Y-shaped branched ventriculo-peritoneal shunt for adult multiloculated hydrocephalus

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Multiloculated hydrocephalus (MLH) due to neurosurgical manipulation, hemorrhage, infection, or tumors is uncommon in adults and cannot be easily resolved by endoscopic fenestration or unilateral ventriculo-peritoneal shunt (VPS) and no consensus on surgical strategy for MLH has yet been reported. The goal of treatment is to restore communication between trapped ventricular compartments,¹¹ and current treatment methods include microsurgical fenestration of separate entrapments by endoscopy or craniotomy, shunt surgery with multiple catheters placed in trapped compartments, or combinations of these modalities.¹² The existing evidence seems to favor neuro-endoscopy as the first line of treatment over traditional shunt placement. However, due to individual anatomic complexity and CSF hydrodynamics, each MLH case must be evaluated individually. The decision on which treatment to apply is based on individual anatomy, underlying pathology, available techniques, and the experience of the treating surgeon. Therefore, no procedure proposed by the literature should be ruled out a priori.¹³ Y-shaped branched VPS has complementary advantages with endoscopic fenestration in treating complicated MLH and is still the treatment of choice for communicating hydrocephalus and after failure of endoscopic fenestration.

The procedure of Y-shaped branched VPS for MLH due to occlusion of foramen of Monro with/without trapped temporal horn is illustrated in Figure 1. The instructions for the procedure are as follows. First, make bur holes for bilateral frontal horn puncture (Kocher’s point, 2.5 cm anterior to the coronal suture and 2.5 cm lateral from the midline [Figure 1A–C] with/without temporal horn puncture (Frazier’s point, 3 cm lateral from the midline and 6 cm superior to the inion [Figure 1C], and puncture the trapped MLH apartments and subcutaneously guide the catheters to the incision on the parietal protuberance [Figure 1A–C]. Second, create an incision in the abdominal skin and guide the peritoneal catheter to the incision on the parietal protuberance. Third, connect the Y-shaped connector to the shunt valve and subsequent peritoneal catheter. Fourth, connect the branched double or triple ventricular catheters to the Y-shaped connector [Figure 1D and 1E]. Finally, make sure CSF drainage flows smoothly and place the peritoneal catheter into the peritoneal cavity.

We conducted a retrospective consecutive case study of adult patients treated with Y-shaped branched VPS from 2012 to 2017, in which double or triple ventricular catheters were branched and connected with a one-shunt valve by Y-shaped connectors. The Ethics Committee of Beijing Tiantan Hospital approved this study (No. KY2021-115-02), and given its retrospective nature, consent was waived. In this paper, we report the long-term outcome of adult MLH patients treated with Y-shaped branched VPS and propose the optimal indications for such a shunt strategy.

Clinical data of the patients are summarized in Supplementary Table 1, http://links.lww.com/CM9/A904. There were 16 males and 12 females, and the age of onset ranged from 17 years to 68 years (37 years ± 14 years). Tumor resection was performed in 12 cases, stereotactic biopsy in 4 cases, and palliative treatment in 12 cases. Double-branch VPS was performed in 26 cases and triple-branch VPS in 2 cases. Among 26 cases with double branches, ventricular tips were placed in the bilateral frontal horns in 22 cases, frontal horn and temporal horn in 3 cases, and frontal horn and subdural space in 1 case. For 2 cases with triple branches, ventricular tips were located in the bilateral frontal horns and trapped temporal/occipital horn. In addition, programmable and anti-siphon shunts were used for 23 patients, and fixed shunts were used for 3 patients.

Xiaohui Ren and Chuanwei Yang contributed equally to the work.

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After the branched VPS, the Karnofsky Performance Scale (KPS) improved in 25 patients and deteriorated in 3 patients. Patients were followed for 0.5 to 95.0 months during which time 13 patients died. The KPS for the patients who were still alive at the last follow-up ranged from 50 to 100, with a median of 90. Procedural complications included intracranial infection in one case, inappropriate location of the ventricular tips in one case, and shunt obstruction in two cases. The case of infection was cured after antibiotic treatment, one patient died from a shunt obstruction, and the other two patients recovered well after shunt revision. The overall complication rate was 14.3% (4/28), and the VPS revision rate was 10.7% (3/28). Of 13 deaths at the last follow-up, 1 patient had died of shunt obstruction, and the other 12 patients died of tumor progression or other diseases. The 5-year overall survival and hydrocephalus-free survival rate were 53.6% and 89.6%, respectively.

Although endoscopic fenestration is often recommended as the first choice for MLH, it requires special medical equipment and surgical experience, as well as more revised procedures due to the fenestration closure. There are still limitations in its application in cases with widely spread tumors [Supplementary Figure 1, http://links.lww.com/CM9/A904] and severe adhesions [Supplementary Figure 2, http://links.lww.com/CM9/A904]. Relative to other treatments, Y-shaped branched VPS is a simple technique with quick and reliable relief of acute MLH that requires less revised procedures and that can be easily mastered by neurosurgeons. According to our experience, branched VPS is indicated as the treatment of choice in some MLH cases. Moreover, the branched VPS strategy can be the first choice for MLH cases with diffuse midline glioma involving the bilateral thalamus and hydrocephalus with trapped temporal/occipital horn.

In the illustrated case 1, bilateral thalamic glioma occluded the foramen of Monro and involved the hypothalamus, which was not suitable for endoscopic fenestration [Supplementary Figure 1, http://links.lww.com/CM9/A904]. In the illustrated case 2, severe adhesion resulted in MLH, which was intractable with endoscopic fenestration [Supplementary Figure 2, http://links.lww.com/CM9/A904]. Hence, branched VPS was more suitable for such MLH cases than endoscopy. Y-shaped branched VPS is also an optimal palliative treatment for tumors occluding the foramen of Monro, such as chordoid gliomas in the third ventricle, large pituitary adenoma, craniopharyngioma, or malignant teratoma. Furthermore, the Y-shaped shunt is also optional for extra-ventricular hydrocephalus.

When implementing Y-shaped branched VPS, the key point is to locate ventricular catheter tips away from the choroid plexus appropriately. For trapped frontal horns, the catheter tip should be located just in front of the foramen of Monro through the Kocher’s point. For trapped temporal horns, the catheter tip should be located near the front wall of the temporal horn, away from the choroid plexus through the Frazier’s point. To accurately locate the ventricular tips, the application of neuro-navigation or Sina neurosurgical assist (Sina) may be helpful. In addition, a pressure-adjustable valve is recommended. As reported in a population-based hydrocephalus study, the complication rate was 21.3% in the first year after VPS, the cumulative rate of CNS infection was 6.1%, and the VPS revision rate was 22.0%, where over-drainage was a leading cause for VPS revision. As shown in our study, the complication rate and the revision rate were lower than this.

Some limitations exist in our study, given its retrospective nature. Selected bias might exist due to the small sample size. Therefore, results should be interpreted cautiously, we call for larger clinical randomized controlled trials in the future. However, this study provides evidence that Y-shaped branched VPS has the specific merit to resolve adult MLH and has complementary advantages with endoscopic fenestration.
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Conflicts of interest

None.

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