

# Transventricular transforaminal endoscopic fenestration with cysto-ventriculoperitoneal shunt to manage a third ventricular arachnoid cyst: a case report

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pISSN: 0853-1773 • eISSN: 2252-8083  
<https://doi.org/10.13181/mji.cr.236856>  
**Med J Indones.** 2023;32:194–7

**Received:** March 10, 2023  
**Accepted:** September 19, 2023  
**Published online:** October 17, 2023

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## ABSTRACT

Regular ventriculoperitoneal (VP) shunt is commonly used as the first option to manage a third ventricular arachnoid cyst due to the lack of facilities, unfamiliarity with endoscopic techniques, or misdiagnosis as purely obstructive hydrocephalus. A 9-year-old girl with obstructive hydrocephalus due to a third ventricular arachnoid cyst was treated with a VP shunt. 2 months later, the previous shunt device was removed due to an infection. Following a sterile cerebrospinal fluid analysis culture, we conducted a navigation-assisted transventricular transforaminal endoscopic fenestration and cysto-VP programmable shunt placement. A decrease in ventricular dilatation was seen on follow-up. This approach was justified due to the possibility of establishing communication with normal cisterns, the high rate of cyst elimination, and the potential for achieving shunt independence. Performing an endoscopic fenestration followed by cysto-VP shunt placement could be an optimal option for managing this condition.

**KEYWORDS** cerebrospinal fluid shunt, endoscopic fenestration, transforaminal, transventricular

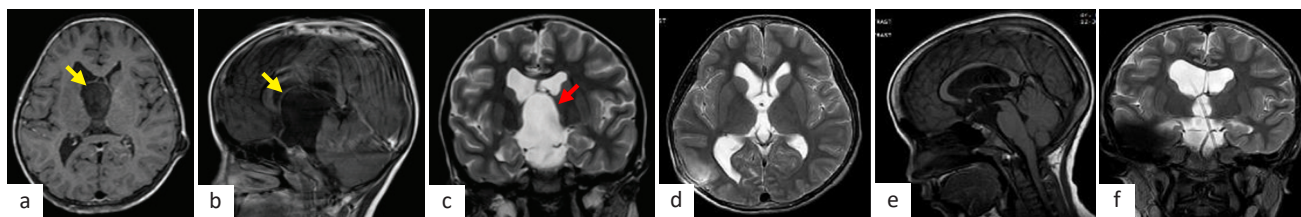
Arachnoid cysts are benign collections of cerebrospinal fluid (CSF) that result from splitting the arachnoid membrane during childhood. Approximately 9% of all arachnoid cysts are suprasellar arachnoid cysts, arising from either the Liliequist membrane or an interpeduncular cistern anomaly that develops toward the third ventricle. As a result, the third ventricle enlarges, cyst formation occurs, and dorsal compression of the brainstem may occur.<sup>1</sup> A small percentage of these cysts eventually enlarge to the point of causing clinical symptoms; however, most cysts remain static over time. Patients may exhibit neurological symptoms of a space-occupying lesion and elevated intracranial pressure due to the compression of nearby structures or hydrocephalus.<sup>2</sup> Headache is the most prevalent clinical symptom, occurring in 66% of patients.<sup>1</sup>

Surgery aims to reduce the cyst volume and the hydrocephalus symptoms. Various treatment methods have been employed, including open craniotomies,

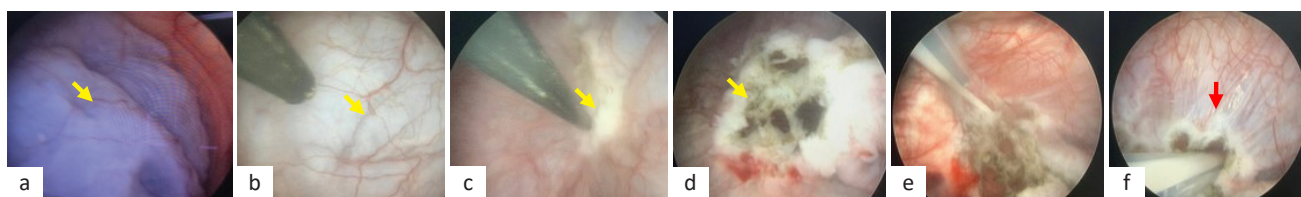
endoscopic procedures, CSF diversion, or a combination of these techniques.<sup>3,4</sup> This case report presented a patient with a third ventricular arachnoid cyst who underwent endoscopic fenestration followed by programmable shunt placement. Endoscopic fenestration is a minimally invasive modality that uses an endoscope to reach the lateral ventricle and foramen of Monroe to fenestrate and explore the cystic cavity.

## CASE REPORT

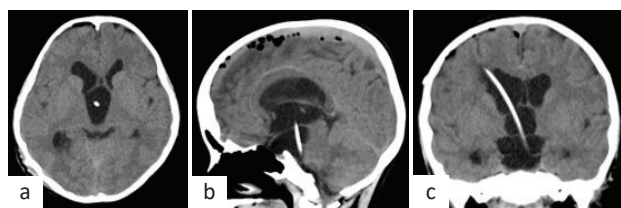
A 9-year-old girl presented with frequent headaches that worsened when coughing, sneezing, or changing positions. No comorbidities or neurological deficits were observed. She showed healthy growth for her age, including refined motor skills, coordination, and muscle control. Her endocrine assessment did not reveal any abnormalities. No precocious puberty, growth



**Figure 1.** Brain MRI. Preoperative MRI showing axial (a) and sagittal (b) post contrast T1 images indicating an enlargement of third ventricle and exposing the cyst membranes (yellow arrows) and a thin-walled cyst (red arrow) (c) with a maximum dimension of 2.6 cm emerging from the quadrigeminal cistern and herniates into the third ventricle, occluding both the foramina of Monro, as shown in the coronal T2 scan; 1 year postoperative MRI acquired in axial (d), sagittal (e), and coronal (f) T1 images. MRI=magnetic resonance imaging



**Figure 2.** Cyst membrane fenestration and cysternostomy. Stages of endoscopic cauterization of the cyst until the foramen of Monro became patent (a–f); the cyst wall was ablated (yellow arrows) (c and d); a VCC was performed (e); a proximal programmable shunt tip (red arrow) was placed in the basal cistern (f). VCC=ventriculocystocisternostomy



**Figure 3.** Postoperative CT images. Brain CT images a week after the procedure revealing decreased cyst size, normalization of the ventricular size, and proximal shunt tip location as planned (a–c). CT=computed tomography

hormone deficiency, or hypothalamic dysfunction was observed. She had previously undergone ventriculoperitoneal (VP) shunt placement at another institution to treat obstructive hydrocephalus caused by a cystic lesion in the third ventricle. Following VP shunt surgery, the headaches were reduced. However, 1 month later, the clinical symptoms recurred. Magnetic resonance imaging (MRI) was performed to enable a detailed analysis of the cyst. Imaging revealed a larger cyst, left ventriculomegaly, and right-slit lateral ventricle (Figure 1a–c). Surgical site infections were also detected. Therefore, we removed the shunt device and performed a CSF examination.

The patient was placed under general anesthesia and positioned at a 30° head-up angle. A semilunar scalp incision (2.5 cm lateral to the midline and 1 cm anterior to the coronal suture) was made on the right frontal

scalp. The right lateral ventricle was cannulated via the anterior horn using a 0° straightforward rigid endoscope (Lotta System, Karl Storz, USA), with the assistance of an image-guided surgery system (Stealth Station S8, Medtronic, USA). Following the identification of the thalamostriate and septal veins, the endoscope was moved toward the foramen of Monro. The cyst wall was pulsating in rhythm with the CSF flow and protruding from the foramen of Monro. Subsequently, navigation-assisted transventricular transforaminal endoscopic fenestration (ventriculocystocisternostomy [VCC]) was performed (Figure 2b–d). A bipolar instrument was used to coagulate the small blood vessels on the cyst wall, and a monopolar instrument was used to fenestrate the apical membrane as extensively as possible. A portion of the cyst wall was excised for histological analysis using forceps, and its contents were aspirated to eliminate the mass effect inside the third ventricle. With navigational assistance, the endoscope was moved into the cyst; fenestration was performed within the third ventricular floor to allow the CSF to reach the basal cistern. Finally, a programmable shunt (Codman Hakim Programmable Valve, Integra, USA) was placed inside the cavity with a regular pressure setting of 1.5. One week after the procedure, a follow-up computed tomography scan showed a collapsed cyst and reduced ventricular size (Figure 3a–c). To avoid postoperative CSF leakage and subdural

collection, the cortical hole was blocked with an absorbable gelatin sponge. After surgery, the patient was transferred to a regular pediatric ward. A follow-up MRI 1 year postoperatively showed a decreased cyst size and good positioning of the proximal shunt tip at the basal cistern (Figure 1d–f).

## DISCUSSION

The best method for treating third ventricular arachnoid cysts in children has been widely discussed, with numerous modalities considered to restore normal CSF flow. The two common methods are microsurgical fenestration and cystoperitoneal shunting (with or without partial cyst excision).<sup>5</sup> Recently, endoscopic fenestration, either with or without CSF diversion, has been widely accepted.<sup>3,6–8</sup>

As a single treatment, CSF diversion using a VP shunt has a low success rate.<sup>9</sup> According to Ma et al,<sup>10</sup> failures in treating third ventricular arachnoid cysts with shunt placement, as evidenced by slit ventricle and cyst enlargement on neuroimaging, are typically due to shunt apparatus malfunction, such as obstruction, infection, or dislocation. Thus, clinical symptoms may recur. By diverting CSF flow into the abdominal cavity, VP shunts may lower intracranial pressure; however, they cannot normalize CSF circulation. Persistent occlusion of the foramen of Monro results in a slit ventricle. Moreover, the pressure difference between the cyst cavity and ventricle may lead to cyst enlargement.<sup>11,12</sup> In the present case, VP shunts were initially considered a promising first-line treatment due to their availability in most neurosurgical centers in Indonesia. However, they are only sustainable in the short term due to the possibility of malfunctioning and the tendency to replace or adjust over time. In the present case, a VP malfunction was observed 3 months after the initial placement. Conversely, although endoscopic surgical treatment is widely accepted, its availability and accessibility in some areas remain limited.

Microsurgical cyst fenestration with open craniotomy for cyst resection can avoid the risk of permanent shunt malfunction.<sup>5,13</sup> Moreover, rapid cyst decompression may cause insufficient CSF absorption and subdural hygromas owing to wide surgical apertures.<sup>14,15</sup> Therefore, the inherent risks of open craniotomy should be considered in patients with minor symptoms related to arachnoid cysts.

Endoscopic fenestration has been widely accepted as a treatment option because of the anatomical proximity of the cyst to the ventricular system and subarachnoid cisterns. This method is less invasive than microsurgical procedure and requires less time. Considering its proximity to important structures, such as the pituitary gland, hypothalamus, and optic nerve, neuronavigation increases patient safety and allows the selection of the best angle when using a rigid endoscope.<sup>9</sup> Ventriculocystostomy (VC) and VCC can be performed using an endoscopic fenestration technique. In VC, the apical membrane of the cyst is fenestrated using an endoscope and instruments, whereas VCC uses the same endoscopic technique to fenestrate the apical membrane before continuing through the inferior membrane, creating a second fenestration that enables the cyst to communicate with the basal cisterns.<sup>3</sup> In the present study, the patient was treated with VCC rather than VC because VCC was associated with a lower incidence of recurrence, risk of infection, and other postoperative problems.<sup>2,5</sup> Although usually successful, VCC may present additional risks to nearby anatomical structures, such as the basilar artery and cranial nerves.<sup>3</sup>

Surgery aims to reduce the size of the cyst and the associated hydrocephalus to normalize CSF flow. CSF hydrodynamics, changes in cyst size over time, and the relationship with the efficacy of this procedure require further investigation. Pitsika et al<sup>16</sup> showed that, after successful endoscopic fenestration of symptomatic arachnoid cysts, the cyst volume markedly decreased in the first few months and reached a plateau in the following 6 months. Despite the cyst not completely disappearing and, in some cases, even remaining large and reaching a state of compensation, the patients may remain asymptomatic in the long term.<sup>16</sup> When El Refaee and Elbaroody<sup>17</sup> performed endoscopic cystocisternostomy in nine cases of arachnoid cysts, four cysts almost completely disappeared, three cysts decreased in size by more than 60%, and two cysts decreased in size by more than 30%. The cysts disappeared after 3–18 months.

The absorption of CSF is not increased by the fenestration of the wall itself. This explains why the prevalence of collapsed cysts is low without shunt therapy.<sup>18</sup> In contrast, cyst wall fenestration occasionally causes subdural CSF accumulation, which may require surgery, as reported by Cinalli et al.<sup>19</sup> The endoscopic procedure may provide a good

fenestration to release CSF trapped inside the cyst, but a rapid increase in circulating CSF volume may not be followed by complete absorption due to the saturated arachnoid villi. Using the CSF diversion method may increase the amount of absorbed CSF.<sup>20</sup>

Endoscopic fenestration combined with programmable cysto-VP shunt placement could reduce cyst volume and restore normal CSF circulation inside the cisternal space.<sup>21</sup> By generating a pressure gradient between the cerebral parenchyma and the cyst while maintaining a negative pressure gradient inside the arachnoid space, the shunt may provide brain expansion.<sup>18</sup>

To reduce shunt dependence, a programmable valve may facilitate shunt weaning by changing the shunt pressure rate, thereby preventing shunt revision and valve removal. Mottolese et al<sup>18</sup> demonstrated that the shunt opening pressure increased after the disappearance of the cyst to facilitate shunt independence. Radiographs were acquired each time the pressure was adjusted. After the shunt was regulated at a higher opening pressure, they waited at least 15 months before finally removing the valve. This approach allowed for complete collapse of the cyst while reducing shunt dependence.

In conclusion, endoscopic fenestration followed by cysto-VP programmable shunt placement was an effective strategy for treating third ventricle arachnoid cysts. This method provides some advantages, such as establishing communication with normal cisternal pathways, a high rate of collapsed cysts, and the possibility of achieving shunt independence. However, a longer follow-up period and a larger number of cases are required to confirm these results.

#### Conflict of Interest

The authors affirm no conflict of interest in this study.

#### Acknowledgment

None.

#### Funding Sources

None.

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