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Laparoscopic-assisted intraperitoneal placement of lumboperitoneal shunt in patients with idiopathic intracranial hypertension

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Abstract

Background: Lumboperitoneal (LP) shunting is an effective treatment option aiming at cerebrospinal fluid diversion in cases of idiopathic intracranial hypertension. Confirming the distal end position, on the other hand, could be technically difficult, especially in obese people. With minimal invasive procedures, laparoscopic-assisted placement of the peritoneal side of the LP shunt became a valid treatment option. In this study, we aim to evaluate the operation duration, possible complications, and patient outcomes after the placement of a peritoneal catheter using the laparoscopically assisted technique.

Methods: A retrospective analysis of clinical, preoperative, and postoperative data for 18 patients diagnosed with idiopathic intracranial hypertension and undergoing LP shunt surgery using the laparoscopic-assisted technique for intraperitoneal catheter placement between 2019 and 2021 was performed.

Results: The average operating time was 93.89 min, and the average hospital stay was 2.3 days. There was no mortality among cases treated with the described technique, and no intraoperative complication occurred. Seven patients (38.9%) had LP shunt failure, with a median duration to failure of 212 days; three cases for slippage, two cases had over drainage, one case had peritoneal adhesions around the shunt tip, and one case had Arnold Chiari malformation.

Conclusions: The laparoscopic assisted technique is safe and feasible. It allowed a direct vision of the shunt tip position within the peritoneal cavity which helped in confirming position and assessing function, resulting in a superior option over classic surgical options. Short hospital stay, minimal postoperative pain, and low failure rates are the main advantages of described technique.

Keywords: Laparoscopic, Lumboperitoneal, Shunting, Idiopathic

Introduction

Idiopathic intracranial hypertension (IIH) affects young obese females. The most common symptoms include headache, blurred vision, and pulsatile tinnitus. Papilledema is a diagnostic requirement that can result in optic atrophy and eventual vision loss [1].

Ventriculoperitoneal (VP) and lumboperitoneal (LP) shunts are common treatment options for IIH. However,

the VP shunt remains morbid because of the risk of cerebral ventriculostomy in slit ventricles, which are standard in IIH [2, 3]. Failure rates are higher with VP shunts than LP shunts. However, redo surgeries are more common with LP shunts [4].

LP shunts are typically inserted using an open surgical technique to achieve access to the peritoneal cavity placing the patient in a lateral position. Open laparotomy is associated with significant risks of hematoma formation and subsequent shunt malpositioning, especially in patients with coexisting coagulopathy, thrombocytopenia, obesity, or uremia [5, 6].

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A common complication of implantation is a high rate of revision, particularly at the peritoneal end [7]. The open abdominal technique was replaced with minimal invasive procedures, which reduced most of the associated hazards [8, 9]. Therefore, using laparoscopic assistance during LP surgery may be advantageous for position accuracy and function assessment [10–12].

The LP shunt is technically demanding, especially in patients with spinal deformity or obesity, as well as certain possible complications such as radiculopathy, myopathy, and Arnold Chiari malformation [13].

Our study describes the clinical outcome, operative time, and complications following laparoscopic-assisted peritoneal catheter insertion in the LP shunt procedure as a treatment of IIH.

Methods

After receiving institutional review board approval from the ethics committee for human research at Zagazig University, Faculty of Medicine, a retrospective analytical study of 18 patients who were treated with LP shunt using laparoscopic-assisted intraperitoneal catheter placement from 2019 to 2021 was performed. All patients were diagnosed with IIH and had not responded to medical treatment. The patient's age, gender, body mass index (BMI), previous abdominal interventions, and shunt indication were all recorded. We also recorded the average surgical time, also the length of hospital stay (LOS), post-operative complications, and possible etiology of shunt malfunction.

Technique The patient is properly padded and placed in a lateral decubitus position after general anesthesia. Mild hip and knee flexion, as well as spine flexion, were recommended during the procedure to facilitate lumbar puncture. The peritoneal end is usually placed on the left side of the abdomen unless there is a contraindication.

All of the back, flank, and abdomen are sterile prepped and wrapped. A short (2 cm) linear incision at the level of the L4-5 disc space is made, cutting down to the lumbothoracic fascia. The subarachnoid space is accessed with a Tuohy needle, and the lumbar tip of the tube is inserted after proper cerebrospinal fluid (CSF) flow where anchor sutures to fix the shunt tube were made. The shunt is then tunneled to a subcutaneous pocket which is closed temporarily with silk sutures. The patient's position is then changed to a supine position where the laparoscopic surgeon inserts an optical access trocar through the lower midline to gain access to the peritoneal cavity. Intraperitoneal CO₂ gas insufflation is performed at a pressure of 12 mm Hg. For the best visualization, a 30-degree laparoscope is used. Any intra-abdominal adhesions in the left flank are assessed laparoscopically. Through the stab incision in the abdomen, a disposable split trocar is inserted under laparoscopic visualization. A subcutaneous catheter tunneling is done using a short passer to reach the left flank. Using a split trocar, the peritoneal end is placed within the peritoneal cavity under direct laparoscopic visualization through a stab incision in the abdomen. An optional 5 mm port in the right mid-abdomen may be placed if needed when the catheter tip needs to be manipulated. To confirm the final catheter patency and function, the tip of the catheter is inspected for CSF droplets (Fig. 1). Another anchor suture is made at the peritoneal end. The incisions are then closed and dressed as needed.

Statistical analysis

For case demographics, data were analyzed using Statistical Package for Social Sciences (SPSS, version 25, IBM Corporation, NY, US); mean, median, range, and standard deviation for continuous variations, and frequency for separate information, were calculated. To compare

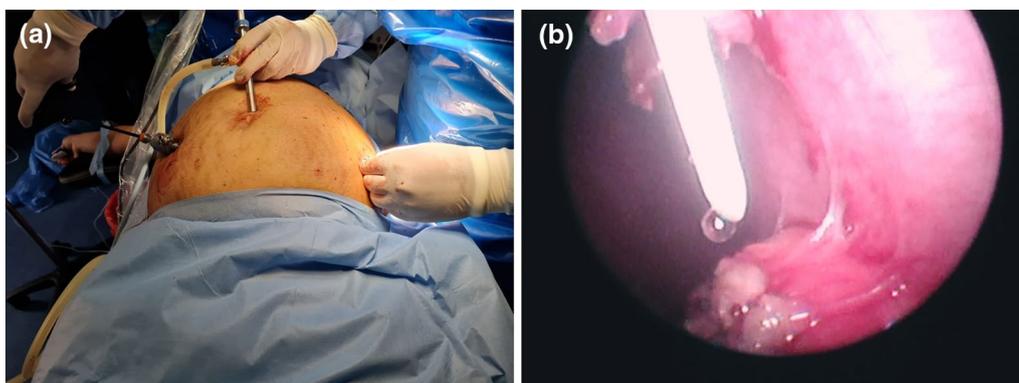


Fig. 1 **a** Patient lying supine with the laparoscopy ports inserted to the peritoneal cavity. **b** laparoscopic view showing a proper function of LP shunt confirmed by CSF droplets

the differences in values between classes, the Mann–Whitney and χ^2 (Chi-square) tests were used. The significance of p value is when $p < 0.05$.

Results

At the Zagazig University hospital, we had 18 patients (13 women and 5 men) who had LP shunts placed using the described technique. The age range is from 23 to 78 years (average 52.2 years). The mean body mass index (BMI) was 30.19. Eight patients (44.4%) had undergone earlier abdominal operations. Open surgery was not needed for any of the patients, and there was no mortality among the patients studied. We had zero intraoperative complications. All patients were early mobilized with minimal postoperative pain which was controlled on paracetamol. There was an immediate improvement in headaches and visual symptoms in all of our patients. The mean surgery time was 93.89 min and the mean hospital stay (length of stay, LOS) was 2.3 days (Tables 1 and 2).

Failure of LP shunts necessitating revision occurred in seven patients (38.9%). The median time of failure is 212 days. Regarding causes of failure, we recorded three cases (16.6%) with shunt slippage (two patients from the spinal side and one patient from the peritoneal side). Furthermore, two patients had excessive drainage, one patient had peritoneal adhesions around the shunt tip (Fig. 2), and one had Arnold Chiari malformation

(Table 2). All revisions related to the peritoneal end in our study were made by laparoscopic-assisted approach. Excessive drainage was initially managed by conservative measures including lying flat, proper fluids intake, and low dose of caffeine. Out of two cases of excessive drainage, only one case was managed surgically by replacing the lumboperitoneal shunt with a ventricular shunt 6 weeks after the initial surgery. The Arnold Chiari malformation case was managed conservatively as it was asymptomatic and was discovered accidentally on a routine cervical MRI the patient was having for radicular arm pain, some of our authors do believe that this specific finding is already present in the patient before surgery and preferred to mention it as an incidental finding.

Discussion

To reduce the morbidities with the LP shunt procedure, the peritoneal step of the procedure can be performed with the help of minimal invasive laparoscopic surgery, which adds a diagnostic benefit in cases who have had previous abdominal interventions and allows adhesion-lysis before the insertion of the shunt's distal tip. Laparoscopy is indicated in revising the peritoneal end of the shunt avoiding classic open surgery [5, 14, 15].

Minimally invasive techniques became popular, and they improved clinical outcomes, reduce hospital costs,

Table 1 Basic and operative data of the studied cases: This table shows that there was no statistical significant difference between the studied groups in age, sex distribution, or risk factors

Variable		(N = 18)	
Age: (years)	Mean \pm SD	52.28 \pm 16.27	
	Range	23–78	
BMI	Mean \pm SD	30.19 \pm 6.24	
	Range	18.1–41.2	
Variable		No	%
Sex:	Female	13	72.2
	Male	5	27.8
Visual field abnormality	Yes	18	100
	No	0	0
Transverse sigmoid stenosis	Yes	11	61.1
	No	7	38.8
Complaint	Headache	18	100
	Visual affection	18	100
Previous abdominal surgery	No	10	55.6
	Yes	8	44.4
Conversion to minilaparotomy	No	18	100
Intraoperative complication	No	18	100
Operation time (minutes)	Mean \pm SD	93.89 \pm 17.4	
	Range	65–123	
Length of stay (days)	Mean\	2.3	

SD stander deviation, N number

Table 2 Relation between outcome and basic and operative data of the studied cases

Variable	N	Succeed (N = 11)		Failed (N = 7)		P Value
		No	%	No	%	
Sex	Male	5	4	80	1	0.6
	Female	13	7	53.8	6	
Age	Mean ± SD		48.73 ± 16		57.85 ± 16.23	0.26
BMI	Mean ± SD		29.85 ± 5.98		30.71 ± 7.09	0.79
Previous abdominal surgery	No	10	7	70	3	0.63
	Yes	8	4	50	4	
Operation time (min)	Median (IQR)		90.27 ± 17.91		99.57 ± 16.18	0.28
Hospital stay (day)	Median (IQR)		5(4–7)		7(4–8)	0.36
Complications	Number		11	61.1	7	38.8
	slippage		0	0	3	16.6
	peritoneal adhesions		0	0	1	5.5
	Over drainage		0	0	2	11.1
	Arnold chiari malformation		0	0	1	5.5

P value: all mentioned values are statistically insignificant

IQR interquartile range; BMI body mass index; Min minutes; N number; SD standard deviation

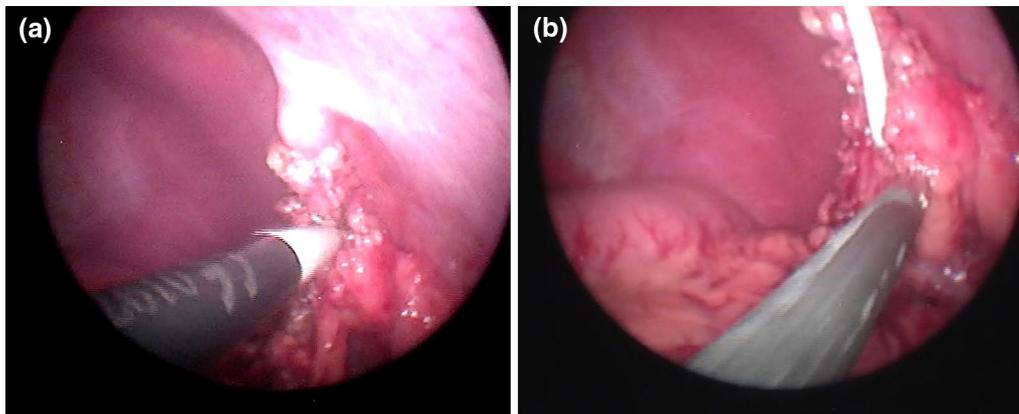


Fig. 2 **a** shows a laparoscopic view of peritoneal adhesions blocking the catheter tip at the peritoneal end causing shunt failure. **b** shows a clear shunt tip after laparoscopic adhesiolysis

and were less hazardous than the classic technique [3, 5, 16, 17].

Females made up the majority of our study sample (72%), which is consistent with the findings of Azad et al. [1] Maa et al. [5] and Sosin et al. [6] who all reported female predominance (92.5%, 71.4%, and 66%, respectively). The mean age of the patients was 52.28 years, with a range of 23 to 78 years, which is consistent with Sosin et al.'s finding that the mean age of 53 patients was 51 years, with a range of 16 to 83 years [6]. Maa et al. [5] reported a younger mean age of 41.5 years, with a range of 18 to 75 years. In contrast to Sosin et al. [6] who reported a mean BMI of 27.6 (range, 16–54), and Azad et al. [1] who reported that just 31.9% of their research

group were obese, the majority of our study sample was overweight or obese, with a mean BMI of 30.19.

We used the described treatment modality in the LP shunt procedure to treat IIH patients. Other indications for LP shunt, on the other hand, have been found. According to Johna et al. [14] the most common reason for LP shunt insertion is communicating hydrocephalus (44.4%), followed by normal pressure hydrocephalus (31.1%), and pseudotumor cerebri (13.3%). Tarlov cysts account for 8.8% of all cases, while 2.2% of cases had hydromyelia. Furthermore, Maa et al. [5] reported that LP shunt is indicated in cases of IIH (35%), pseudomeningocele (20%), and normal pressure hydrocephalus (19%).

Patients who have previously had a shunt placed, have had a history of abdominal surgery, have coagulopathy, or are obese are at high risk of complications or shunt failure. In our study, eight cases (44.4%) had previous abdominal surgery.

Laparoscopic-assisted shunt surgery reduced the operative time, which is advantageous for both the patient (by reducing anesthesia time) and the hospital. Raysi Dehcordi et al. and Naftel et al. [18] both were able to demonstrate that such findings were statistically significant. The mean surgery time was 93.89 min, with a range of 65–123 min. The mean operative time in Sosin et al. [6] study was 84 min. However, we discovered a decreased mean LOS (mean is 2.3 days) than Sosin's study which reported a mean LOS of 8.6 days ranging from 2 to 16 days. Argo et al. were also able to demonstrate a reduction in LOS in laparoscopic patients as well. [19].

The LP shunt has some drawbacks, according to Aoki et al. [20] including a limitation to communicating hydrocephalus or IIH, technical difficulties in patients with spinal deformity or obesity, and specific consequences such as radiculopathy, myelopathy, and Arnold Chiari malformation.

In our study, the conversion rate from laparoscopic assisted procedure to open procedure was 0%, and our intraoperative complication rate was 0%, demonstrating the technique's dependability and safety. This is similar to the results of several studies [5, 14, 17, 21].

LP shunt failure occurred in seven (38.9%) of the patients examined in our study. The median time of failure was 212 days. In terms of failure causes, we found three cases (16.6%) of shunt slippage (two patients from the spinal side and one patient from the peritoneal side). Furthermore, two patients had over drainage, one patient had peritoneal adhesions around the shunt tip, and one patient had Arnold Chiari malformation. Four patients developed postural headaches as a result of excessive draining, according to Johna et al. [14] study, and one patient developed Arnold Chiari malformation. Over 2 years, they were all treated with a laparoscopic shunt revision. Turner et al. reported on 111 patients who had a laparoscopic assisted procedure of LP shunt peritoneal catheter. The mean time of follow-up was 21.7 months. The mean hospital stay was 1–2 days. After 1 year 91% of cases had good outcomes regarding shunt function. Despite the 13.5% 1-year revision rate, no patient experienced any complications as a result of the peritoneal catheter placement [17]. Another complication that has been reported is cranial migration to the proximal spinal end [22, 23].

Percutaneous LP shunts were also described [24], which were followed by laparoscopic transabdominal LP shunts [13]. The transabdominal procedure requires

laparoscopic exposure of the anterior lumbar disc spaces. So it required advanced laparoscopic skills which may not be available at all institutes. Laparoscopy-assisted LP shunt placement outperforms percutaneous VP or LP shunt placement, whether percutaneous or laparoscopic transabdominal. It avoids brain cannulation and open abdominal wounds, allows good positioning of the tube tip, and allows diagnostic value and possible adhesiolysis. If a revision is required, the shunt tip can be localized and repositioned using laparoscopic techniques, avoiding the hazards of an open procedure [14].

As we explained in our results, Hay et al. [25] in their study concluded that laparoscopic-assisted LP shunt implantation resulted in better control of the disease, a shorter LOS, an earlier return to work, and better cosmetic results.

In their study, Taha et al. [26] concluded that the clinical outcome between both LP and VP in the treatment of IIH was not significant. However, in their results, the incidence of complications was (20.7% vs. 0%) and shunt revisions were more common in cases who had LP shunts than cases with] ventricular shunts applied with stereotactic technique.

In another study, Elatrozy et al. [27] described their technique for the placement of the peritoneal tip of LP using the ventriculoscope. They included 15 patients and results showed that the operative time was 84.5 min. They had 2 cases of shunt infection but no migration or obstruction [27].

Therefore, it is accepted that the routine method of placing LP shunt devices progresses to a laparoscopic-assisted technique. Our experience supports the use of laparoscopic.

Conclusions

The laparoscopic assisted technique is safe and feasible. It allowed a direct vision of the shunt tip position within the peritoneal cavity which helped in confirming position and assessing function, resulting in a superior option over classic surgical options. Short hospital stay, minimal postoperative pain, and low failure rates are the main advantages of described technique.

Limitations of the study

We have a relatively small patient's number in our study. Also, it is a non-controlled study and in the future, we do recommend a comparative study between open versus laparoscopic techniques.

Abbreviations

BMI: Body mass index; CSF: Cerebrospinal fluid; IIH: Idiopathic intracranial hypertension; LOS: Length of stay; LP: Lumboperitoneal; SPSS: Statistical Package for Social Sciences; VP: Ventriculoperitoneal.

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Author contributions

AA & HA & MAS has participated in performing surgical procedures, helped in drafting the article & revising it. EMY AAM participated in the research and article preparation and acquisition, analysis and interpretation of data. All authors have materially participated in the research and article preparation. All authors approved the final version to be submitted. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations**Ethics approval and consent to participate**

The study protocol was formally reviewed and approved by the ethics committee for human research at Faculty of Medicine, Zagazig University.

Consent for publication

Not applicable.

Competing interests

The authors declare there are no competing interests.

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