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Outcomes of Laparoscopic Secured Suprahepatic Placement of Distal Catheter of Ventriculo-Peritoneal Shunt in Hydrocephalic Children with Previous Peritoneal Failure

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Abstract

Background: Various approaches for peritonealcavity have been described for distal shunt placement; mini-laparotomy is the traditional one. Though easy doable by neurosurgeons, this approach carried a significant risk for distal shunt blockage, preperitoneal placement, adhesion formation, visceral injury and increased postoperative pain.

Laparoscopic supra hepatic placement of distal catheter of ventriculo-peritoneal shunt (V-P shunt) might offer CSF drainage into the subdiaphragmatic space with its inherent high absorptive capacity, away from omental reactions and bowel entanglement.

Aim of Study: To present the technical description and the early outcomes of laparoscopic secured supra-hepatic placement of the distal end V-P shunt, regarding distal shunt failures, in hydrocephalic children with previous peritoneal failure.

Patients and Methods: A prospective study of 17 hydrocephalic childrenwho presented with peritoneal failure of previously inserted VP-shunt. Distal shunt placement into the peritoneal cavity was carried out laparoscopically to secure the supra hepatic placement. Close outpatient clinic follow-up was carried out to detect procedure-related morbidities and distal shunt failures.

Results: 17 hydrocephalic children admitted to Misr Children Hospital between 2021 and 2023 were included in this work. The mean age at operation was 6.7 months, with a mean body weight of 7.2kg.

The operative time for laparoscopic placement ranged between 35min and 50min (mean 47.5 min).

All patients were followed-up for 6 months at minimum. No procedure related mortalities were reported in the enrolled group. Three distal shunt re-failures were documented (18%).

Conclusion: Mid-term results proved that laparoscopic secured supra-hepatic placement of distal catheter of V-P shunt is a feasible and safe approach in children with previous peritoneal failure. It guarantees effective CSF drainage with low rates of shunt malfunction. Nevertheless, long term follow-up and comparative evaluation with bigger patients' sample seemed crucial to validate these results.

Key Words: *Hydrocephalus – Children – Laparoscopy – Supra-hepatic – V-P Shunt.*

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Introduction

SHUNT malfunction is not an uncommon complication of V-P shunt surgery. It may be due to misplacement of the proximal or distal catheter at the time of insertion, later obstruction of either catheters or both, infection, or failure of the valve **[1-3].**

Blind placement of distal catheter through conventional laparotomy carried distal catheter failure rates between 5% and 35% **[4,5].**

Since it was first introduced in 1993, laparoscopically guided distal catheter placement offered a feasible alternative to laparotomy placement with significant lower rates of shunt malfunction **[6,7].**

Several laparoscopic techniques have been presented for distal catheter placement in hydrocephalic adults; a distal catheter with an intra-abdominal length of ~20cm seemed sufficient in those reports **[8-12].**

To our knowledge, this is the first reported prospective enrollment of laparoscopic placement of

distal shunt catheter in hydrocephalic children who presented after previous distal shunt failure. The authors hypothesize that such approach would offer effective CSF drainage into the subdiaphragmatic space with its good inherent absorptive capacity and away from omental reactions and bowel entanglement.

Patients and Methods

A prospective study carried on 17 consecutive children admitted to Misr Children Hospital from Jan. 2021 to Dec. 2023 with congenital hydrocephalus for shunt revisions. Excluded from the study were cases of secondary hydrocephalus, and children with severe associated CNS anomalies.

One neurosurgeon and two general pediatric surgeons managed the included cases per intervention.

For all patients, shunt re-placement was done into the sub diaphragmatic space using a unified laparoscopic technique, as described thereafter.

Preoperative patients' characteristics and operative data were thoroughly investigated, in relation to outcome.

Operative technique:

Under general anesthesia, patients were placed across the table, supine with the head turned laterally. A prophylactic intravenous dose of third generation cephalosporins was uniformly administered in the studied group.

Meanwhile the neurosurgeon commenced placement of the intracranial portion of the shunt, two general pediatric surgeons accessed the peritoneal cavity laparoscopically; a circum-umbilical skin incision was done to introduce a 30º5mm scope using Hasson technique. Insufflation pressures were kept between 6-8mHg throughout the procedure. Two 3mm working instruments were inserted, portless, at mid-clavicular line of both hypochondrial areas.

A monoplolar electrocautery applied to the right working instrument as well as ligasure were used to do adhesiolysis and to create a hole at the falciform ligament midway between its liver and abdominal wall attachments, 1cm from the central tendon of the diaphragm.

After been subcutaneously tunneled by neurosurgeons, a subcostal mid-clavicular stab incision was used to introduce the intra-abdominal segment of the shunt, that was directed to traverse the falciform ligament through the created hole to the left sub diaphragmatic space then revolved around the free edge of the falciform ligament to the right sub diaphragmatic space, from where it was re-introduced into the falciform hole.

Bilateral hypochondrial anchoring stitches, 4/0 Silk/EthibondTM, were used to fix the revolving shunt in place. The procedure ended by checking the subdiaphragmatic course of the shunt and testing the whole system functionality through vertical presses on shunt reservoir. Fig. (1 A-D).

Post-operative work:

Patients were discharged home 6-8 hrs after surgery. Post-operative clinic follow-up started a week later, where an erect abdominal X-ray film was done to check the hinged sub-diaphragmatic shunt positioning.

All enrolled cases were assessed clinically for shunt function for at least 6 postoperative months (at 2 weeks, 6 weeks, 3 months, and 6 months), and CT brain was ordered for suspiciousfollow up results. Shunt failure was defined as shunt obstruction, infection, component fracture, skin breakdown, or shunt over drainage.

Dependent variables being evaluated in our study were the occurrence of shunt failure and its cause, intra operative mishaps, and operative time. The most recent patient encounter (clinic visit or hospital discharge) was taken as the end point of the study. We assume that patients who did not present to outpatient clinic had a functioning shunt for the interim period. Other endpoints of the study were any occurrence of shunt revision, shunt removal, or patient death.

Results

Through the years 2021-2023, 17 hydrocephalic children admitted to Misr Children Hospital were enrolled in this work. There were 12 males and 5 females. The mean age at operation was 6.7 months, with a mean body weight of 7.2kg.

The operative time for laparoscopic placement ranged between 35min and 50min (mean 47.5min).

There were no reported incidents of intra-abdominal visceral injury in the studied group. No conversion to laparotomy was reported. System failure due to ventricular catheter misplacement was detected at the end of the laparoscopic procedure in one case, where immediate correction was done.

After an average follow-up of 11 months (range: 6-29 months), no procedure related mortalities were reported in the studied group. Three shunt failures were documented (18%), all were due to distal catheter failure. There were no reported cases of shunt infection or skin breakdown. None of our cases presented with adhesive bowel obstruction.

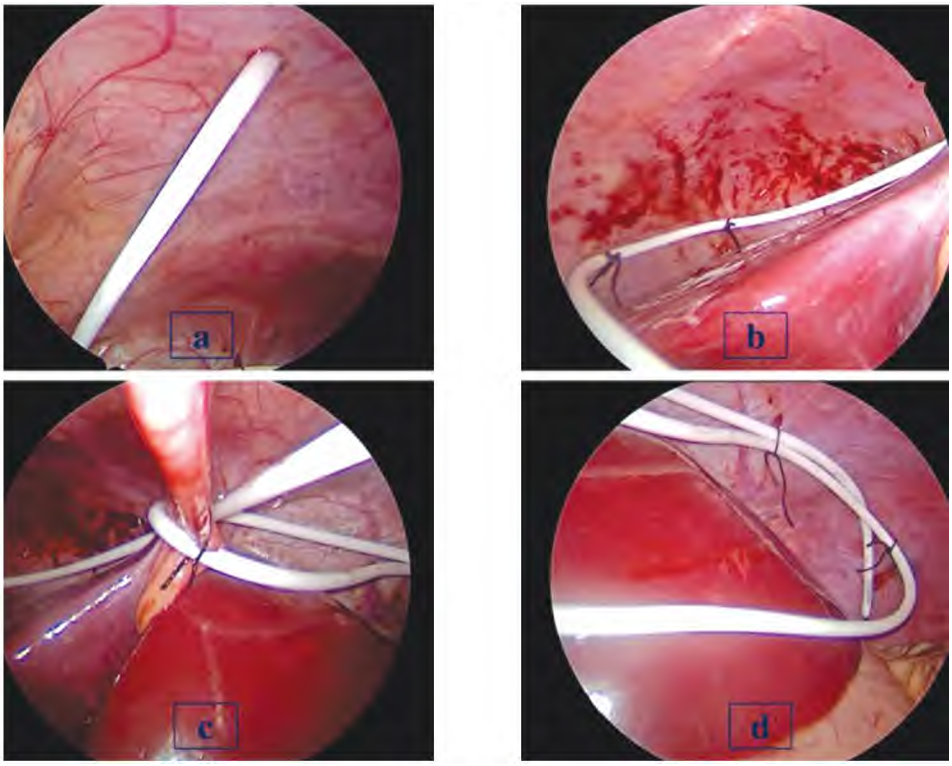

Fig. (1): Illustrates the operative steps of securing the suprahepatic placement of the distal catheter of the VP shunt: (A) Entering the abdominal cavity, (B) Silk stitches anchoring the distal catheter in the right subphrenic space, (C) Catheter traversing the falciform ligament, (D) Silk stitches anchoring the distal catheter in the left subphrenic space.

Discussion

Ventriculo-peritoneal shunting is the most common treatment option in cases with hydrocephalus. However, management alternatives include endoscopic third ventriculostomy and choroid plexus coagulation *[13]*.

A strong advantage of laparoscopically guided catheter placement is the ability to insert the catheter correctly in a desirable location without endangering the abdominal viscera *[5]*. In addition, it allows confirmation of the whole system functionality by the end of surgery by giving vertical pressures on the reservoir and observing for free CSF flow from the distal catheter under direct laparoscopic visualization. In other words, this tests the integrity of the whole hardware shunt system *[14]*.

Various reports proved these advantages in adults with hydrocephalus of variable etiologies. The peritoneal catheter was inserted through either a vertebroplasty needle *[15]* or a veress needle with peel-apart introducer *[16,17]* and guided toward the left lower abdominal compartment under videoscopic observation. Other authors utilized a curved dissector to poke the abdominal wall from the inside to grasp the tip of the catheter and direct it into an adhesion-free territory of the peritonealcavity *[18]*. Others reported the employment of the falciform ligament to tether the distal catheter above the liver with *[19]* or without clipping *[3]*, or through being drilled into 2 or 3 holes *[3]*, seeking a more secure fixation.

Even though a diversity of laparoscopic techniques was described, all showed a significant lower incidence of distal shunt obstruction than with conventional laparotomy, with no intraoperative bowel injury, conversion to laparotomy, or intolerance to pneumoperitoneum *[1,3,20]*.

Turner et al., reported a one-year shunt survival rate of 91% among his series (n=113) of laparoscopically assisted shunt placements *[21]*.

Naftel et al., enrolled 810 hydrocephalic adults in his study. He reported that shunt obstruction occurred significantly more often in the conventional laparotomy group (p=0.012). Among his reported cases with shunt obstructions, distal obstruction occurred in 35.7% of the laparotomy group obstructions and 4.8% of the laparoscopic group obstructions (p=0.014). He concluded that the relative risk of distal obstruction in laparotomy cases versus laparoscopic cases was 7.5 *[4]*.

In our series, Laparoscopic placement of distal catheter was applied in a group of hydrocephalic children (n=17). In such children, the relatively

lengthy distal catheter to be threaded abdominally represents a technical laparoscopic challenge. So, to achieve results like previous reports of adult hydrocephalus, some technical steps need to be taken to secure the position of the distal catheter during laparoscopic insertion away from bowel entanglement, omental block or poking against bowel wall.

The adopted technique in our series utilized the falciform ligament and the bilateral hypochondrial non-absorbable hinging stitches to allow exact placement of the lengthy catheter into the sub diaphragmatic space. Checking the shunt function by the end of procedure allowed detection of proximal catheter failure in one case, and prompt treatment of the problem.

Short-term follow-up, small sample size and lack of comparative evaluation are the limitation points in our work.

Conclusion:

Mid-term results proved that laparoscopic secured supra-hepatic placement of distal catheter of V-P shunt is a safe feasible approach for children with previous shunt failure. It guarantees effective CSF drainage with lower rates of shunt malfunction. Nevertheless, long term follow-up and comparative evaluation with bigger patients' sample seemed crucial to validate these results.

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نتائج تثبيت القسطره البريتونيه بالمنظار فوق الكبد فى الاطفال المصابين باستسقاء الرأس ما بعد فشل بريتونى سابق

تم وصف طرق مختلفة لوضع القسطره داخل التجويف البريتونى؛ عملية فتح البطن المصغرة هى الطريقة التقليدية. على الرغم من أنه من السهل تنفيذه من قبل جراحى الأعصاب، إلا أن هذا النهج يحمل خطرًا كبيرًا لانسداد القسطره الطرفيه، وتكوين الالتصاق، وإصابة الأحشاء الداخليه، وزيادة الألم بعد العملية الجراحية.

قد يوفر وضع القسطرة الطرفيه للتحويلة البطينية البريتونية (تحويلة VP) بالمنظار فوق الكبد تصريفًا للسائل الدماغى الشوكى إلى المنطقه تحت الحجاب الحاجز والتى تمتاز بقدرتها الامتصاصية العالية، بعيدًا عن التفاعلات البريتونيه وتشابك الأمعاء.

الهدف من الدراسة: تقديم الوصف الفني والنتائج المبكرة للوضع فوق الكبدى الآمن بالمنظار للقسطره البريتونيه لتحويلة VP، لدى الأطفال المصابين باستسقاء الرأس الذين يعانون من فشل بريتونى سابق.