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SURGICAL ENDOSCOPY
and Other Interventional Techniques

Laparoscopically assisted peritoneal shunt insertion in hydrocephalus

A prospective controlled study

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Abstract
Background: Shunting of cerebrospinal fluid to the peritoneal cavity is standard therapy for the management of hydrocephalus. Common problems, however, are infection and shunt malfunction, which frequently is related to the peritoneal end of the catheter. Laparoscopic revision of distal shunt malfunction has become popular, but endoscopic techniques for primary placement of the peritoneal catheter are not performed often. This study aimed to compare laparoscopically assisted peritoneal catheter placement with the conventional minilaparotomy technique.
Methods: In the prospective arm of the study, 50 patients underwent laparoscopic distal shunt placement. The findings were compared with those for another group of 50 patients who underwent surgery by the standard transrectal or pararectal approach. Both groups were similar with regard to age, gender, American Society of Anesthesiologists (ASA) scores, indications for surgery, and frequency of previous abdominal operations.
Results: No intraoperative complications occurred. The mean time for surgery was 59 min in the laparoscopically assisted treatment group and 49 min in the standard group. During follow-up assessment, 3 instances of distal catheter malfunction or infection (2 malfunctions and 1 infection) occurred in the endoscopic group, and 12 instances (6 malfunctions and 6 infections) occurred in the control group. This difference was statistically significant.
Conclusions: The findings from this prospective controlled study indicate that the risk for long-term complications attributable to distal shunt malfunction is reduced when laparoscopic techniques are used to place the peritoneal end of the shunt catheter.

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Key words: Endoscopy — Hydrocephalus — Laparoscopy — Shunt

Shunting of cerebrospinal fluid (CSF) to the peritoneal cavity is the most frequently used therapeutic option for the management of hydrocephalus [10, 15]. As a primary procedure, CSF shunting constitutes a major medical and economic problem [15]. Although intraoperative complications are rare, shunt malfunction may occur in 30% to 40% of patients [10, 15]. Shunt malfunction can be related to infection, overdrainage, underdrainage, and hardware-related or mechanical problems. Often, the peritoneal end of the shunt has been identified as the cause for the dysfunction [13]. Therefore, since the late 1970s, attempts have been made to ensure proper placement of the catheter in the peritoneal cavity using laparoscopic techniques [18].

The advantages of a laparoscopic approach include lesser trauma to the abdominal wall and peritoneum, where the CSF is absorbed. The laparoscopic approach also offers the possibility of performing adhesiolysis and exquisite visualization of the peritoneal cavity, with *in situ* testing of catheter function. To date, endoscopically assisted techniques have been considered chiefly for patients undergoing revision surgery to resolve problems with the peritoneal end of the shunt catheter [16]. Only a few studies, however, have evaluated the usefulness of minimally invasive laparoscopic techniques for primary placement of the shunt catheter in the peritoneal cavity.

We report a prospective study of 50 patients with hydrocephalus who underwent laparoscopically guided shunt surgery. The results were compared with those for a group of 50 patients who underwent surgery by the standard minilaparotomy approach at the same institution.

Table 1. Demographic data, periprocedural course, and follow-up evaluation for two groups of 50 patients: an openVPS (minilaparotomy approach) group vs a lapVPS (laparoscopically assisted peritoneal shunt insertion) group

	OpenVPS ($n = 50$)	lapVPS ($n = 50$)
Mean age: range (years)	54 (0.02–86)	54 (1–85)
Sex (male / female)	23 / 27	22 / 28
ASA score I / II / III / IV	2 / 20 / 24 / 4	3 / 25 / 20 / 2
Previous abdominal operation	22	25
Primary shunt / revision surgery	39 / 11	37 / 13
Complication during operation	0	0
Mean first postoperative defecation (days)	2	2
Mean procedure: length in min (range)	49 (20–110)	59 (20–140)
Distal shunt malfunction/infection[a]	12	3
Mean follow-up: time in months (range)	18 (0.2–42)	11 (0.2–31)

ASA, American Society of Anaesthesiologists
[a] Difference is statistically significant ($p < 0.05$)

Materials and methods

All the patients were diagnosed and treated in the Department of Neurosurgery at the Oberschwaben Klinik in Ravensburg. In the prospective arm of the study, 50 patients underwent laparoscopically assisted distal catheter placement (LapVPS) over a period of 2 years. The control group comprised a cohort of 50 consecutive patients who underwent shunt surgery by a pararectal or transrectal minilaparotomy approach (OpenVPS) before the endoscopic study was initiated.

In the LapVPS group, the endoscopic surgeon inserted the shunt catheter into the peritoneal cavity immediately after proximal shunt placement was completed by the neurosurgeon. The distal catheter was tunneled subcutaneously from the head down to the abdominal wall, where it was temporarily externalized. The peritoneal cavity was entered via a small infraumbilical incision for positioning of a Veress-needle (Storz, Tuttlingen, Germany).

After carbon dioxide insufflation, a 5- or 10-mm trocar was inserted. Peritoneal inspection was performed with a 30° angle endoscope (Endovision; Storz). For placement of the shunt catheter, a disposable fragmentable needle (Braun, Melsungen, Germany) was used to enter the abdominal cavity under visual control, with the endoscope at the site where the shunt catheter was externalized. This type of fragmentable needle is used commonly by urologists to establish a suprapubic fistula of the urinary bladder. Through this needle, the catheter was introduced into the peritoneal cavity. Then the needle was split, and its two fragments were removed, leaving the catheter positioned in the abdominal cavity. The residual external sling of the catheter was pushed forward, thus completing its insertion. The position of the catheter within the peritoneal cavity and the free flow of CSF were controlled with the endoscope, allowing correction of its position if necessary.

For comparison of the two groups, the following data were evaluated and analyzed: age, sex, American Society of Anaesthesiologists (ASA) scores, cause of hydrocephalus, previous abdominal operations, primary or revision shunt surgery, complications during or after surgery, length of the procedure, first postoperative defecation, infection, and distal shunt malfunction during follow-up evaluation. Symptoms attributable to proximal shunt malfunction or overdrainage were not analyzed. Statistical analyses were performed using the chi-square test, the exact test of Fisher and Yates, and Student's *t*-test.

Results

There was no statistically significant difference between the two groups in terms of age, sex, distribution of ASA scores, and frequency of previous abdominal surgery (Table 1). Primary shunt placement or revision surgery was a similarly frequent indication for surgery in both groups. The causes underlying hydrocephalus are listed in Table 2.

Table 2. Etiology of hydrocephalus in two groups of 50 patients: an openVPS (minilaparotomy approach) group vs a lapVPS (laparoscopically assisted peritoneal shunt insertion) group

Indication	OpenVPS	LapVPS
Normal pressure hydrocephalus	11	14
Subarachnoid haemorrhage	18	10
Severe craniocerebral trauma	2	6
Congenital hydrocephalus	2	5
Myelomeningocele	1	1
Intracranial cyst	4	0
Brain tumor	1	5
Obstructive hydrocephalus	7	5
Malresorptive hydrocephalus (other causes)	4	4
Total	50	50

The mean length of the procedure was 59 min in the LapVPS group and 49 min in the OpenVPS group. This time span included the endoscopic part in the LapVPS group. No intraoperative complications were recorded. There was no difference in occurrence of the first postoperative defecation between the two groups.

The mean follow-up period for the OpenVPS group was 18 months. During that period, 12 instances of shunt malfunction or infection (6 infections and 6 mechanical distal catheter problems) were observed, requiring 11 operations for shunt revision. One shunt infection was treated successfully with antibiotics. The mean follow-up period for the LapVPS group was 11 months. In this group, three instances of shunt malfunction occurred: two related to mechanical peritoneal catheter obstruction and one attributable to shunt infection. Revision surgery was performed via standard minilaparotomy. The difference in complication rates and frequency of reoperations was statistically significant.

Discussion

Laparoscopic operations have become widely accepted in abdominal surgery. In particular, because laparo-

Table 3. Endoscopically assisted peritoneal shunt placement: literature review

Authors	Year	Primary operations	Revisional operations	No. of cases
Armbruster et al. [1]	1993	3	0	3
Basauri et al. [2]	1993	6	0	6
Schievink et al. [20]	1993	10	0	10
Cuatico and Vannix [4]	1995	11	0	11
Box et al. [3]	1996	4	2	6
Khosrovi et al. [8]	1998	2	11	13
Reimer et al. [17]	1998	53	0	53
Khaitan and Brennan [7]	1999	10	0	10
Roth et al. [19]	2000	17	10	27
Kubo et al. [11]	2001	8	0	8
Kirshtein et al. [9]	2004	28	24	52

scopic surgery involves only minimal surgical trauma to the abdominal wall, patients experience less postoperative pain. Because placement of the distal shunt catheter usually is performed using a small laparotomy, postoperative pain poses no serious problem for hydrocephalic patients.

In contrast to laparoscopic placement of the catheter, however, visual control of the catheter position and its functioning is not possible with the open approach. This, in our opinion, is the main advantage of the laparoscopic technique. The results of the current study indicate that the risk for long-term complications attributable to distal shunt malfunction is reduced when laparoscopic techniques are used to place the peritoneal end of the shunt catheter.

In the past few years, various new shunt valves to reduce the risk of overdrainage have become available [10, 21]. It appears, however, that the number of reoperations attributable to shunt malfunction or infection has not changed considerably over the decades [14]. The frequency of shunt malfunction related to problems with the distal end of the catheter varies from series to series. The most common complications involving the peritoneal end of the shunt catheter include extraperitoneal placement or dislocation of the catheter, subcutaneous or intraperitoneal collection of CSF because of adhesions or cyst formation, subclinical infection with subsequent obstruction of the shunt, restriction of free CSF flow by the great omentum, incisional herniation, and, more rarely, perforation of abdominal organs [13].

Rodgers et al. [18] were the first to describe the use of laparoscopic techniques for patients with ventriculoperitoneal shunts and shunt malfunction in 1978. Since their report, endoscopic techniques have been used to retrieve "lost" abdominal catheters and to handle abdominal CSF retention cysts, abdominal wall perforations, and intestinal strangulations caused by the catheter [5, 12, 16]. Since Armbruster et al. [1] explored the feasibility of laparoscopically assisted implantation of ventriculoperitoneal shunts in 1993, several reports have commented on this technique [2–4, 7–9, 11, 17, 19, 20] (Table 3). In general, endoscopic techniques were found to be helpful, and it was claimed that the overall rate of shunt malfunction would be reduced. Only one study, however, compared its results with those of a control group [4]. In this study, 11 consecutive patients underwent laparoscopically guided insertion of the peritoneal end of the shunt catheter without failure. In a group of 11 historical controls, 3 patients required repeat surgery. The length of the follow-up period was not provided in this article. Endoscopic insertion of the shunt catheter into the peritoneal cavity has been modified in various technical modifications [6].

Our prospective, controlled multipatient study on endoscopically assisted insertion of the peritoneal end of the shunt catheter verifies the conclusions of earlier reports. Although this is the first study with a large control group and longer follow-up evaluation, methodological challenges remain that must be considered when the data are interpreted. First, the sample size of both groups was limited to 50 patients. Second, only the endoscopic arm of the study was prospective, and the frequency of infection was relatively high in the control group.

Overall, we believe the endoscopic technique described in this report has several advantages. In particular, it is most useful for very obese patients and those who have undergone previous abdominal surgery. The mean operative time is prolonged by only 10 min. With the described technique, expensive one-way materials are not necessary. Although still longer follow-up observation is needed in a larger cohorts of patients, we suggest that laparoscopic distal shunt catheter placement is a suitable method for reducing the frequency of shunt malfunction.

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