache (85%), vision problems (65%), nausea (24%), vomiting (15%), photophobia (8%), phonophobia (8%), and cognitive impairment (8%). Patients with IIH showed papilledema in 54% of cases and optic neuropathy in 62%. Median opening pressure (IQR) was 350 (330-440) mm H_2O.

In our series, we found that 18 shunts patients (69%) developed at least one complication. Complication characteristic details are shown in Figures *1*, *2* and Table *2*.

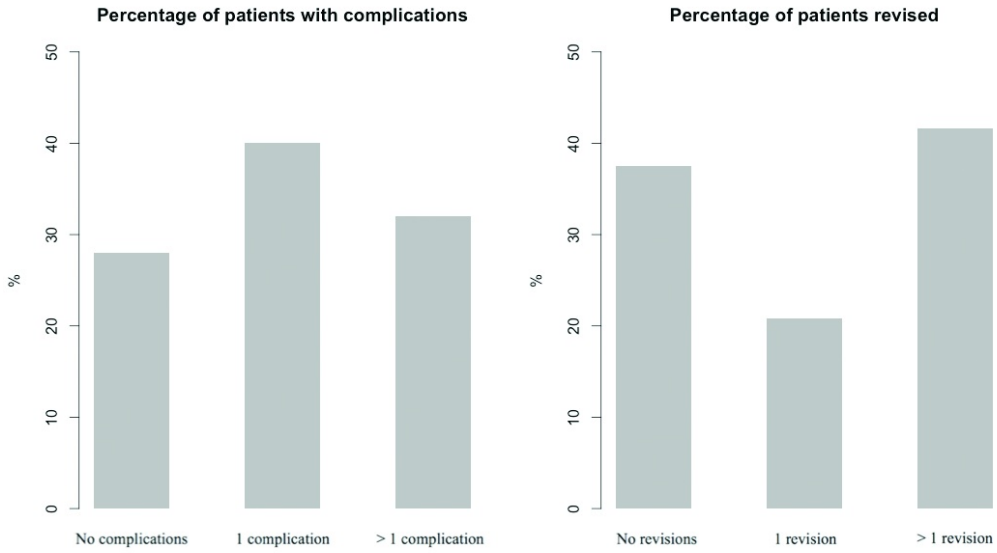

FIGURE 1: Barplots showing: A) Percentage of LP shunt patients with no complications, one complication, or more than one complication.

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

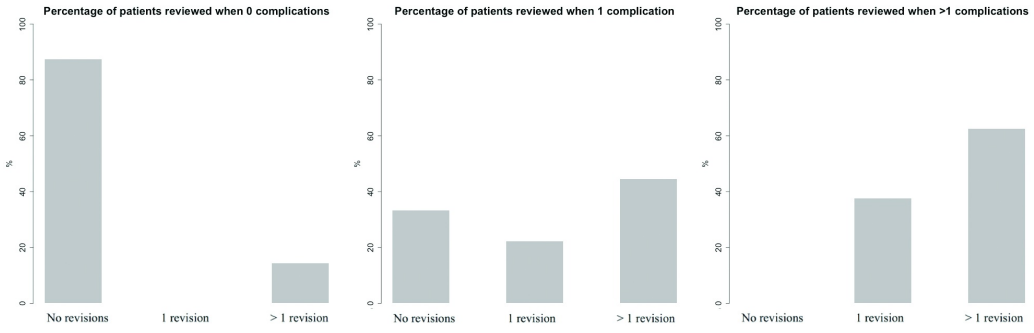

FIGURE 2: Barplots showing: A) Percentage of LP shunt patients with no complications that get no surgical revisions, one surgical revision, or more than one surgical revision.

B) Percentage of LP shunt patients with one complication that get no surgical revisions, one

surgical revision, or more than one surgical revision. C) Percentage of LP shunt patients with more than one complication that get no surgical revisions, one surgical revision, or more than one surgical revision.

	IIH n=26 (%)
Overdrainage	9 (35%)
Obstruction	5 (19%)
CSF leak	4 (15%)
Abdominal pain	4 (15%)
Infection	2 (8%)
Wound dehiscence	2 (8%)
Tinnitus	1 (4%)
Back pain	1 (4%)
Radiculopathy	1 (4%)
Hearing loss	0 (0%)
Pseudomeningocele	0 (0%)
TOTAL # of PATIENTS WITH COMPLICATIONS	18 (69%)

TABLE 2: Post-LP shunt complications

Among the patients that received LP shunt, 58% required revision surgery (n=15). Further details are shown in Figures *1*, *2* as well as Table *3*. Among subjects requiring a shunt revision, 33% (5 out of 15) had one revision while 66% (10 out of 15) required multiple revisions. Notably, 20% (3 out 15) subjects required five or more revisions (range 5–10 revisions). Therefore, primary shunts were inserted into 26 patients and 53 revision surgeries were required. Median time to surgical revision was four (3-22) months (Figure *3*).

	IIH n=26 (%)
Number of patients surgically revised	16 (58%)
Patients that required multiple revisions	10 (39%)
Time to revision (months)	4 (3-22)
Conversion to other type of shunt	11 (42%)
Change of type of valve	2 (8%)
Reprogramming	1 (4%)
Subtemporal decompression craniectomy	1 (4%)
Suboccipital decompression	0 (0%)

TABLE 3: Surgical revisions post-LP shunt.

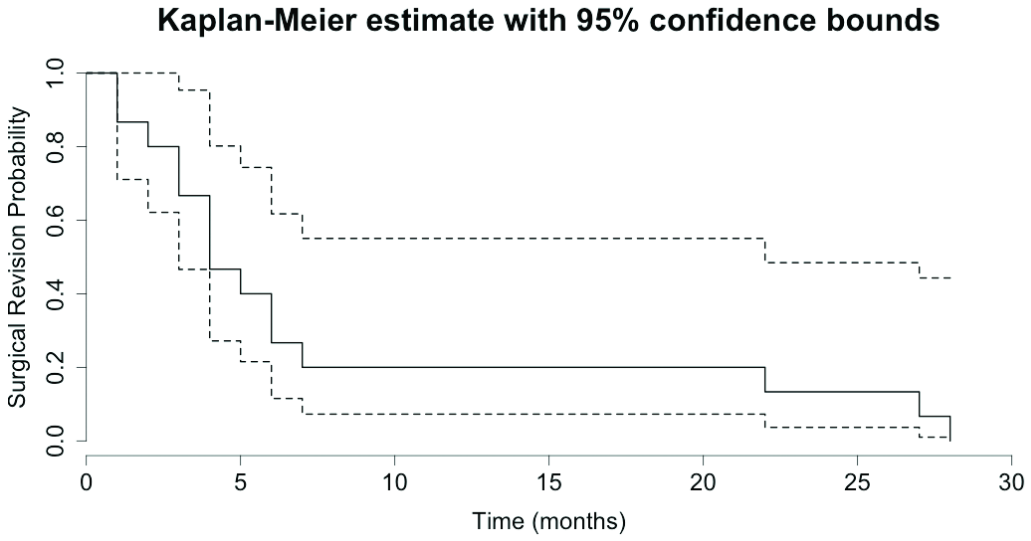

FIGURE 3: Kaplan Meier curves of time to surgical revision

The majority (71%) of revisions occurred within a year of initial shunt surgery, and 29% of these occurred within the first three months after surgery. Among the patients requiring shunt conversion, 36% had ventriculoperitoneal shunts (five out of 14), 29% had ventriculoatrial shunts (four out of 14), 21% had lumbopleural shunts (three out of 14), and 14% had lumboatrial shunts (two out of 14).

Univariate logistic regression showed correlation between presence of preoperative headaches and post-LP shunt complications with an OR = 12.75 (95% confidence interval (CI) 1.27-300.56) p = 0.047. Preoperative headaches showed correlation with complications in an univariate analysis. However, after conducting multivariate logistic regression weighted for all significant

predictors, the relationship between preoperative headaches and post-LP shunt complications disappeared. In a further logistic regression, there was no correlation between preoperative headaches and post-LP shunt overdrainage.

As expected, when analyzing the outcomes of surgical revisions using univariate logistic regression analysis, the presence of post-LP shunt complications showed correlation with surgical revision with an OR = 16.92 (95% CI 2.91-354.52) p = 0.013. As well, this relationship disappeared after conducting multivariate logistic regression weighted for all predictors. Additionally, there was no statistically significant relationship between any preoperative patient characteristic and surgical revision rate.

Discussion

Lumboperitoneal shunting minimizes intracranial risks associated with ventricular shunting systems [5, 36-41]. During the initial attempts of this technique, perioperative mortality was very high [9, 16, 42]. Substitution of polyethylene catheters by silastic catheters in 1967 led to a dramatic decline in obstruction and shunt fracture rate [42-43], although shunt complications remained a serious problem [2, 12, 23, 26, 29, 44-46]. Progress in preventing short and long-term shunt complications requiring surgical revision has been slow over the last several decades [2]. Furthermore, the literature lacks uniformity in the reporting of complication and surgical revision rates after LP shunting [2, 12-15]. This variation may be explained by the different size of previous cohorts' studies as well as the tendency to under-report poor outcomes [1, 12, 16-34].

Data shown in this manuscript is quite similar to previously reported rates in either complication or surgical reviews post-LP shunt. However, the rates we report on shunt revision are higher than other previously published ones. This may be due to the fact that in our clinical approach we include monitoring and investigating the possibility of postoperative symptoms, which could indicate possible intracranial hypotension. In our study, the presence of symptoms for overdrainage such as headaches secondary to intracranial hypotension appeared in 36% of patients with IIH post LP shunt placement. Overdrainage represented by far the largest cause of reoperation in our series. Surgical revision was performed in 89% of IHH patients with overdrainage and it could explain why there were no overdrainage related complications, such as subdural collections or acquired secondary tonsillar herniation. Thus, no decompressive posterior fossa craniectomy was required in our series. Despite this, our revision rate remains high and requires our patients to go in for multiple operations. An improvement in the valve technology will likely improve this regrettable state of affairs.

Finally, we did not find any of the following known postoperative complications after LP shunt placement in our patients: 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, or hydrocele.

The high rate of postoperative complications as well as the frequent need for multiple shunt revisions is a significant disadvantage for LP shunt. Optic nerve sheath fenestration does not fare much better because of the postoperative visual loss risk after optic nerve sheath fenestration [47-48].

We suggest the indication for shunt surgery in IIH should be reserved for those patients who experience rapid visual decline and time does not allow for alternative therapeutic strategies, those who fail other medical efforts and continue to develop visual deterioration, and those patients who are not candidates for primary therapeutic options.

We acknowledge the limitations of our study that may influence our results: the study was not controlled or prospectively designed; it looked at data over a very long period of time; and it was characterized by loss to follow-up and incomplete medical documentation. Furthermore, the sample size may have limited the statistical power when analyzing significant associations. However, this series, limited to a single surgeon experience, reduced the variability of both indication and surgical technique derived from it as well as it tried to overcome limitations from previous studies with a more uniform cohort with adult IIH patients that have not had any previous surgery. Stronger scientific evidence requires larger samples and prospective randomized studies to compare risks and benefits of shunting in IIH versus effective weight loss and/or venous sinus stenting.

Conclusions

Our data suggests that our revisions were mostly performed to reduce the rate of post-LP shunt tonsillar herniation. The introduction of newer hardware is expected to positively impact the symptoms and signs of overdrainage post-LP shunt and the need for revision.

Surgical intervention should be carefully and prudently offered in the management of IIH. A lumbar shunt is certainly indicated when visual decline occurs rapidly and there is no to time to treat the patient with alternative medical therapeutic measures. Shunting is indicated when medical treatment, including effective weight loss and dural sinus stenting, fails.

Additional Information

Disclosures

Human subjects: Consent was obtained by all participants in this study. Johns Hopkins University. School of Medicine. Institutional Review Board (IRB) issued approval NA_00044584/CIR00002058. **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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