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Experience with use of extended length peritoneal shunt catheters

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The placement of a ventriculoperitoneal (VP) shunt is the current treatment of choice for diversion of cerebrospinal fluid associated with hydrocephalus. Although there are a host of reported potential abdominal complications related to the procedure, they are notably uncommon. The authors report their experience with the primary insertion of an extended length open-ended peritoneal tubing (120 cm) undertaken expressly to avoid the need for a lengthening procedure because of growth of the patient. In a review of new insertions of VP shunts using the extended length tubing over a 14-year period at Childrens Hospital of Los Angeles, a total of 998 shunts were placed in 952 patients, with a mean follow-up period of 6.7 years. The patients experienced a total of 52 distal shunt revisions for a variety of malfunction etiologies. In patients ranging in age from premature neonate to 20 years, there was no increase in the distal complication rate, and specifically no complications were experienced that were directly related to the use of the extended length tubing. The authors conclude that the use of an extended length peritoneal shunt catheter is not associated with an increase in complications and eliminates the need to lengthen the peritoneal catheter for growth of the patient.

KEY WORDS • ventriculoperitoneal shunt • obstruction • distal revision • extended length tubing • shunt malfunction

VENTRICULOPERITONEAL (VP) shunting has become the standard method for cerebrospinal fluid (CSF) diversion in the management of hydrocephalus. Since the introduction of relatively inert silicone elastomeres for the distal catheter, many of the initial reactive fibrotic problems of early peritoneal catheters have been alleviated.[10,11] A litany of additional potential problems associated with placement of a peritoneal catheter have been well documented in the literature and these include catheter obstruction, various manifestation of infection,[13,24,27,28] pseudocyst formation,[4,7,18] bowel and bladder perforation,[1,17] volvulus,[25] abdominal wall penetration,[6] diaphragm transmigration,[15] scrotal extrusion,[20,21] umbilical fistula,[3] and increased incidence of inguinal hernia.[16] For 20 years at the Childrens Hospital of Los Angeles an extended length of peritoneal tubing has been used during the insertion of VP shunts in children of all ages including premature neonates. We report our experience with the use of this extended tubing over a 14-year period at the Childrens Hospital.

Clinical Material and Methods

A retrospective review was performed of patients who underwent insertion of a new, complete VP shunt at our institution in the 14-year period between January 1979 and February 1993. All patients treated during this time, regardless of age, were equipped with a standard Holter–Hausner ventricular catheter reservoir, with or without an accompanying valve, and a one-piece extended (120 cm) length of open-ended peritoneal tubing. All patients received intraoperative antibiotic drugs (15 mg/kg vancomycin to a maximum of 500 mg intravenously and 4 mg genamicin intrathecally) at the time of shunt insertion. Additionally, three postoperative doses of vancomycin were administered intravenously. Only those patients receiving follow-up care over time at our institution, where subsequent shunt revisions were recorded and performed, were included in the present analysis.

Results

Over the 14-year inclusive period from January 1979 to February 1993, 952 patients underwent a total of 998 new complete shunt insertions. The number of shunts exceeded the total number of patients because 20 patients underwent two and two patients underwent three separate new shunt insertions resulting in simultaneous indwelling shunts. The series was comprised of 531 male and 421 female patients with a mean age of 3.4 years (range premature neonate to 20 years). The mean follow-up duration for the series was 6.7 years. There were 92 infections in 81 patients.

There were a total of 888 proximal shunt revisions performed in 350 patients (mean 0.89 revisions/shunt insertion, range one–28 revisions) for failure of the proximal

TABLE 1

Etiologies of distal malfunctions leading to ventriculoperitoneal shunt revisions in 44 children

Etiology	No. of Revisions
obstruction	35
pseudocyst	6
fractured tubing	3
incarcerated bowel	3
disconnection	2
cerebrospinal fluid ascites	2
abdominal wall protrusion	1
total	52

shunt system. Failure was defined as obstruction of the ventricular catheter, proximal valve failure, or disconnection at these sites.

In comparison, 52 distal revisions were performed in 44 patients (mean 0.052 revisions/insertion, range one–four revisions) for reasons of obstruction, fracture, infection of the distal tubing, or associated diverse peritoneal pathology and comprised the focus for this review (Table 1).

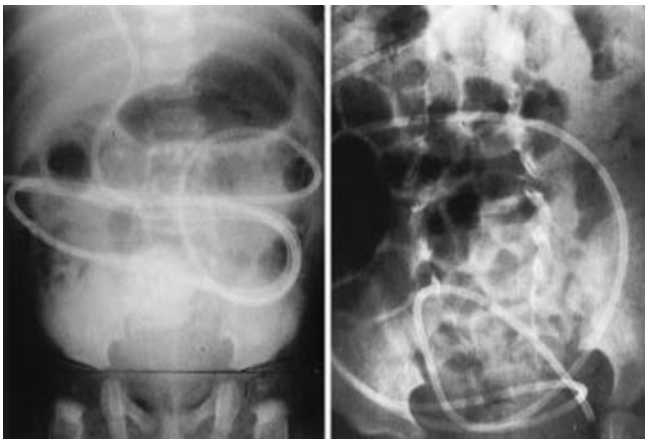

FIG. 1. *Left:* Abdominal radiograph demonstrating the presence of an extended length catheter with the redundant shunt tubing coiled in the peritoneal cavity. *Right:* Abdominal radiograph in the same patient 9 years later showing that much of the tubing has spontaneously migrated out of the peritoneal cavity with growth of the child.

Discussion

Since the early 1970s, the use of the VP shunt has eliminated cardiovascular, pulmonary, and renal complications associated with ventriculoatrial shunt devices,[9] and this procedure has been established as the method of choice for CSF diversion in infancy.[2,14] Mechanical malfunction and infection are the most significant problems associated with shunting devices.[22,26] Although there are fewer reports on the pathogenesis of peritoneal catheter failure as compared to proximal malfunction,[5,12] nonetheless several well-recognized complications associated with the distal peritoneal tube have been described.

Low-grade shunt infection is an important determinant of shunt malfunction and may occur without evidence of clinical sepsis.[8] Peritoneal obstruction may also occur with low-grade infection, and pathological studies have demonstrated granulomatous inflammation of foreign bodies in this location.[26] In addition, embolization of choroid plexus and leptomeninges may precipitate peritoneal obstruction. Cellular invasion of the lumen or a thin veil of tissue may also produce obstruction. Perforation of the bowel is a well-recognized complication of VP shunting.[23,29] Most of the cases reported in the literature are secondary to the use of a Raimondi peritoneal catheter, especially with fracture leading to exposure of a free wire end.[19] Aberrant catheter migration into a variety of abdominal viscera, the abdominal wall, or diaphragm may occur.

Extended length tubing inserted in young children or premature neonates appears to be extremely well tolerated. Patients undergoing follow-up evaluation throughout their major growth period have noted no problems with the tubing, which gradually uncoils as length is required. The primary insertion has offered little difficulty with placement of the additional tubing in the peritoneum; the tube is coiled in large loops (Fig. 1 *left*). The 120 cm of peritoneal tubing inserted in the patients in the present series is more than ample length for the adult, thereby avoiding the need for a subsequent lengthening procedure due to patient growth (Fig. 1 *right*). Moreover, a connector is eliminated, obviating a site for disconnection while allowing the tubing to slide freely between the peritoneal cavity and the attachment to the proximally located valve as the patient grows. The redundant tubing within the abdominal cavity enables migration within the peritoneal cavity and theoretically decreases the possibility for loculation and pseudocyst formation.

Calcification and breakdown of the silicone elastomeres with age potentiates fragility of the catheter and thus breakage and may prevent advancement of the tubing along the tract as the child grows. However, tube fractures befell only three patients in the present series, occurring in the neck (presumably due to increased motion) after extended periods in place ($>$ 6 years). This complication may be alleviated in the future pending development of more durable elastomeres.

Special mention should be made of the three patients experiencing strangulated/incarcerated viscera. These three patients developed this complication only after attempted removal via the cephalad incision of the peritoneal tube using traction on the catheter. This attempt resulted in fracture of the tubing, leaving an intraabdominal segment that had become knotted around a loop of bowel or the omentum. In our experience, immediate peritoneal exploration is mandatory under these circumstances. One child experienced protrusion of the shunt catheter through the abdominal wall, but this was secondary to an abcess that had formed at the abdominal incision.

In this study there were no patients who required lengthening procedures of the peritoneal catheter for growth of the child. The above experience suggests that there is no increased incidence of distal shunt malfunctions specifically attributable to the extended tubing length. The use of the open-ended peritoneal tube has resulted in a low rate of distal obstruction (3.5% per insertion) and a paucity of distally related complications in

general. Primary placement of such tubes is a useful technique in VP shunt insertion.

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