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Laparotomy vs minimally invasive laparoscopic ventriculoperitoneal shunt placement for hydrocephalus: A systematic review and meta-analysis

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ABSTRACT

Ventriculoperitoneal shunt (VPS) surgery is the most commonly used method for the treatment of hydrocephalus. Traditionally, distal catheters in the VPS surgery have been placed either through a standard small open laparotomy or via a laparoscopic technique. Although there are many studies demonstrating the benefits of a minimally invasive approach, limited research has directly compared the two techniques used in VPS surgery. The present meta-analysis aims to provide the first comprehensive review of all published observational studies and randomized controlled trials reporting outcomes of laparotomy and laparoscopy in VPS. Electronic searches were performed using six databases from their inception to February 2015. Relevant studies comparing conventional laparotomy and a laparoscopic video-guided approach in VPS were included. Data were extracted and analyzed according to predefined clinical endpoints. A total of ten studies were identified for inclusion in the present analysis. Results indicated that the laparoscopic technique was associated with a slight but significant reduction in operating time (~10 min), a significantly lower rate of abdominal malposition, distal obstruction and distal shunt failure. There was no difference between the laparotomic and laparoscopic approaches in the length of hospital stay, complication rate, proximal shunt failure or infection rate. The present systematic review and meta-analysis demonstrated that the laparoscopic technique in VPS surgery is associated with reduced shunt failure and abdominal malposition compared to the open laparotomy technique, with no significant difference in rates of infection or other complications. The lack of studies with high levels of evidence may contribute to bias in our conclusions and the long-term relative merits require validation by further prospective, randomized studies.

Contents

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1. Introduction

Hydrocephalus is defined as the abnormal accumulation of cerebrospinal fluid (CSF) in the ventricles of the brain due to congenital, acquired or idiopathic pathologies. As a consequence of increased volume, there is a subsequent rise in intracranial pressure (ICP) driving various neurological defects. In the pediatric population, hydrocephalus has been demonstrated to cause an increase in cranial size, and more severely, developmental, intellectual, and physical disabilities [1,2]. The reported incidence in developed countries is estimated at 0.2–1.2 per 1000, though this figure is thought to be underestimated due to missed diagnoses [1].

The most common treatment of hydrocephalus is ventriculoperitoneal shunting (VPS), which involves diversion of extra CSF from the ventricular system into the peritoneum, though the surgical technique through which this is achieved varies. The goals of surgical intervention include: normalization of CSF flow or arresting the level of hydrocephalus while avoiding severe complications [1].

Initially described in 1908, the classic method of establishing a VPS via open laparotomy became popular when the Silastic catheter was introduced in 1967, and it remained the mainstay of surgical therapy across all age groups for decades [2]. In this technique, a distal catheter is passed subcutaneously from the valve to the right upper abdominal quadrant, where it is placed into the peritoneal cavity.

Though successful in improving ICP, the open approach has several risks for complications including infection, visceral injury, adhesion formation, postoperative hernia formation, and increased postoperative pain at either the ventricular or peritoneal insertion sites [3]. Recent cohort study data by Reddy et al. estimated adult infection rates from VPS procedure to be as high as 5.1% with the figure almost doubled in pediatric populations [4].

Further, mechanical failure, improper placement, or dislocation of the shunt also happens frequently, requiring the patient to undergo a shunt revision. Current published studies demonstrate revision rates of around 40% in adult populations, with the vast majority of these patients requiring revision within 6–12 months [4–7]. According to Reddy et al. the mean number of revisions per patient is 0.6, with the figure almost four-fold in the pediatric population [6].

The emergence of new techniques since the end of the 20th century, namely minimally invasive operations, has been aimed at reducing the high complication incidence associated with open laparotomy. Amongst all, a laparoscopic approach originally used as a secondary shunt revision procedure quickly became a popular alternative as it highlights several advantages, including ability to inspect abdominal cavity, perform adhesiolysis and ensure the peritoneal end is not kinked or placed in a pocket of abdominal adhesions. Secondly, laparoscopy also reduces abdominal wall trauma and post-operative morbidity, since it requires smaller incision with smaller peritoneal and fascia openings and fewer formed secondary adhesions, less post-operative pain, a decrease in the incidence of post-operative ileus, less risk of perforating abdominal organs and a decrease in the frequency of incisional herniation. This can result in reduced complication rate, improved post-operative pain and a reduced hospital length of stay (LOS) [8–11]. Using a laparoscopic approach in a cohort of 111 patients, Turner et al. demonstrated a one-year shunt survival of 91% and reported infection rate of <2% [12]. Further, a modified laparoscopic approach has been highlighted to be of particular benefit to obese patients and those with previous abdominal surgeries [13–15].

On the contrary in a non-obese patient a small laparotomy would be only slightly bigger than multiple laparoscopic wounds. Laparoscopy is not a common skill for neurosurgeons and will likely need the assistance of a general surgeon.

Despite individual studies suggesting improvements associated with a minimally invasive approach, there are few studies directly comparing outcomes across both methods (open laparotomy vs laparoscopic approach) in the context of VPS surgeries. There is one multicenter study demonstrating a lack of benefit with an endoscopic approach, which, however, only included pediatric patients [7]. The present meta-analysis is the first comprehensive review, to our knowledge, of all published randomized controlled trials and observational studies reporting the clinical outcomes of laparoscopy and laparotomy in VPS.

2. Methods

2.1. Search strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses PRISMA guidelines were followed for the present systematic review [16,17]. Electronic searches were performed using Ovid MEDLINE, PubMed, Cochrane Central Register of Controlled Trials (CCTR), Cochrane Database of Systematic Reviews (CDSR), ACP Journal Club, and Database of Abstracts of Review of Effectiveness (DARE), from their dates of inception to February 2015. To achieve maximum sensitivity of the search strategy, we combined the terms “minimally invasive” OR “laparoscopic” OR “video-assisted” AND “laparotomy” AND “shunt” AND “ventriculoperitoneal” which were searched as text words and exploded as MeSH headings where possible. Two authors performed the search independently, and any discrepancies were resolved by discussion. The reference lists of all retrieved articles were reviewed for further identification of potentially relevant studies, assessed using the inclusion and exclusion criteria. Expert academic neurosurgeons were consulted as to whether they were aware of any unpublished data.

2.2. Selection criteria

Eligible studies for the present systematic review and meta-analysis were comparative studies comprised of patients requiring a ventriculoperitoneal shunt, either via conventional laparotomy or a laparoscopic video-guided approach. Studies that did not include mortality or complications as endpoints were excluded. Studies with fewer than 10 patients in each cohort were also excluded. When institutions published duplicate studies with accumulating numbers of patients or increased lengths of follow-up, only the most complete reports were included for quantitative assessment. All publications were limited to those involving human subjects