Case Report

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Distal Ventriculoperitoneal Shunt Catheter Migration into the Pulmonary Vasculature and Cardiac Chamber: A Case Report

뇌실-복강 단락 원위도관의 폐동맥 및 심장 내 전위: 증례 보고

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Ventriculoperitoneal shunting is the most common neurosurgical procedure for treatment of hydrocephalus. Shunt-related complications are relatively common and associated with a high rate of shunt revision. However, migration of the distal ventriculoperitoneal shunt, especially into the cardiac and intravascular regions, has rarely been reported. Awareness of this rare but potentially hazardous complication is important owing to its significant morbidity, which can be prevented by prompt management. Here, we introduce a case of a 23-year-old male with migration of the distal shunt catheter through the left internal jugular vein into the cardiac chamber and both pulmonary arteries, which occurred 2 months after receiving ventriculoperitoneal shunting. Furthermore, we discuss the possible mechanisms and management of this condition.

Index terms Ventriculoperitoneal Shunt; Thromboembolism; Heart

INTRODUCTION

Ventriculoperitoneal (VP) shunts are widely used for the neurosurgical management of hydrocephalus (1). However, they are associated with fairly common potential complications, which in many cases warrant the removal or revision of the shunt (1). Among the various

complications, including obstruction, disconnection, and infection, migration is a rare one and almost occurs in 1 among 1000 patients with shunts (2). Relatively common migration sites include the bowel, genitourinary region, and abdominal wall, while migration to the thorax, heart, and intravascular system is unusual. We report a rare case of shunt migration into the heart and both pulmonary arteries and its subsequent management.

CASE REPORT

A 23-year-old male presented to the emergency room with progressive mental deterioration after sudden onset headache and dizziness. Nine years ago, the patient had undergone surgical clipping for the treatment of a subarachnoid hemorrhage due to a ruptured anterior communicating artery aneurysm. A CT scan of the brain at the emergency department showed subarachnoid hemorrhage, intraventricular hemorrhage, and hydrocephalus. The patient underwent surgical clipping of the ruptured aneurysm with decompressive craniectomy, and external ventricular drainage catheters were inserted for draining cerebrospinal fluid. After admission to the intensive care unit, severe swelling of the craniectomy site with persistently high intracranial pressure was noted; therefore, cranioplasty and CT-guided VP shunt placement were planned. The procedure was uneventful, and no major venous bleeding occurred during the subcutaneous tunneling of the catheter. The patient had no associated neurologic symptoms, and the shunt function was normal. Postoperative chest and abdominal radiographs confirmed appropriate intraperitoneal placement of the distal catheter (Fig. 1A).

The patient exhibited poor alertness and awareness levels with motor weakness on both sides and was transferred to the rehabilitation department for physical therapy and gait training. Approximately 2 months after the shunt procedure, an abdominal CT performed for the evaluation of the patient's persistent nausea and vomiting showed a partial filling defect of the right inferior pulmonary artery. Chest and abdominal radiographs revealed migration of the distal catheter from the intraperitoneal space into the thorax, and the distal catheter was observed in the cardiac shadow (Fig. 1B). Follow up chest radiograph taken two days later showed migrated distal shunt catheter wedged into both pulmonary arteries (Fig. 1C). A subsequent chest CT image showed for the evaluation of pulmonary thromboembolism revealed migration of the distal shunt catheter through the left internal jugular vein (IJV). After penetrating the left IJV, the catheter migrated into the right atrium, right ventricle, exited into the left pulmonary artery, and looped back into the right pulmonary artery. Both pulmonary arteries showed thromboembolism (Fig. 1D).

A decision was made to replace the catheter that had migrated, and a combined surgery in coordination with the thoracic surgery department was planned. The preoperative electrocardiogram (EKG) showed a normal sinus rhythm. An oblique incision was made along the posterior border of the sternocleidomastoid muscle, and the VP shunt catheter and its entry site into the left IJV were identified. Under the guidance of fluoroscopic imaging using a C-arm and transesophageal echocardiography (TEE), the catheter was carefully removed without any resistance. The cerebrospinal fluid dribbling at the tip of the removed catheter implied that its function was not impaired. There was no residual foreign body on the C-arm or TEE probe after catheter removal. Subsequently, a new distal catheter was positioned

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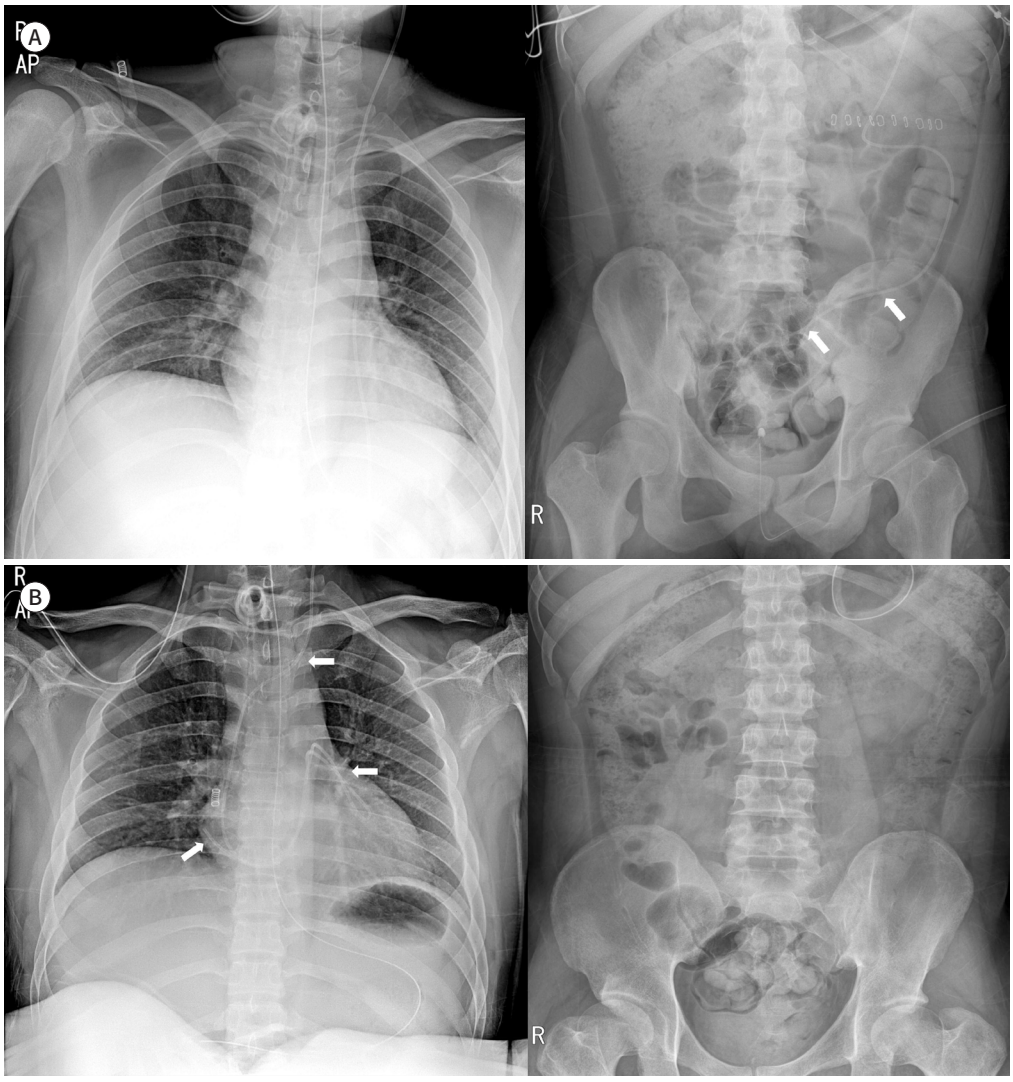
Fig. 1. A 23-year-old male with distal VP shunt migration into pulmonary vasculature and cardiac camber.
A. Initial chest and abdominal radiographs after VP shunting show distal shunt catheter properly located in left lower quadrant of abdomen (arrows).
B. Chest and abdominal radiographs taken 2 months after VP shunting show distal shunt catheter in the cardiac shadow (arrows); however, the catheter is no longer visible in the peritoneal cavity.
VP = ventriculoperitoneal shunt



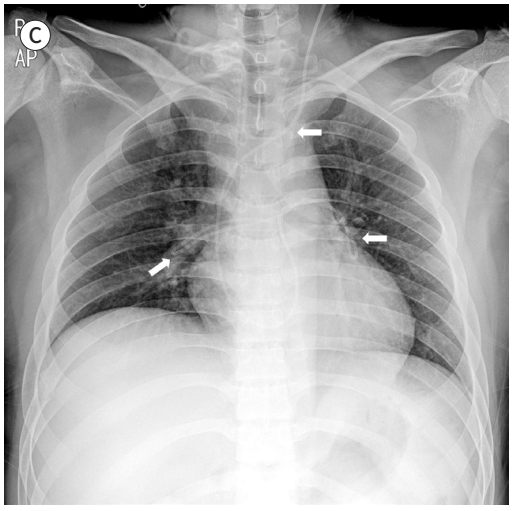
through another subcutaneous tract and reconnected with the proximal catheter. The new VP shunt exhibited normal function, and the postoperative abdominal radiograph showed the new distal catheter placed properly in the peritoneal cavity.

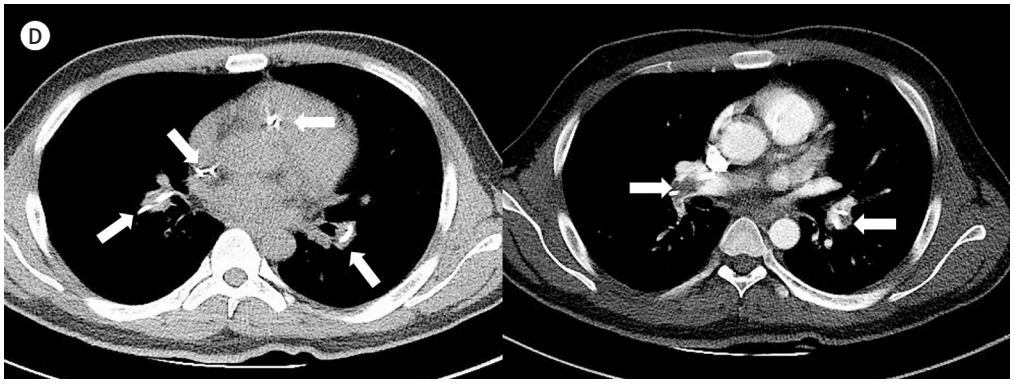
This retrospective study was approved by the Institutional Review Board of Yeungnam University Hospital (IRB No. 2021-02-049), which waived the requirement for informed consent.

DISCUSSION

Despite its efficacy in the treatment of hydrocephalus, complications arising from VP shunt-

Fig. 1. A 23-year-old male with distal VP shunt migration into pulmonary vasculature and cardiac camber.
C. Follow up chest radiograph taken 2 days after the discovery of shunt catheter migration shows distal shunt catheter wedged into both pulmonary arteries (arrows).
D. Pre-contrast chest CT shows the distal shunt catheter within the right atrium, right ventricle, and entangled in both pulmonary arteries (arrows). The distal tip of the catheter is located in the right pulmonary artery. Post-contrast chest CT shows thromboembolism in both pulmonary arteries (arrows).
VP = ventriculoperitoneal shunt





ing remain a persistent problem in the clinical management of patients who have undergone this procedure (3). Complications at the rate of up to 40% to 50% are reported to occur after VP shunting, and the most common ones are related to mechanical obstruction and infection (4, 5). Other reported complications include migration, disconnection, fracture, and distal compartment-related complications, such as abdominal pseudocyst, peritonitis, and cerebrospinal fluid ascites.

Migration of the catheter is considered unusual, and patients may or may not present with symptoms. A majority of shunt migrations are noted in children (< 18 years), and the most common migration site is the gastrointestinal system, while in adults, there is a higher tendency for migration to the heart, breast, and abdominal wall (2). The time interval between VP shunt placement and migration diagnosis was found to vary widely between 7 days and 4 years (6), which makes it more challenging to anticipate this exceptional complication. Some reported clinical manifestations of this rare type of migration include symptoms related to shunt dysfunctions, such as gait disturbance and decreased cognition, cardiac symptoms,

such as arrhythmia and abnormal heart murmur in addition to localized swelling and tenderness of the neck (6). The patient in this case was almost completely bedridden due to quadriplegia and exhibited poor awareness and impaired verbal response at the time of diagnosis; therefore, it was difficult to decide whether there were any associated symptoms related to shunt migration.

Two theories have been proposed to explain the mechanism of unusual distal catheter migration into the heart and pulmonary arteries (6, 7). The first suggests iatrogenic damage to the internal or external jugular vein during tunneling of the subcutaneous tract as a risk factor. Profuse bleeding at the neck may be present, although this unexpected damage can go unnoticed. The tunneling process requires great care and precision and using a blunt device or employing a more lateral course in the neck is recommended to prevent any damage to the vascular structures. Another predisposing factor could be the proximity of the shunt and veins (6, 8). Through repeated movement of the neck, the catheter could cause damage to the adjacent veins. Once the catheter has penetrated the internal or external jugular vein, negative intrathoracic pressure, positive intra-abdominal pressure, and venous flow together propel migration toward the heart (7, 8). Pulsatile cardiac impulses may drive the catheter into the pulmonary arteries.

Obesity, especially in individuals with a body mass index > 30 kg/m^2, and the number of previous shunt procedures have been reported as independent risk factors for shunt migration (4). Although there is no proven method to prevent this unusual complication, numerous attempts have been made to minimize this possibility. Some surgical techniques, such as the use of a hernia patch to increase friction or mild fixation of the catheter to the peritoneum to lower the risk of subcutaneous extrusion of the catheter, have been suggested (3, 9).

Cardiac or intravascular migration of the catheter should be dealt with quickly because it may lead to additional complications, such as thromboembolism, sepsis, and cardiac arrhythmia (10). Various procedures, ranging from blind removal to open-heart surgery, have been performed to resolve intravascular shunt migration (3, 6). Vascular intervention was attempted in cases where the migrated catheter was impinged on the valves or fixed within the pulmonary arteries because of knot formation or multiple loops (3, 7).

Chest CT is recommended to confirm the exact location of the misplaced catheter. Before any intervention, it is advisable to perform echocardiography to evaluate heart function and brain imaging to assess possible associated shunt malfunction. Real-time visualization using fluoroscopy and intraoperative cardiac monitoring are recommended during the withdrawal of the migrated catheter, especially when any resistance is noted (6). Surgeons should be aware of the possible damage that entangled or adhered catheters may cause to the vessels, cardiac valves, and myocardium. After the migrated catheter is removed, the distal catheter may be repositioned into the peritoneum or converted into a ventriculoatrial shunt. A new distal catheter can be inserted immediately or electively after an interval. Using the contralateral side for the revision may help avoiding the risk of damaging the already weakened vessels (6). In this case, the preoperative EKG and brain CT findings were unremarkable. The catheter was pulled without any resistance under fluoroscopic guidance, and the new distal catheter was tunneled immediately through a new subcutaneous tract.

In conclusion, we report an unusual case of shunt migration into the heart and both pul-

monary arteries through the IJV and its subsequent management. Surgeons should be aware of both the common mechanical and infectious complications as well as rare complications, such as cardiac and intravascular shunt migration that is addressed in our report. Awareness of this unusual yet hazardous complication is important because prompt diagnosis and management are necessary to prevent significant morbidity.

Author Contributions

Supervision, P.J.; writing—original draft, L.C.B.; and writing—review & editing, P.J.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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뇌실-복강 단락 원위도관의 폐동맥 및 심장 내 전위: 증례 보고

이채빈 · 박종수*

뇌실-복강 단락술은 가장 널리 사용되고 있는 수두증의 수술적 치료 방법이다. 단락술과 관련된 합병증은 비교적 흔하게 발생하며, 높은 단락장치 교정술 시행률과 관련이 있다. 그러나 원위도관이 다른 장기 내로 전위되는 경우, 특히 심장 및 혈관 내 전위는 드물게 보고되었다. 드물지만 잠재적으로 위험한 합병증에 대해 알고 있는 것은 신속한 처치를 통해 위중한 상황을 예방할 수 있기 때문에 중요하다. 저자들은 뇌실-복강 단락술 시행 2개월 후 원위도관이 좌측 내경정맥을 통해 심장 및 양측 폐동맥 내로 전위되었던 23세 남자 환자의 증례를 보고하고, 발생 가능한 기전과 치료에 관해 논의해 보고자 한다.

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