

Ventriculoperitoneal Shunt Failure as a Complication of Laparoscopic Surgery

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ABSTRACT

Objective: The authors report the first documented case of laparoscopically induced ventriculoperitoneal (VP) shunt failure.

Summary Background Data: Laparoscopic surgery has become a preferred method of accessing and treating a variety of intraperitoneal pathology. Surgeons can expect to encounter patients who have previously undergone placement of cerebrospinal fluid (CSF) shunts who present as candidates for laparoscopic procedures. Currently, the presence of a CSF shunt is not considered to be a contraindication to laparoscopy. We report the first documented case of laparoscopically induced VP shunt failure.

Clinical History: A patient with shunt-dependent hydrocephalus underwent laparoscopic placement of a feeding jejunostomy. Postoperatively, clinical and radiographic evidence of shunt failure was noted. The patient underwent emergent shunt revision. Intraoperatively, an isolated distal shunt obstruction was encountered. Gentle irrigation cleared the occlusion. We believe that this shunt dysfunction was secondary to impaction of either soft tissue or air within the distal catheter as a consequence of peritoneal insufflation.

Conclusions: It is concluded that laparoscopic surgery may represent a potential danger in patients with pre-existing CSF shunts. The risk of neurological injury faced by this patient population during laparoscopy is derived from peritoneal insufflation and relates to two primary concerns. The first is impaired CSF drainage due to a sustained elevated distal pressure gradient or, as in our case, an acute distal catheter obstruction. The second concern relates to the potential for retrograde insufflation of the CSF spaces through an incompetent shunt valve mechanism. Distal shunt catheter externalization performed in conjunction with a neurosurgeon during the laparoscopic

procedure would prevent these complications. Internalization of the distal shunt catheter would then be performed at the completion of the laparoscopic procedure.

Key Words: Shunt failure, Laparoscopy.

INTRODUCTION

In recent years, laparoscopic surgery has emerged as a preferred method of accessing and treating a variety of intraperitoneal pathology. Its popularity among both the medical and lay communities has been sustained by its demonstrated economic and cosmetic benefits when compared to the historic alternative of open laparotomy. In appropriate surgical candidates, laparoscopic surgery is considered safe, with a mortality rate of less than 0.5% and a major complication rate of 2.49%.¹ Given the increasing applications of laparoscopic intervention, general surgeons can expect to encounter patients who have previously undergone placement of ventriculoperitoneal (VP) or lumbo-peritoneal (LP) shunts for the treatment of hydrocephalus and who present as potential candidates for a laparoscopic procedure.

Currently, the presence of a cerebrospinal fluid (CSF) shunt is not considered by the surgical or shunt manufacturing communities to be a contraindication to laparoscopy. A review of the Medline literature failed to reveal any report within the general surgical, obstetric/gynecological, or neurosurgical database of shunt-related morbidity or mortality as a complication of laparoscopic surgery. In fact, the safety of laparoscopic surgery has been described in a small series of patients with VP shunts.² We report, however, what appears to be the first case of VP shunt failure as a direct consequence of a laparoscopic surgical procedure.

CASE HISTORY

A 52-year-old Native American male presented to the neurosurgical service with a precipitous decline in mental status. The patient's medical history included hypertension with a previous cerebrovascular accident, metabolic encephalopathy related to chronic alcoholic liver disease, intravenous drug use, and aseptic meningitis for which he had been treated four months earlier. On arrival, he was

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afebrile and his vital signs were stable. His Glasgow Coma Scale (GCS) score was 4 with extensor posturing noted. A comprehensive emergency room evaluation included a serum toxicology screen positive for cocaine and a basic head computed tomogram (CT) that demonstrated communicating hydrocephalus. There was no evidence of intracranial hemorrhage.

The patient was admitted to the intensive care unit (ICU), and a right frontal external ventricular drain (EVD) was placed after normal coagulation parameters were confirmed. Both lumbar and ventricular CSF cultures were negative for infectious pathogens, including bacteria, fungus, and tuberculosis. A follow-up head CT demonstrated good position of the EVD with ipsilateral ventricular decompression. However, the left ventricular system remained distended. The placement of a contralateral EVD was associated with radiographic improvement of the hydrocephalus. Thereafter, the patient's GCS score improved to 14, and he became alert and purposeful but remained confused. Symptomatic elevations in intracranial pressure (ICP) accompanied efforts to wean the EVDs. The patient was scheduled for placement of a VP shunt, but the procedure was delayed because of infectious complications (blood, urine) and electrolyte abnormalities encountered during the patient's ICU course. His GCS score declined in conjunction with these metabolic issues, fluctuating between 6 and 10 in the midst of stable serial head CT and electroencephalographic (EEG) evaluations.

Following medical clearance, the patient was taken to the operating room. Bifrontal ventricular catheters were inserted given the demonstrated isolation of the lateral ventricles on the patient's first postventriculostomy head CT. These catheters converged through a "Y" connector onto a single medium-pressure valve. The distal aspect of the shunt system was tunneled subcutaneously to a mini-laparotomy wound and was placed within the peritoneum. There were no apparent intraoperative complications, and the patient was extubated and returned to the ICU with his neurological examination unchanged.

Given the patient's persistent obtundation, a feeding jejunostomy was placed by a general surgeon five days later through a standard laparoscopic approach without intraoperative difficulty. Insufflation pressures within the peritoneum were maintained at approximately 15 mm Hg for the duration of the procedure (1.5 hours). Postoperatively, the patient tolerated extubation but was markedly more lethargic than his baseline condition. Within the recovery room, he failed to improve from a GCS of 4 (E 1, V 1, M 2) and developed intermittent periods of apnea. He was reintubated and the neurosurgery

service was notified. An emergent head CT demonstrated ventriculomegaly with no evidence of intracranial hemorrhage or pneumocephalus. The patient was returned to the operating room for an anticipated shunt revision, with efforts at bilateral shunt taps technically unsuccessful.

Intraoperatively, the shunt valve was disconnected from the distal system tubing. Brisk CSF outflow was observed from the valve. When the two ventricular catheters were disconnected from the proximal aspect of the shunt valve, CSF drained well from both. A manometer connected to the proximal aspect of the distal shunt tubing measured a static fluid column at 35 cm H₂O. Irrigation through the distal tubing with sterile saline initially met with resistance but was overcome with approximately 5 ml of fluid. Subsequent manometric testing repeatedly demonstrated distal fluid run off to less than 3 cm H₂O. With the individual shunt components verified as functional, the system was reconnected and the single incision reapproximated in a layered fashion. Postoperatively, the patient improved to a GCS of 7 (E 2, M 4, V 1) consistent with his prelaparoscopic neurological examination. A follow-up basic head CT obtained the next morning demonstrated a return of the patient's baseline ventricular size. The patient remained neurologically stable throughout the remainder of his acute hospitalization, and no further shunt difficulties were observed.

DISCUSSION

Laparoscopic approaches comprise an increasingly popular means of accessing the peritoneal cavity. In part, their appeal stems from a cost-containment perspective that documents shorter hospital stays and a more expeditious convalescence in patients who undergo the laparoscopic counterpart of an open surgical procedure. There is also the significant cosmetic advantage of substituting a typically obvious open laparotomy wound for a series of less obtrusive "stab" incisions. The use of laparoscopy in patients with CSF shunts has been addressed only briefly in the literature and typically has been limited to descriptions of laparoscopy as a means to accurately place the peritoneal aspect of shunts,³ to retrieve disconnected distal shunt catheters,⁴ or to treat intraperitoneal CSF pseudocysts in patients with shunts.⁵

There has been no prior documentation of shunt failure (VP or LP) as a primary result of laparoscopy, either after procedures specifically for shunt placement or revision, or as a complication of an intraperitoneal procedure performed for non-neurosurgical indications. At present, the literature contains a single case report of a previously placed VP shunt complicating a laparoscopic procedure.⁶

In that case, severe subcutaneous emphysema developed during peritoneal insufflation along a VP track created ten days earlier. The shunt system remained functional, and the authors concluded that a “recently” placed “peritoneo-subcutaneous” catheter should be viewed as a relative contraindication to laparoscopy. No literature yet suggests that the presence of a CSF shunt should preclude the performance of laparoscopy to maintain shunt function or to avoid neurological injury.

Two theoretical concerns are associated with performing laparoscopic procedures in patients with CSF shunts. First, during a laparoscopic procedure intraperitoneal pressure that approached or exceeded the upper range of normal ICP would establish a circumstance of “functional” shunt failure for the duration of the procedure. CSF drainage, if observed, would require an abnormally elevated and potentially harmful ICP to overcome the distal intraperitoneal pressure gradient. Furthermore, patients with low brain turgor (Kb),⁷ whose brains are abnormally compliant, would suffer severe ventricular distention even at distal insufflation pressures that were in a lower “physiologic” range. As indications for laparoscopic surgery expand to include larger and more lengthy procedures (i.e., hemicolecotomy), this period of “CSF stasis” and associated elevated ICP could become substantial.

The second concern pertains to the implicit reliance on a shunt system’s valve mechanism to prevent retrograde conduction of air to the ventricular or subarachnoid spaces. This property of “competence” refers not only to the in-line valves within VP shunt assemblies and sometimes added to LP shunt systems, but also to the slit valves intrinsic to the distal peritoneal catheters that sometimes function as the only resistance mechanism within LP shunt systems. A standard parameter of any shunt valve’s hydrodynamic profile, as derived by the manufacturer, is a quantification of “retrograde flow.” This variable is defined as the distal pressure head that a shunt valve can tolerate before allowing retrograde flow to occur.⁸ This “retrograde tolerance” would be expected to vary as a function of the specific mechanical construction of a valve.

Because it defines the upper limit of insufflation pressure that can be safely produced, the retrograde flow tolerance is relevant when laparoscopy is being considered in patients with a particular type of shunt valve. However, this parameter is not specifically detailed within standard shunt package inserts. Moreover, we contacted several individual shunt-valve manufacturers directly but could not always obtain the retrograde flow tolerance. Even if known, the retrograde flow tolerance is not amenable to in-vivo testing or confirmation. Consequently, the integri-

ty of a shunt valve with regard to this parameter can only be assumed. The potential danger of this assumption is underscored by a patient who died from intracranial hypertension as a consequence of tension pneumocephalus incurred during a laparoscopic procedure [personal communication, Kim Manwaring, MD, 1996]. It is unclear if this event was related to utilization of insufflation pressures that exceeded the valve’s intended tolerance, or if it was a function of a defective valve.

Our patient had shunt-dependent postinflammatory (aseptic meningitis) hydrocephalus and deteriorated acutely after a laparoscopic procedure. Ventriculomegaly was demonstrated on head CT and acute shunt failure was diagnosed. The head CT did not demonstrate pneumocephalus, which, if present, would have suggested an incompetent shunt valve. Given the testimony of the general surgical service that the peritoneal cavity was completely decompressed after the laparoscopic procedure, we believe that the observed hydrocephalus was unrelated to a “pseudofailure” of the shunt caused by elevated intra-abdominal pressure. This phenomenon has been described in pregnant women with VP shunts and can often be managed conservatively with scheduled reservoir flushing and serial shunt taps.⁹ In this case, an urgent shunt revision was undertaken and distal shunt failure was recognized intraoperatively. Re-establishing distal patency was easily achieved by flushing the distal tubing with sterile saline, at which time the operator initially perceived a minimal degree of resistance. The precise mechanism of transient distal occlusion is uncertain because the catheter obstruction was corrected without intraperitoneal inspection being necessary. We speculate that either soft tissue was impacted (i.e., omentum), or an air lock was produced within the distal shunt tubing in the course of intraperitoneal insufflation. Of note, the distal slit valves had been removed from the intraperitoneal tubing at the time of shunt insertion, leaving only a single distal aperture for CSF outflow. Retrospectively, had the neurosurgical service been immediately available to perform successful diagnostic and therapeutic shunt taps, a more conservative solution that incorporated active pumping of the shunt reservoir to clear the acute distal obstruction could have been initiated.

Although many patients with CSF shunts that involve the peritoneum have presumably undergone laparoscopic surgery without difficulty, a potentially fatal complication has been observed as discussed above. A simple means of preventing shunt-related complications in patients undergoing laparoscopy would be to externalize the distal shunt catheter(s) through a dedicated laparoscopy port for the duration of the procedure. Externalization could easily be accomplished by noting the location of the mini-

laparotomy incision previously utilized for shunt insertion. The incision would guide intraperitoneal localization of the distal catheter with the laparoscope, which could then be pulled proximally and externalized. This maneuver would guarantee both continued CSF drainage throughout the procedure and would eliminate any assumptions regarding the competence of the shunt valve or the risk of retrograde insufflation. Although no prospective, randomized evidence is available to quantify the risk of infection associated with shunt externalization in this situation, it would likely be minimal with careful technique. Only a segment of distal catheter long enough to allow connection to a sterile collection system within the operative field would need to be exposed. Whereas the alternative of temporarily placing a vascular clip across the distal shunt tubing would prevent reflux of insufflation along the shunt and allow the shunt system to remain intraperitoneal, it would also deprive the patient of CSF drainage for a potentially dangerous period. Placing a butterfly needle within the proximal or flushing reservoir of a VP shunt would allow ICP transduction and CSF drainage during the procedure. This management scheme, however, would likely carry a higher risk of shunt infection than simple distal externalization of the shunt, and it would introduce the possibility of damaging the shunt valve if a needle had to be inserted within the flushing reservoir. After the peritoneal cavity has been decompressed at the completion of a laparoscopic procedure, the distal shunt catheter should be internalized and inspected to insure continued patency.

If CSF output was not observed upon externalization or inspection of the distal VP shunt catheter, the shunt flushing reservoir should be manipulated to expel air or soft tissue that may have been impacted within the distal shunt system upon initial insufflation. Failure to observe CSF flow would imply one of two possibilities: 1) the patient arrived at surgery with a nonfunctional shunt and is apparently shunt independent, or 2) the mechanism of acute shunt dysfunction is proximal to or involves the VP shunt valve and is unresponsive to closed manipulation for correction. Preoperative percutaneous manipulation of the VP shunt's flushing reservoir and associated proxi-

mal and distal occluders, if present, by an experienced neurosurgeon would provide further information regarding baseline shunt function before laparoscopy. LP shunts cannot be manipulated percutaneously. In the event that an LP shunt is present and no CSF output is noted after externalization, gentle aspiration of the distal end should be performed. This maneuver would correct a reversible obstruction to CSF flow and could be performed even if an in-line valve had previously been incorporated within the LP shunt system. We believe that consultation with a neurosurgeon for shunt manipulation or externalization before or during laparoscopy is advisable.

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