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A Clinical Chronicle: The Use of Ventriculo-Atrial Shunt in Tuberculous Hydrocephalus Treatment

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Abstract

Tuberculous meningitis (TBM) is the predominant bacterial meningitis form in children under 13, with an incidence of 8.6 per 100,000 before age 15. Tuberculous Hydrocephalus (TH), often presenting with hydrocephalus, poses a significant challenge in Indonesia for both children and adults. The commonly used Ventriculo-peritoneal (VP)-shunt procedure for TH, though prevalent, is associated with multiple complications. As an alternative, the Ventriculo-atrial (VA)-shunt procedure has been explored, but reports on its use in TH in Indonesia are lacking. This case report details a 1-year-old girl with TH who initially underwent a VP-shunt procedure, which proved unsuccessful. Subsequently, the VA-shunt procedure was employed, leading to a complete recovery. Our findings contribute valuable insights into the potential effectiveness of the VA-shunt as an alternative intervention for TH, especially in the Indonesian medical landscape.

1. Introduction

Tuberculosis (TB) is still considered the most common infectious disease among children in Indonesia. TB could occur extrapulmonary with the number of incidences as high as 20-25% [1]. Tuberculous Meningitis (TBM) is one of the most severe forms of extrapulmonary tuberculosis which infects the brain meninges and could result in death [1]. The incidence rate of TBM is 8.6/100.000 children younger than 15 years old [2].

Tuberculous Hydrocephalus (TH) is more complication of TBM with average incidence 80% in children [3], in which there is a disruption in cerebrospinal fluid (CSF) circulation due to the inflammation process. The disruption of CSF circulation could enlarge the ventricular system, followed by the increased of intracranial pressure (ICP) [1].

The management of hydrocephalus consists of non-operative or operative methods. The non-operative method includes decreasing the production of CSF, degrading the inflammation and fibrotic process which could happen at intracranial hemorrhage or meningitis, also protecting of the axonal and brain cells after ventriculomegaly happens [4]. The later event can help postpone the operative procedure, even though the non-operative method is not as effective as the operative method [1, 4].

Ventricular shunts are devices that allow cerebrospinal fluid to drain into extracranial regions. There are several choices of ventricular shunts, including VP-shunts and VA-shunts. VP-shunts are more common than VA-shunts procedure for hydrocephalus. VP-shunts are used to move CSF from the cerebral ventricle to the peritoneal,

however VA-shunts are used to move CSF to the right atrium of the heart [5].

The revision rate of VP-Shunt ranged from around 43.8%, with multiple revisions at 18.7% in the first year. The high revision rate is probably caused by infection and mechanical complications. Some literature said that shunt infection usually happens in the first six months after the procedure, with the highest rate in the first 2 months ranging from 5%-11%. Based on research by Azzam, et al (2021), they concluded that 88.7% of total VP-shunt procedures (126 cases), and 5.6% of total VA-shunt procedures (8 cases), the revision rate is 96.2% (25 cases) in VP-shunt cases [6].

VA-shunts were initially favored as the preferred shunt procedure for patients with Tuberculous Hydrocephalus (TH), and concerns about disseminating the tuberculous disease through such shunt systems were allayed by reports from Bhagwati et al. [7]. The versatility of VA-shunts as an alternative method for continuous cerebrospinal fluid drainage is noteworthy, particularly in settings with limited resources. Advancements in VA-shunt catheter replacement, placement methodologies, and monitoring systems over the past few years have contributed to increased success rates in VA-shunt placements [8].

Therefore, in this case report, we present a 1-year-7-month-old girl who underwent VA-shunt procedure due to TH, which has never been reported in Indonesia. This case underscores the potential viability and success of VA-shunts in managing TH, offering valuable insights for medical practitioners facing similar challenges.

2. Cases

A 1-year-7-month-old girl, weighing 7.8 kg, was brought to the hospital by her parents due to vomiting and an open wound resulting from a previous VP-shunt surgery on her head. The surgical wound exhibited redness, warmth, and accompanying fever. As per family information, stiffness (spasticity) was noted in the body, feet, and hands. While the patient denied experiencing seizures, she appeared fussy.

The patient was initially diagnosed with Tuberculous Hydrocephalus (TH) at the end of June 2022 and has been undergoing treatment with a Fixed Drug Combination consisting of Rifampicin 75mg, Isoniazid 50 mg, and Pyrazinamide 150 mg for the past 8 months. The patient underwent her first right VP-shunt surgery in June 2022 due to TH. Subsequently, in October 2022, she underwent left VP-shunt surgery due to shunt malfunction. In November 2022, an externalization of the shunt was performed again due to shunt malfunction.

In November 2022, the patient underwent a craniotomy for tumor removal and the insertion of an Ommaya shunt. The pathological anatomy result revealed the tumor to be a tuberculoma. Following this, in December 2022, the patient underwent shunt repair due to the ineffectiveness of the VP-shunt. Due to persistent ineffectiveness, a ventriculo-gall bladder shunt surgery was performed in the same month. Finally, in February 2023, in response to recurrent ineffectiveness, the decision was made to proceed with a VA-shunt.

Upon the patient's initial admission, she manifested medium pain while remaining compos mentis. Her heart rate was 109 beats per minute, respiratory rate was 24 breaths per minute, with a temperature of 40.1°C, and oxygen saturation of 98% on room air. Neurological examination revealed normal findings without lateralization, neck stiffness, or pathological reflexes. Pupillary examination showed isochoric pupils (4mm/4mm) with positive light reflexes, and physiological reflexes were positive (+2/+2).

There is a wound exposed from the installation of Ommaya shunt's side in the right point with slow recoil, and on the left side (Kocher Point), the recoil was normal. The head CT pre-surgery shows that there is bilateral cerebellar cystic mass pressing and constricting the fourth ventricles cause by obstructive hydrocephalus and third trans-frontal, right trans-parietal, and non-patent trans-occipital shunts were implemented (Figure 1).

2.1. Operation Technique of VA-shunt

The patient was placed in the supine position under general anesthesia with endotracheal intubation. The patient's hair was shaved and then asepsis and antisepsis procedure with povidone-iodine then performed, and the operating field was narrowed down using surgical drapes.

Marking was done in the operating area, insert the proximal catheter to the cerebral ventricle, followed by transverse incision on left neck, treat bleeding afterwards. Perform fascia dissection and identified the internal jugular vein. Performed Venotomy and insert the distal catheter approximately 7 cm and the tip of the distal catheter then placed in the right atrium with C-arm guiding.

The distal catheter then connected to the proximal catheter (Figure 2). Evaluate the shunt pump, the shunt

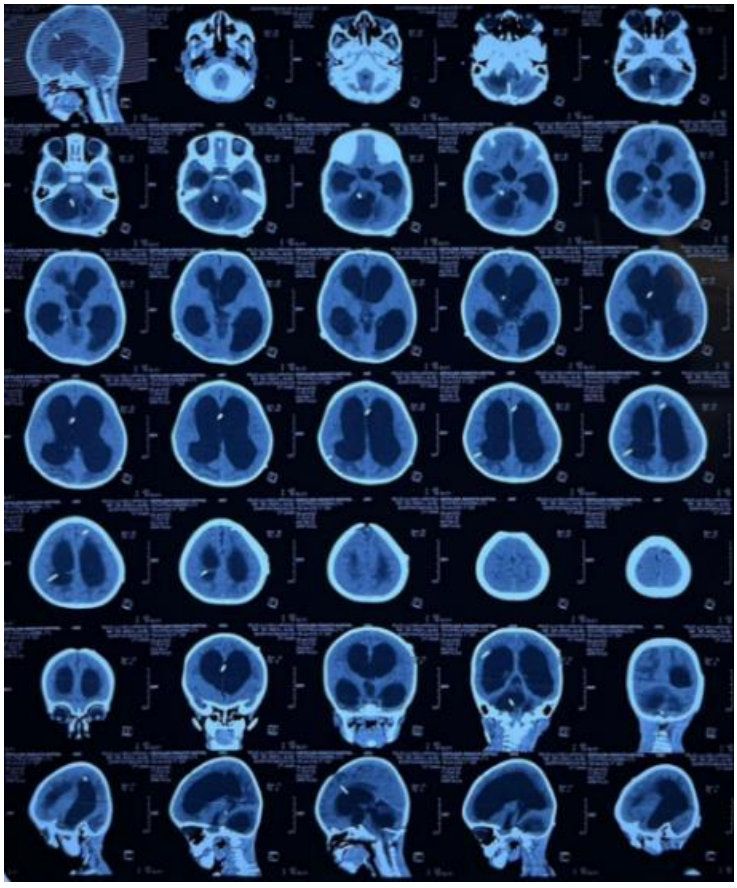

Figure 1. Head CT pre-surgery. Bilateral cerebellar cystic mass pressing and constricting the fourth ventricles cause by obstructive hydrocephalus. Third trans-frontal, right trans-parietal, and non-patent trans-occipital shunts were implemented.

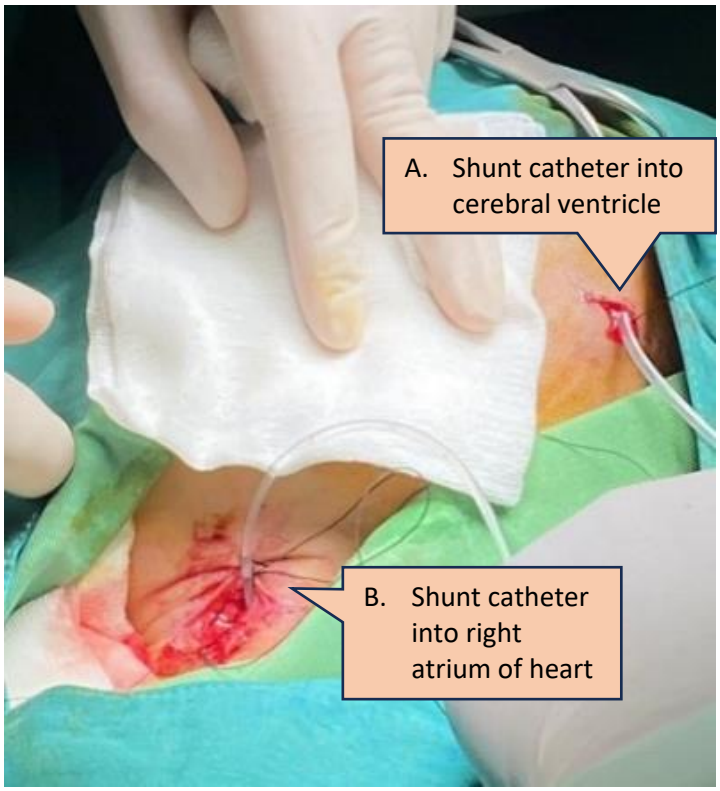

Figure 2. VA-shunt operation procedure. The shunt catheter was inserted to the cerebral ventricle (A) and right atrium of heart via jugular vein (B).

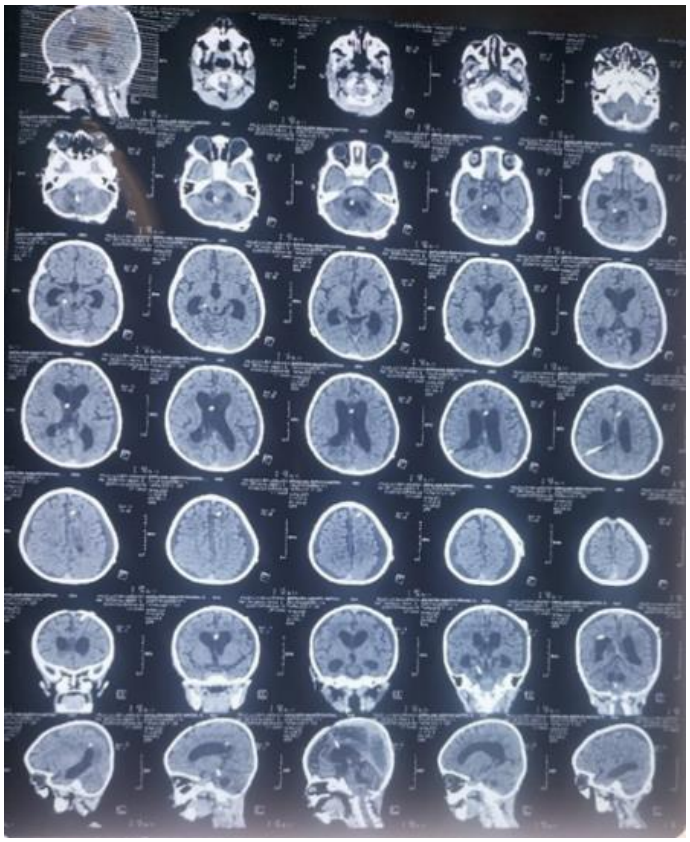

Figure 3. Head CT days 25th post VA-shunt procedure shown that improvement of the cerebral ventricle and reduced pressure on the fourth ventricle.

pump appeared to be effective, the operation field then closed layer by layer, treat bleeding and operation was finished.

2.2. Outcome

After the operation and the anesthetic effect wears off, the patient immediately regained consciousness. The patient then treated for 2 days in the Intensive Care Unit (ICU). Days 25th postoperative Head CT results showed an improvement and reduced pressure on the fourth ventricle (Figure 3).

3. Discussions

Tuberculosis is still a global health issue, particularly in developing countries. One of the complications of TB is Tuberculosis meningitis and is still a very common problem in children and adult in Indonesia. Hydrocephalus is one of the most common complications of tuberculosis meningitis occurring in up to 80% of children with the disease [3].

Our patient had hydrocephalus due to tuberculosis. Tuberculous meningitis is frequently accompanied with disturbance of CSF circulation and the development of hydrocephalus. It is primarily related to basal adhesions, with aqueduct and fourth ventricular outlet obstruction. Shunt insertion has been proven to be quite beneficial, particularly in youngsters whose sensorium was not severely impaired. Many children's hemiparetic limbs and vision returned to normal. In semi-comatose and comatose patients, the results were unsatisfactory [3].

Individuals with aqueduct and fourth ventricular outlet block and thick fibrous basal adhesions became shunt reliant and required shunt modifications. TBM is more common in children than in adults, and it frequently occurs in the context of malnutrition, overcrowding, and low socioeconomic position. TBM is most commonly caused by hematogenous dissemination of tuberculosis from an extracranial source, usually pulmonary [9].

This usually happens within 3-6 months following the first infection. The meningeal exudate that initiates the process of basal tuberculous meningitis is caused by an outward extension of the Rich focus, a tiny focus in the cortical surface. Its focal point could be subpial or subependymal [10].

The CSF flow may be blocked by the exudate that is produced as a result of the hypersensitive reaction to the presence of mycobacterial antigen in the basal arachnoid cisterns, leading to communicative hydrocephalus. Another cause of hydrocephalus in TBM is exudate obstructing the aqueduct, third ventricle, or fourth

ventricle outlet foramina; this type of hydrocephalus is known as non-communicating [8].

Early attempts at surgical management of hydrocephalus in patients with TBM included repeated tapping of the ventricles through burr holes, suboccipital decompression, lateral and third open ventriculostomy, and ventriculo-subarachnoid shunts [2, 7].

23 patients who had shunts implanted for TH were the subject of a 9-month follow-up research by Bullock & van Dellen. They considered some criteria to be the requirements for shunting, including a decreased in level of consciousness, increased ICP (such as dilatation of the pupils and rigidity of the extensor muscles), and CT evidence of increasing ventricular enlargement [2].

The VP-shunts gives extended reduction of ICP and are quite simple to insert. The main problem of this therapy approach is if the catheter malfunctioned. These are some causes of catheter dysfunction, such as shunt infection, valve obstruction, catheter migration, disconnection of the shunt, bent catheter (malposition), or any combination of these factors can cause shunt malfunction. This is an emergency situation that could result in fatalities. Nonetheless, if it founded fast, will still be manageable, and the risk of shunt-related problems has been lowered as a result of recent breakthroughs in surgical technique and shunt design [6].

Since 1952, VA-shunts have been the mainstay treatment for ICP caused by hydrocephalus. Nevertheless, the favorable intervention resulted in considerable concerns over the ensuing years, with the recognition of a wide spectrum of severe and even fatal condition related to circulation system [8].

According to recent data, despite the fact that VP-shunts are the preferred approach, a significant patient population still requires a VA-shunt. In expert hands, VA-shunts may be a good option if the intended result in recurring VP instances cannot be attained [8].

For VA-shunts, minimally invasive procedures and radiological guidance are also being developed. As a result, in some circumstances, VA-shunts are a viable alternative to VP-shunts. However, complications should not be overlooked, which can range from something as simple as an occlusion to more serious issues including bacteremia and heart diseases caused by cardiac implantation and systemic drainage [8].

Procedures involving VA-shunts may result in problems that could be fatal. The most frequent issues with VA-shunts include shunt infections, pulmonary hypertension, and thrombosis. There have been many reported difficulties in the literature, and the majority of them could have been handled or avoided [5].

A partial abnormal pulmonary venous return was observed in a documented case by Elhammady et al. [11], where a VA-shunt displacement occurred. They recommended employing additional scans, such as computed tomography, in suspected cases. Radiographic evidence is deemed helpful for both diagnosing and treating such changes.

Natarajan et al. discovered catheter related right heart problems such as substantial calcific tricuspid stenosis and a dilated right atrium on transthoracic echocardiography [12]. Ben-Ami et al. described a catheter related gram-positive bacteremia and nephritis in a 47 years old woman who had a VA-shunt for 10 years due to hydrocephalus [13].

In contrast, in our case, following a 1-month follow-up, there were no discernible signs or symptoms of complications, highlighting a favorable outcome in the management of the patient's condition.

4. Conclusions

The utilization of VA-shunts emerges as a potential alternative for cerebrospinal fluid drainage when compared to the more common VP-shunts. While VP-shunts are frequently preferred by surgeons and boast a higher post-insertion repair rate, they are also associated with increased risks of malfunction and infection. However, the invasive nature of VA-shunts, attributable to the cardiac systemic linkage, should be acknowledged in contrast to VP-shunts.

Operationally, the techniques for VA-shunts mirror the difficulty level of VP-shunt procedures, rendering them feasible without the necessity for specialized instruments. It is imperative to adhere strictly to aseptic and antiseptic techniques during these procedures to mitigate the risk of postoperative infections and potential serious complications.

In the presented case, our findings underscore that VA-shunts represent a viable alternative for cerebrospinal fluid drainage in cases where VP-shunt procedures have proven unsuccessful, even in settings with limited resources or rural areas. This supports the consideration of VA-shunts as a valuable option in the management of TH.

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