

Migration of atrial catheter of ventriculo-cysto-atrial shunt into heart and pulmonary artery — case report and literature review

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ABSTRACT

Ventriculoatrial shunts are the alternative treatments when it is impossible to use ventriculoperitoneal shunts. Limited indication for ventriculoatrial shunt is due to the possibility of very serious complications inherent with this procedure. We present a case report of a young patient who suffered from disconnection of an atrial catheter from the valve after an accidental blow to his neck. The atrial catheter was dislocated to the heart and pulmonary artery and it was extracted through the femoral vein in the groin area using an endovascular technique. The procedure went without complications. A new atrial catheter was introduced under ultrasonic guidance during surgical revision.

Keywords: ventriculoatrial shunt, rare complication, atrial catheter, hydrocephalus

Introduction

Shunt implantation is a universal method of treating patients who suffer from hydrocephalus [1]. Ventriculoperitoneal shunts (VPSs) are the current treatment of choice for hydrocephalus. If this system cannot be introduced, implantation of a ventriculoatrial shunt (VAS) is the next option in most centres. Limited indication for VAS is due to the possibility of very serious complications of this procedure [2]. In this case report, we present a rare case of migration of an atrial catheter into the heart and pulmonary artery.

Case report

A male in his 20s was admitted to the neurological department at the regional hospital after an accidental blow to his neck when he was opening the door of a bookshelf at home. Because there was an implanted VAS, our clinic was consulted and we were asked to admit the patient into our care.

The patient was found to have an enlarged head circumference in his first months of life. A temporal arachnoid cyst on the right side was diagnosed on magnetic resonance imaging. The patient underwent the implantation of a cysto-peritoneal

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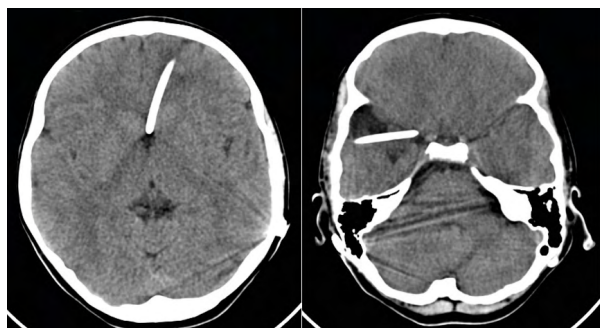


Figure 1. CT scan of brain with implanted ventriculo-peritoneal shunt (on left) and a cysto-peritoneal shunt (on right) at age of 12. First catheter is introduced into arachnoid cyst of right temporal lobe and second one into frontal horn of left ventricle. There are asymptomatic slit ventricles

shunt. After a few years, a programmable VPS was introduced because of a ventricular enlargement. The patient was checked by a paediatric neurologist and at the outpatient department of neurosurgery at the Children's Hospital (Fig. 1). In all, the patient underwent six surgical revisions during his childhood.

After reaching adulthood, the patient began to be followed up in an adult neurosurgery department. Due to a malfunction of the cysto-peritoneal (CP) shunt, a revision was performed when the patient was in his early 20s. The CP shunt was extracted and a new catheter was inserted into the arachnoid cyst and connected to the VP shunt via a T-connector (Fig. 2). In the last revision in his late 20s, the ventriculo-cysto-peritoneal shunt was converted to a ventriculo-cysto-atrial shunt. The reason was a pseudocyst filled with cerebrospinal fluid in the abdominal cavity and a high amount of derived cerebrospinal fluid (Fig. 3).

On the present admission, the patient complained of neck pain but did not report any other problems. The patient was conscious, fully oriented and cooperative, without focal neurological deficit. The scars of the post-shunt implantation areas were healed without signs of inflammation. The valve chamber was palpable and filled promptly.

Laboratory samples and an X-ray image of the course of the shunt were performed, which showed the disconnection of the atrial catheter and its dislocation to the heart and pulmonary artery (Fig. 4). An invasive cardiologist was contacted immediately. It was decided to try to extract the displaced atrial catheter. The cardiac surgeon was also informed and was ready to perform open surgery to remove the atrial catheter if the endovascular procedure should fail.

The patient was taken to the interventional angiography department at the Cardiology clinic. After local anaesthesia with 1% mesocaine, access to the right femoral vein was obtained by the Seldinger technique. A GooseNeck 10 F catheter with a 10 mm loop was inserted through an introducer. Using this, the end of the atrial catheter was secured and extracted slowly out through the femoral vein in the groin area (Fig. 5).

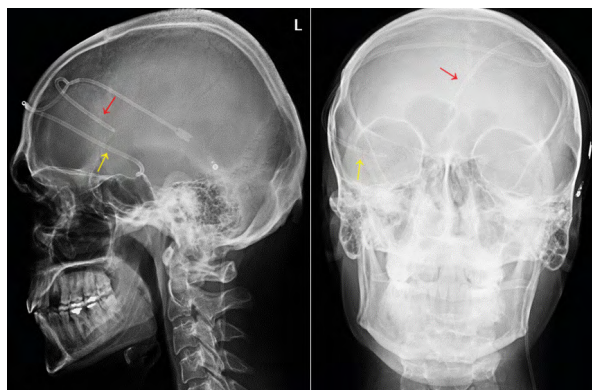


Figure 2. X-ray scan of skull of patient after revision. Catheter introduced into temporal arachnoid cyst (yellow arrows) on right side was connected through T-connector to ventricular catheter (red arrows)



Figure 3. CT exam of abdominal cavity. CT exam of abdominal cavity with pseudocyst filled with cerebrospinal fluid around distal end of ventriculoperitoneal shunt (yellow arrows). For this reason, peritoneal catheter was exchanged for atrial catheter

The procedure went without complications. The puncture canal was treated with a suture.

Subsequently, a surgical revision was performed under general anaesthesia, during which a new atrial catheter was inserted into the patient under ultrasonic guidance. The procedure went without complications. Even before the revision, the patient began to report headaches as a sign of

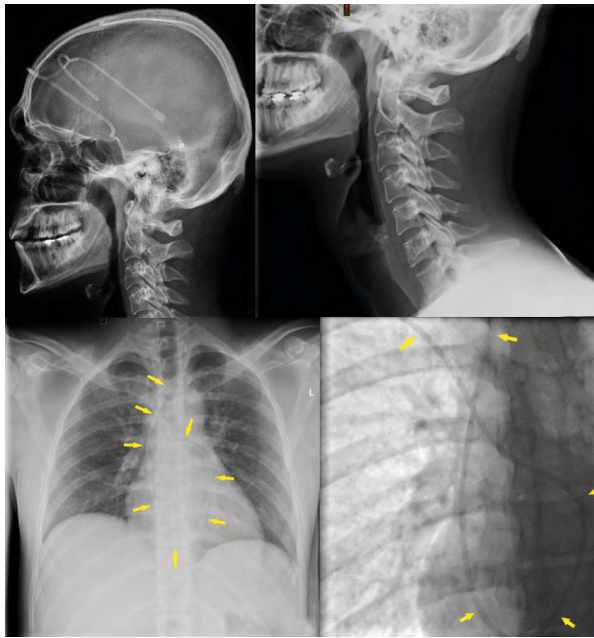


Figure 4. X-ray images of disconnected atrial catheter. X-ray images of ventriculo-cysto-atrial shunt show disconnected atrial catheter from valve moving towards heart and pulmonary artery. Last two images display difference in position of atrial catheter from initial image and just before its endovascular removal when distal end of catheter was located in pulmonary artery

shunt dependency. After the revision, the symptoms subsided. The patient was discharged home on the fifth postoperative day. Surgical wounds were healed by first intention.

Discussion

After the introduction of the Spitz-Holter valve in 1952, VASs became a treatment choice for hydrocephalus [3]. Because over subsequent years various complications of VASs were recognised, VPSs were introduced in the late 1960s and showed fewer long-term complications compared to VASs [4]. As VASs drain cerebrospinal fluid directly into the bloodstream and into the heart they have shown an increased risk of serious complications compared to other techniques, but they remain an important alternative to VPSs in selected cases [5, 6].

Obstructions, malpositions and shunt infections are frequent complications in VASs [7, 8]. The most serious complications of VASs are shunt infections, thromboemboli and misplacement or blockage of the atrial catheter. Migration of the distal segment of a broken atrial catheter is a less common but very serious complication [9].

Atrial catheter migration can be classified either as proximal (retrograde) i.e. retreating back to the superior vena cava or internal jugular vein, or distal (anterograde) i.e. projecting

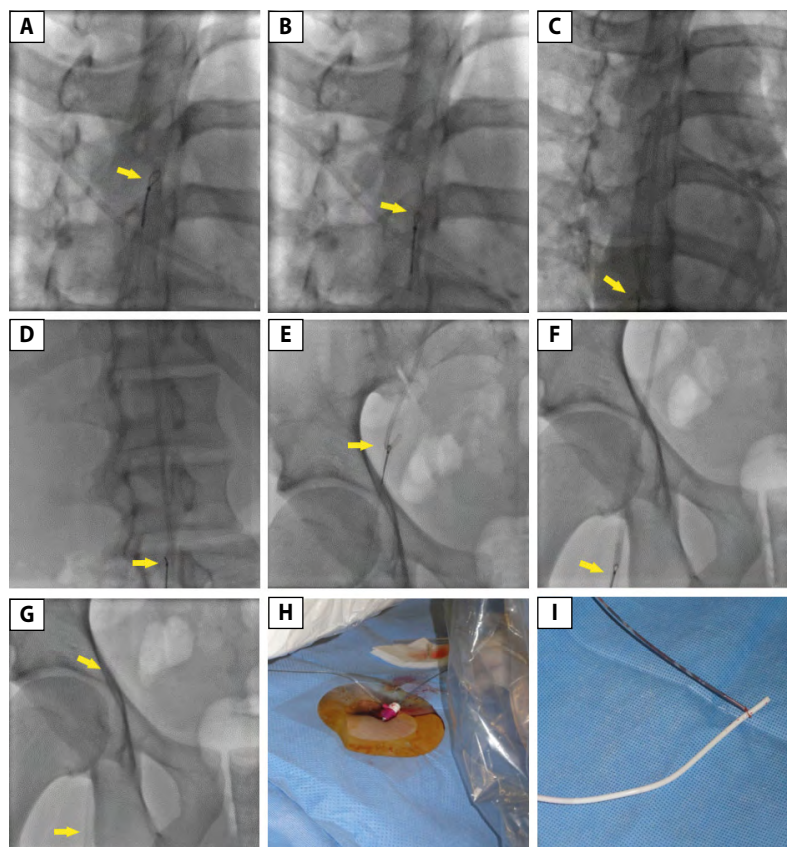


Figure 5. Endovascular removal of atrial catheter. Proximal end of atrial catheter was captured using a teflon-coated metal loop (yellow arrows) and was gradually extruded out of body through groin via venous system

Table 1. Literature review of atrial catheter migration into heart and pulmonary artery

Study	Age (years) /sex	Symptoms	Catheter location	Complication	Treatment	Outcome
Mori et al., 1993 [9]	21/M	Stupor	PA	None	Endovascular	GR
James et al., 1997 [25]	20/M	Headache, nausea, vomiting	PA	None	Endovascular	GR
So and Shirani, 2009 [26]	53/M	Severe chest discomfort	PA	None	Endovascular	GR
Irie et al., 2009 [27]	50/M	Chest distress	PA	Cardiopulmonary arrest (ischaemic cardiac failure)	Medical	Died
Matsubara et al., 2012 [28]	67/M	Disorientation, memory disturbance and gait disturbance	H	None	Endovascular	GR
Aloddadi et al., 2018 [29]	9/M	Progressive neck swelling	PA	None	Endovascular	GR
Xu et al., 2021 [30]	12/F	Poor feeding, fatigue	H	None	Endovascular	GR
López Sánchez et al., 2022 [31]	36/F	General discomfort, headache, neck pain	PA	None	Endovascular	GR
Zervos et al., 2022 [32]	72/F	NPH symptoms	H	None	Endovascular	GR
	79/M	NPH symptoms	H	None	Endovascular	GR
	32/F	Progressive headaches	H	None	Endovascular	GR

The PubMed database was searched for original articles published between 1990 and 2022 with the search term "ventriculoatrial". Eligibility criteria were (i) availability of English abstract and (ii) complications clearly attributed to distal catheter migration into the heart or pulmonary artery. M — male, F — female, PA — pulmonary artery, H — hearth, GR — good recovery

into the tricuspid valve, the right ventricle, or even the pulmonary arteries [10] (Tab. 1). Retrograde migration has been reported in both paediatric and adult populations and can occur when the VA shunt was inserted in infancy, and as the patient grows, it leads to catheter migration by upward pulling of the tubing. It can cause hepatic vein thrombosis, cervical subcutaneous abscess, superior vena cava syndrome, and thrombosis [11–13], but it is sometimes without consequence.

Anterograde migration can lead to right atrial thrombus, pulmonary embolism, pulmonary hypertension, cardiac tamponade, endocarditis and arrhythmias due to direct irritation of the sinoatrial and/or atrioventricular nodes in cases when the catheter tip is located too distally [10].

A broken segment of atrial catheter can be retrieved by a venous catheterisation technique via the transjugular approach [14] or more commonly via the transfemoral approach [9] by the cardiologist, and eventually by the interventional radiologist. If a long time has elapsed since the insertion, potential adhesion of the shunt catheter to intracardiac structures can be problematic for percutaneous removal [15, 16]. If this mini-invasive technique is unsuccessful, it is then necessary to remove the catheter or part of it from the open thoracotomy [17]. In the case of adhesion of the atrial catheter to the right ventricle, the pulmonary valve, pulmonary artery, or superior vena cava, the open heart approach is the safer option [16].

Migration of a VPS into the heart or pulmonary artery has been reported [18, 19]. It is assumed that the subcutaneous catheter guide perforates the internal or external jugular vein during the shunt procedure, and negative pressure in the vein draws the catheter into the heart, despite no evidence of

subcutaneous haematoma or signs of vessel injury during the original shunt procedure [18].

Appropriate vein selection and precise atrial catheter placement are important to reduce the complications of VASs. Therefore, new placement strategies and monitoring methods have been introduced to improve success and reduce complications in atrial catheter placement. Chuang et al. [20] reported the use of percutaneous placement with real-time transoesophageal echocardiogram monitoring because it was quick, safe, more accurate, and less invasive. The endovascular technique was presented by Gonzales et al. [21]. This technique can identify venous system easily, can demonstrate jugular vein patency, and can determine quickly the true placement or malposition [21]. Percutaneous placement of an atrial catheter with ultrasonography guidance was reported by Metellus et al. [22].

Minimising the risk of distal VAS disconnection is particularly important due to the risk of catheter embolisation. This rare event occurs in c.1.56% of implanted VA shunts [23]. There are no clear treatment guidelines in the literature to help prevent and manage this complication [24].

Conclusions

VASs are the usual alternative when it is impossible to use VPSs. Their use is connected with rare but serious complications. Appropriate vein selection, precise atrial catheter placement, and minimising the risk of atrial catheter disconnection are important requirements to reduce the VAS complication rate. Endovascular removal of a displaced atrial catheter is the

method of choice and is minimally invasive. Quick resolution of this complication is essential.

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