Depth-Adjustable Fixation of External Ventricular Drains to Counteract Obstruction in Tight Ventricles
—Technical Note—

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Abstract
Tightness of the lateral ventricle may result in mechanical obstruction of an external ventricular drain (EVD). We propose a modified EVD fixation method that allows retraction of the EVD to reopen the drainage. We used this technique in patients requiring long-term EVD placement in the frontal horn who were expected to develop tightening of the ventricle. We placed a catheter fixation device consisting of a dialysis catheter with a catheter-holding wing and a fixture spring. The wing is placed on the EVD just distal to its exit and tied down, and the fixture spring is attached to the wing to secure the EVD. If EVD obstruction associated with tightening of the ventricle was suspected, we removed the spring and retracted the EVD to the depth required for cerebrospinal fluid drainage, then replaced the spring. Retraction by 5–12 mm (mean 8.7 mm) resulted in opening of 8 of the 10 obstructed EVD devices. We encountered no major procedure-related complications. This modified EVD fixation method facilitates depth adjustments for reopening the obstructed drain.

Key words: brain swelling, external ventricular drain, fixation device, lateral ventricle

Introduction
Patency of the external ventricular drain (EVD) is required for effective cerebrospinal fluid (CSF) drainage and reliable monitoring of the intracranial pressure. Tightness of the ventricle may result in mechanical obstruction, a complication that may be solved by retracting the EVD by several millimeters. We propose a modified EVD fixation method that facilitates depth adjustments for reopening the obstructed drain.

Materials and Methods
Twenty consecutive adult patients required long-term EVD placement in the frontal horn of the lateral ventricle, but were expected to develop tightening of the lateral ventricle associated with midline shift or brain swelling. Six presented with cerebral infarction caused by carotid or middle cerebral artery embolism, 9 with huge putaminal or combined hemorrhage, and 5 with subarachnoid hemorrhage. None of the patients had hematoma cast in the ventricle harboring the EVD.

Our modified EVD fixation technique is illustrated in a patient with wide cerebral infarction. The catheter fixation device incorporated in a dialysis catheter (Blood Access LCV-UK Catheter Kit; Nippon Sherwood Medical Industries Ltd., Shizuoka) consists of a catheter-holding wing made of nylon elastomer and a fixture spring made of stainless steel to secure the catheter (Fig. 1).

The EVD, a Silascon® ventricular drain, type E-5L-8, with an external diameter of 3.5 mm (Kaneka Medix Co., Osaka), is inserted manually by standard technique with a...
Fig. 2 External ventricular drain (EVD) depth adjustment using the catheter fixation device in a patient with wide cerebral infarction. A, B: Computed tomography scan, coronal reconstruction image (A), and photograph of the EVD exit (B) just after insertion of the drain at external decompression performed on the 2nd day after onset. The tip of the EVD is correctly positioned in the floor of the anterior horn (arrow). The asterisk and arrowhead show the site of the burr hole and the distal tie-down suture, respectively. C: The EVD was obstructed in the floor of the anterior horn (arrow) on the 7th day after insertion. To reopen the EVD, its tip was transposed into the roof of the anterior horn by 5-mm retraction, and the cerebrospinal fluid space was maintained (arrowhead). D: The EVD appears elongated between the device and the tie-down suture (bidirectional arrow) after depth adjustment. The repositioned EVD remained patent for 15 days.

Fig. 3 Schematics showing the relationship between the external ventricular drain (EVD) and the anterior horn tightened by a mass lesion on the coronal (left column) and axial planes (right column). The side holes of the EVD in the caudal part are obstructed by contact with the wall (upper row). The side holes are clear after transposition into the rostral part, yielding a wider cerebrospinal fluid (CSF) space (lower row).

stylet through a burr hole in the precoronal parasagittal region (Kocher’s point). In patients with midline shift caused by mass effect, the side contralateral to the mass is selected for entry. The distal end of the EVD is introduced into the exit site after passing through a 3–4-cm long subcutaneous tunnel. The wing is placed on the EVD just distal to the exit and tied down. After confirming that the EVD is located at a depth appropriate for satisfactory CSF drainage, approximately 6 cm from the inner table, the fixture spring is applied to the wing to secure the EVD. For additional safety, a further 2–0 silk tie-down suture is placed several centimeters distal to the device and the wound is closed. The computed tomography (CT) and macroscopic appearances of the EVD exit acquired just after insertion are shown (Fig. 2A, B).

If EVD obstruction is thought to be attributable to tightening of the ventricle (Fig. 2C), the EVD depth can be corrected. The fixture spring is removed and the part of the EVD just distal to the device is retracted to a depth appropriate for sufficient CSF drainage. Then the spring is re-applied (Fig. 2D). All manipulations are performed manually with sterilized gloves. To avoid infection, the retracted EVD must not be pushed back into the exit.

Results

The EVD remained in-situ for 7–22 days (mean 9.6 days).

Discussion

The anterior horn of the lateral ventricle is the most common location for EVD placement because of easy head positioning, apparent external landmarks, and a wide range of successful trajectories. The tip of a correctly-placed EVD is located at the floor of the anterior horn near the foramen of Monro, which is more narrow than at the roof of anterior horn. Therefore, the small drainage holes in the side aspect of the drain, usually located within about 10 mm from the tip, may be obstructed by contact with the caudal part of the wall of the anterior horn caused by the tightening common to various pathologies. In our experience, this complication can be solved by retracting the EVD by several millimeters, resulting in the transposition-
tion of the tip into the wider CSF space in the anterior horn (Fig. 3). Formerly, such depth adjustment required retraction and re-fixation of the EVD by suture tie-down, but such a procedure is not suitable in patients requiring repeated adjustment due to progressive ventricular tightening. Repeated ligation at the same part of the EVD may damage the silicone-rubber drain and result in CSF leakage. In addition, repeat suturing increases the risk of skin damage.

Our present method is designed to solve these complications. Catheter fixation with devices similar to ours is standard when catheters are placed in the vasculature, e.g. central venous catheters. These devices provide secure fixation and facilitate depth-adjustments without damage to the catheter. We suggest that use of these devices in patients with a tight ventricle requiring EVD implantation will allow for depth readjustment and reopening of an obstructed drain. We recommend our technique in patients requiring the placement of an EVD at the side contralateral to the side harboring a mass. In such cases, the CSF space in the roof of the anterior horn tends to be retained and retraction can be expected to re-open the obstructed drain. On the other hand, we do not recommend our method if diffuse brain swelling has caused tightening of all of the anterior horn. In fact, drain re-opening failed in our patients with subarachnoid hemorrhage.

We would like to encourage manufacturers to develop a genuine EVD fixation device to secure the drain but also allow easy release for depth adjustment. We recommend that the device feature a sterile telescopic sleeve covering the EVD between the scalp exit and the distal part of the drain similar to the Swan-Ganz catheter. This configuration would allow depth adjustments, including moving the EVD deeper into the ventricle while maintaining sterility, and facilitate repositioning of the drain if it is wrongly positioned at the initial procedure.

References

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