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Technical Notes & Surgical Techniques

Ventriculoatrial shunt in adults. A case series, with emphasis on atrial catheter migration☆

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ABSTRACT

Objectives: Few studies have described retrograde migration of the atrial catheter tip in ventriculoatrial shunt to treat adult hydrocephalus.
Methods: We placed ventriculoatrial shunts in 25 selected adult patients with a previous complicated abdominal surgery or concurrent bowel disease and in patients with persistent symptoms after a ventriculoperitoneal, potentially due to conflicting internal abdominal pressure. Clinical and radiological follow-ups were performed at least 18 months postoperatively.
Results: No mortality or early or late infection occurred in the series of patients. At the long-term clinical and radiological follow-up (mean 4.5 years), eight patients died due to causes unrelated to shunt surgery. All other patients were able to live independently but some experienced neurological decline related to their neurodegenerative disease. In five patients (20%), atrial catheter migration was detected on a control chest x-ray; in four patients, it was associated with worsening of their clinical condition. These patients underwent surgical substitution of the atrial catheter. The remaining asymptomatic patient was managed conservatively.
Conclusions: The ventriculoatrial shunt was a safe, effective procedure for treating hydrocephalus in adult patients. Retrograde migration of the atrial catheter tip in symptomatic patients required surgical substitution of the atrial catheter.

1. Introduction

Adult hydrocephalus is treated by shunting excess fluid in the brain ventricles through a catheter/valve system, which is connected to a distal drain introduced into the peritoneal or atrial cavity. Nevertheless, due to bowel activity, the abdominal compartment may develop a counteracting internal pressure that hinders drainage of the cerebrospinal fluid. In the right atrium, the low (2–6 mmHg) internal pressure promotes unobstructed cerebrospinal fluid outflow from the catheter/valve system into the bloodstream. We evaluated a series of patients with ventriculoatrial (VA) shunt, and found some cases of retrograde migration of the atrial catheter in the superior vena cava. This complication is very rarely reported in adults with VA shunts. Here, we described the clinical and radiological findings and the long-term follow-up in a series of surgical patients.

2. Patient and methods

Every patient or next of kin provided consent for the collection of clinical and radiological data and the publication of those data in an article for a scientific journal. From January 2004 through December 2016, we placed 25 VA shunts in adult patients with probable or possible idiopathic normal pressure hydrocephalus (INPH, n = 18 patients) or secondary hydrocephalus due to neoplasm, previous hemorrhage, or head injury (n = 7 patients). A tap test, with gait and neuropsychological testing, was used to select patients with INPH [1]. Fourteen

Abbreviations: VA, ventriculoatrial; INPH, idiopathic normal pressure hydrocephalus; I.D., inner diameter; O.D., outer diameter; mRS, modified Rankin Score; CT, Computed Tomography

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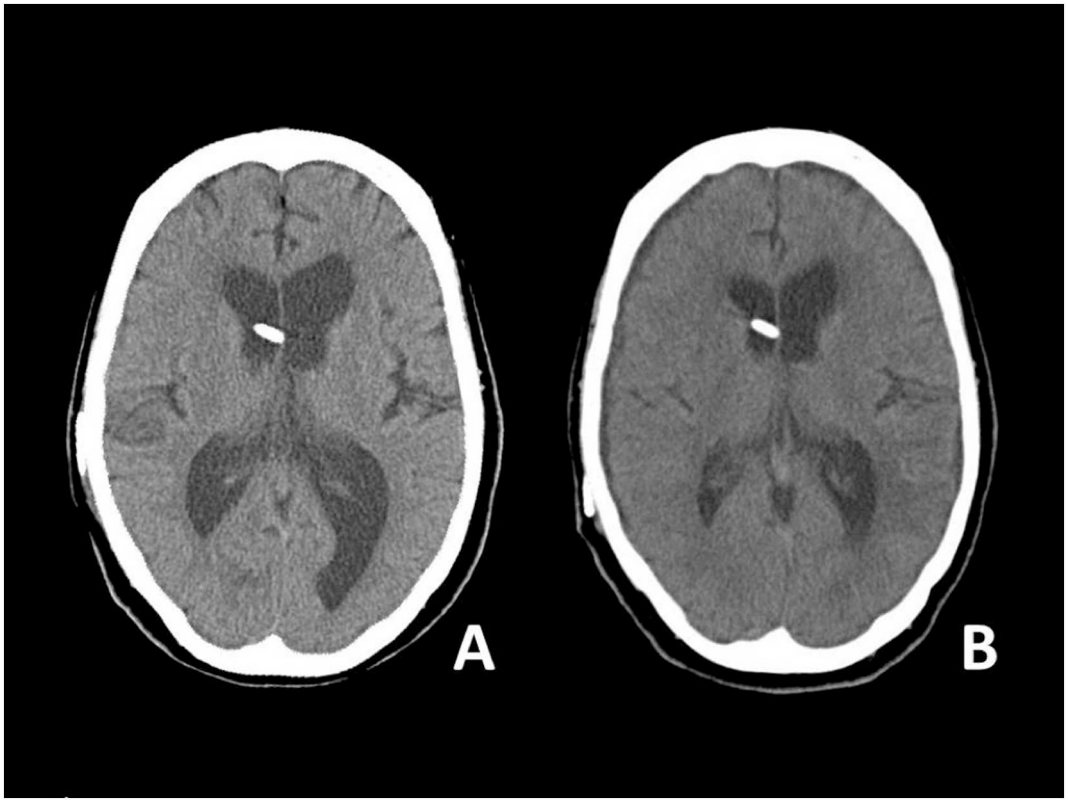

Fig. 1. CT images show the brain of a 72 year-old female with symptoms of hydrocephalus that had previously received a VP shunt. A: The valve settings were repeatedly adjusted without clinical or radiological improvement. Therefore, the VP shunt was presumed to be working improperly, and the distal catheter was relocated to the atrial cavity. B: Control CT scan two weeks later, shows normal sized cavities in the ventricular system, but bilateral subdural effusions; the latter effusions were counteracted by reducing the cerebrospinal fluid valve outflow.

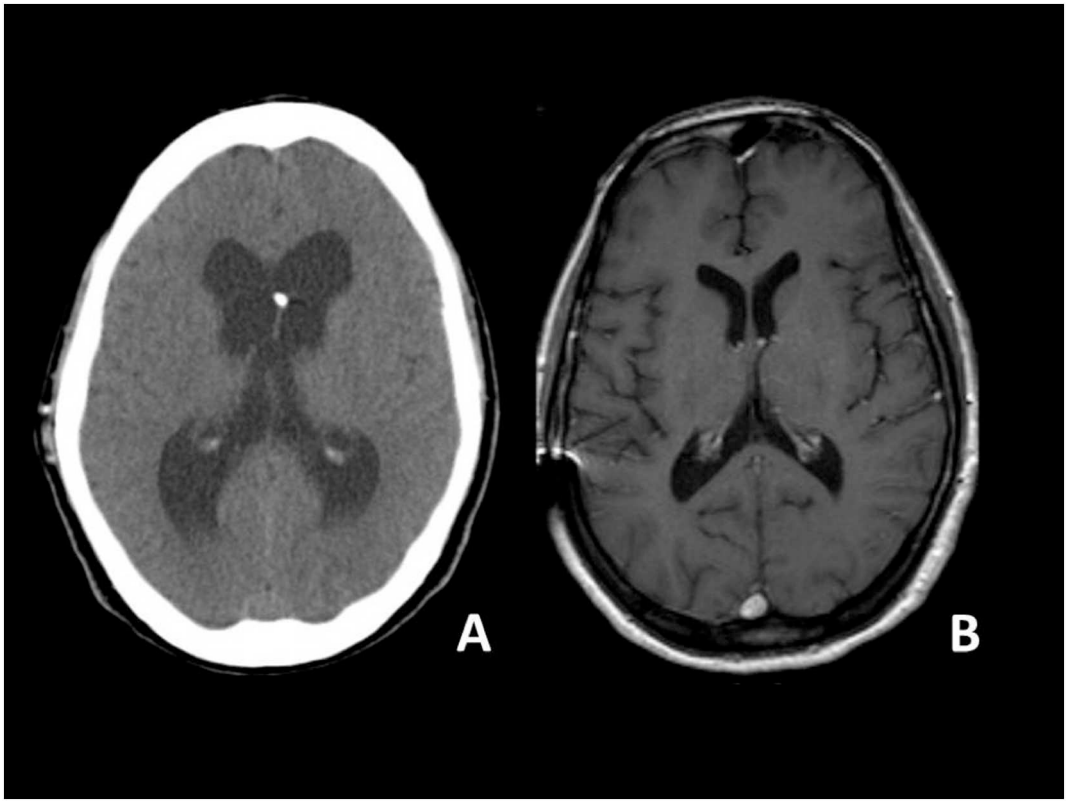

Fig. 2. CT image show the brain of a 38 year-old female with von Recklinghausen Disease, tectal glioma, and hydrocephalus, who previously received a VP shunt after a third ventriculostomy had failed. A: Valve settings had been repeatedly adjusted, without clinical or radiological improvement. The distal VP catheter was relocated to the atrial cavity. B: Control MRI sixteen months later shows normal sized cavities in the ventricular system.

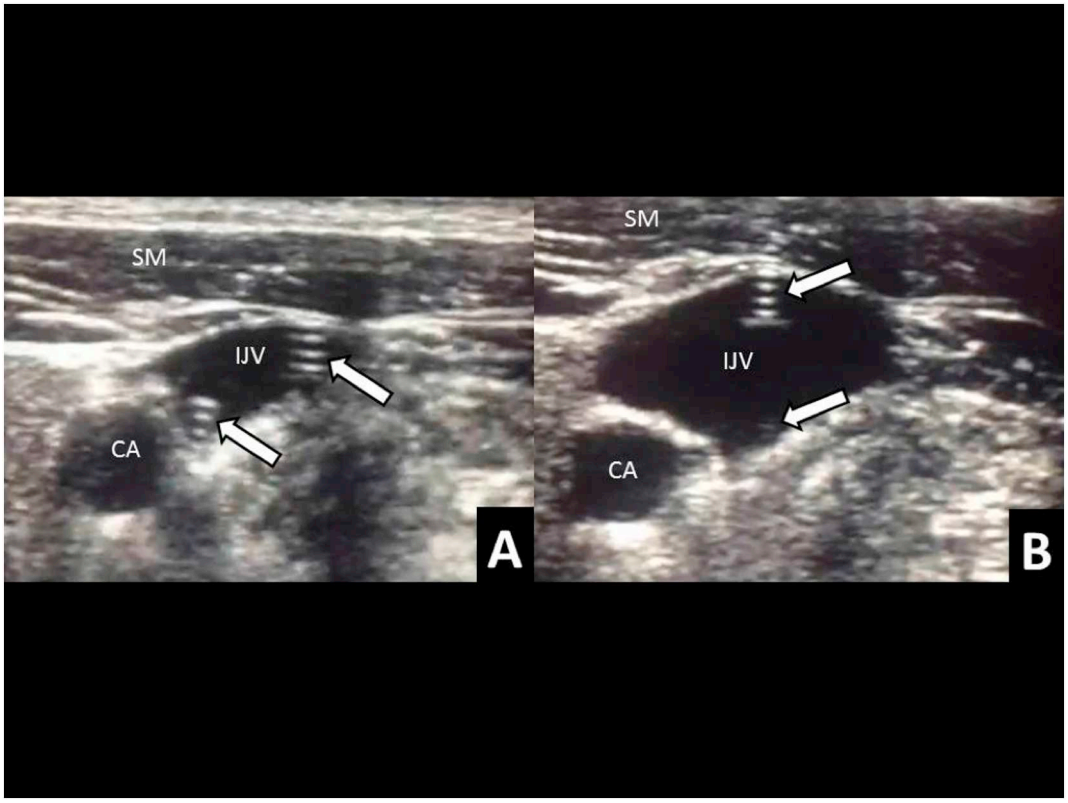

Fig. 3. Intraoperative percutaneous transverse ultrasound echography images in a patient with an atrial catheter that migrated. A: A twisted atrial shunt (arrows) is visible in the IJV, where it slightly pushes on the skin and on the subcutaneous tissue. B: Relieving the pressure on the neck the IJV size increased. CA: carotid artery, SM: sternocleidomastoid muscle.

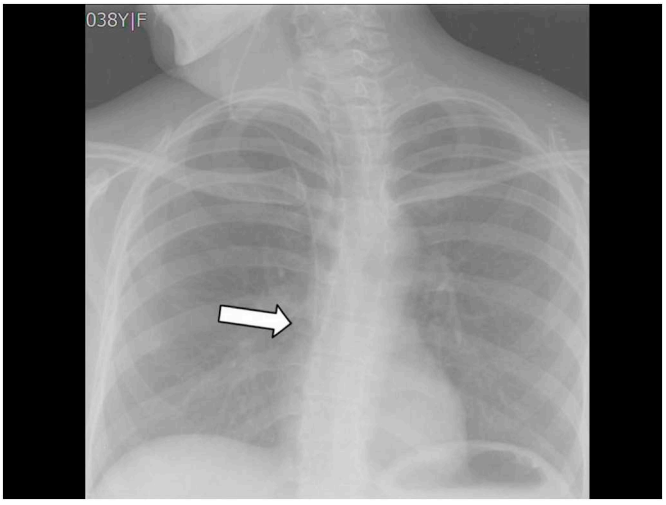

Fig. 4. Anterior-posterior chest x-ray confirms the correct placement of the catheter tip at the cavoatrial junction (white arrow).

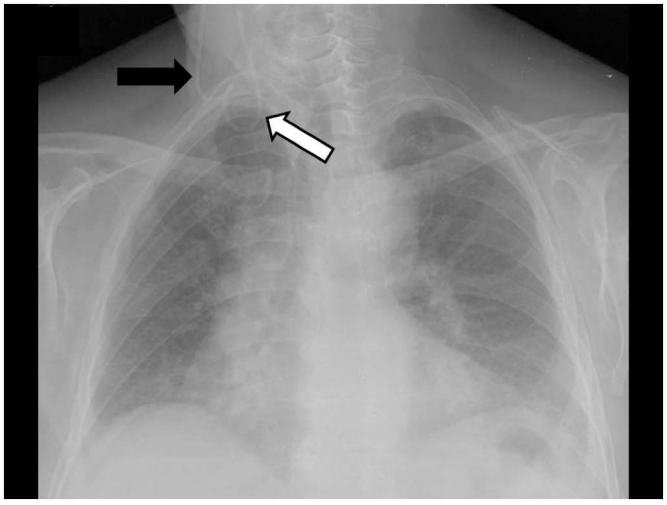

Fig. 5. Chest x-ray shows a VA shunt placed five years previously, for treating an INPH. At the time of this radiography, the patient complained of a worsening in the ability to walk. The radiography shows a lifting and kinking of the atrial catheter (black arrow). The tip of the distal catheter had migrated from its original position in the atrial cavity; it had moved retrogradely in the superior vena cava, up in the large right brachiocephalic vein until it became lodged inside the narrower IJV (white arrow). The black arrow shows the point of the previous transcutaneous insertion of the atrial catheter, which anchoring to the IJV wall avoids further lifts.

patients received an atrial shunt based on a previous history of complicated abdominal surgery or concurrent bowel disease (i.e., tumors, inflammatory disease, diverticula, etc.). Eleven other patients had previously undergone ventriculoperitoneal shunt placement, but the cerebrospinal fluid was presumably improperly absorbed into the abdominal cavity. Consequently, these patients underwent removal of the peritoneal catheter and received a new catheter placed in the atrial cavity (Figs. 1 and 2). Atrial fibrillation was not considered a contraindication for VA shunt insertion. Patients taking antiplatelet or anticoagulant therapies were instructed to stop this therapy 5 days before the surgical procedure, and these therapies were replaced with low molecular weight heparin (40 mg/day), which was continued for at least 4 weeks. The surgical technique was a variation of Harrison's percutaneous technique [2]. An ultrasound probe was used to avoid

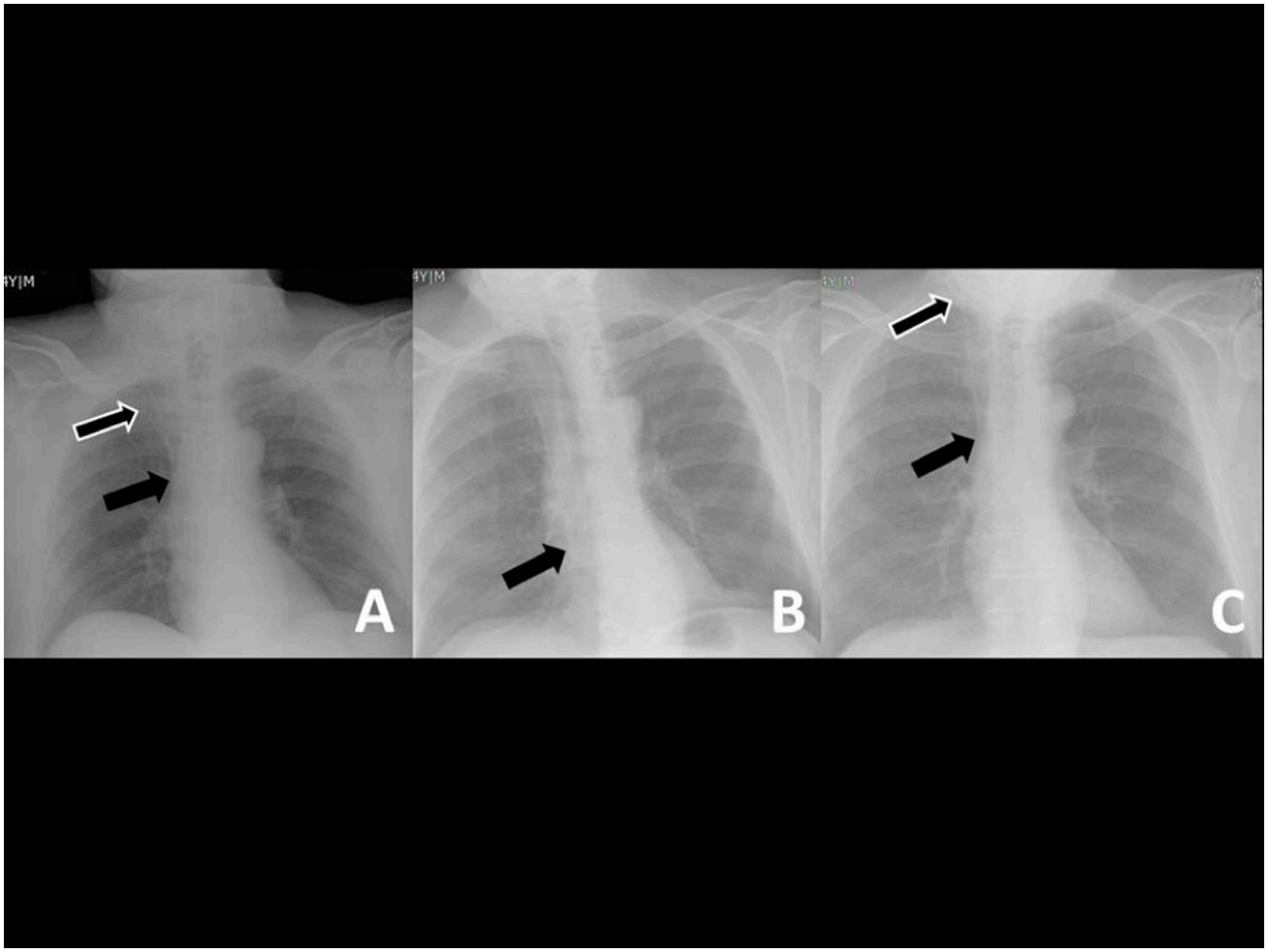

Fig. 6. A: Chest x-ray of an asymptomatic 74 year-old patient with an atrial catheter tip twisted in the superior vena cava (white outlined arrow). B: The next day, the radiograph shows that the catheter tip spontaneously moved into the atrial cavity (black arrow). C: Four months later, the patient complained of slight neurological worsening, and the radiograph shows a new upward displacement of the catheter tip (black arrow), with the tube rolled up, in the right brachiocephalic vein (white outlined arrow). Surgical replacement of the catheter was performed successfully.

percutaneous accidental puncture of the carotid artery or the lung apex (Fig. 3). Viewed on an anterior-posterior chest x-ray, the distal catheter tip (a silicone Bactiseal catheter, inner diameter [I.D.] = 1.0 mm and outer diameter [O.D.] = 2.2 mm) was considered to be in place when it extended to at least the cavoatrial junction, which is distinguishable from the trachea carina (usually at the level of the 5th thoracic vertebra), or when it extended into the midportion of the atrial chamber, which is recognized from the cardiomediastinal outlines (Fig. 4). A programmable valve was positioned in the retroauricular area, and the opening pressure was set at middle-to-high levels (i.e., 160–180 mm H_2O). A postoperative head Computed Tomography (CT) or Magnetic Resonance Imaging and chest x-ray were performed periodically, during monthly check ups, or in cases of recurrent symptoms.

3. Results

Fifteen women and ten men (mean age, 73 years, range: 34–82 years) underwent VA shunt placements. No deaths or infections occurred. Before starting intraoperative neck ultrasound echography, one patient (4%) developed a postoperative pneumothorax due to a possible puncture at the apex of the lung. This condition resolved after 5 days with a chest tube. No infectious (shunt glomerulonephritis) or cardiopulmonary complications occurred during the long-term follow-up (at least 18 months postoperatively, mean 4.5 years). Seven patients (28%) died due to causes unrelated to shunt surgery. Overall, after surgery, no significant disability occurred in 6 patients (24%), slight or moderate disability (modified Rankin Score [mRS] score 2 and 3) occurred in 8 patients (32%), high disability (mRS score 4) occurred in 3 patients (12%), and severe disability occurred in 1 patient (4%).

Eighteen patients required adjustments to the valve setting; cerebrospinal fluid outflow was reduced in 14 patients and increased in 4 patients (Fig. 1). In 5 patients (20%), atrial catheter migration was detected on standard chest radiography (Figs. 5, 6, 7). In four patients, this movement was associated with worsening of the clinical condition. In these patients, the atrial catheter was surgically substituted, without changing the valve settings. The one asymptomatic patient was managed conservatively and did not display any variation in the clinical course after 46 months (Fig. 7).

4. Discussion

Retrograde migration of the venous catheter rarely occurs as a complication of VA shunts in adults [3,4]. This complication was detected in 1–3% of children who received VA shunts [5,6]. To avoid buckling and migration of the atrial catheter in the superior vena cava, insertion of a more rigid atrial catheter is suggested for adults [3,4]. With the implementation of routine checks of the atrial catheter at periodic screenings, this complication might be detected more frequently. Natelson substituted the “J” catheters with a more rigid one, with an I.D. of 1.2 mm and O.D. of 2.5 mm [4]. All our atrial catheters

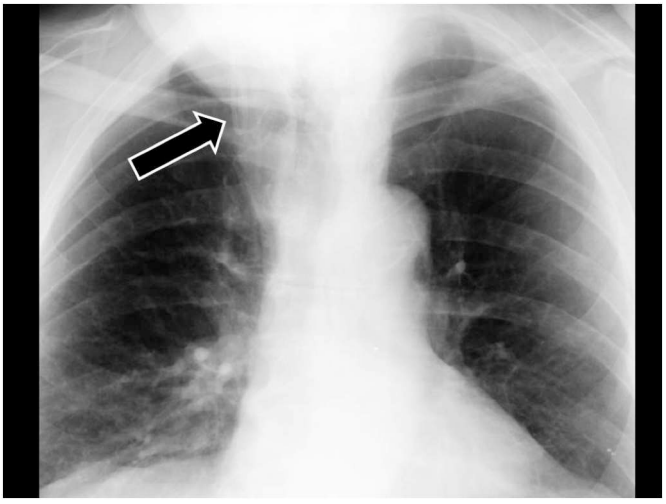

Fig. 7. Chest x-ray shows a migrated atrial catheter, twisted in the right IJV (white outlined arrow) in an asymptomatic 73 year-old patient. Due to good neurological performance, the patient was placed under clinical and radiological observation. After 60 months, no clinical changes or complications occurred due to the catheter migration (i.e., no infection or embolism).

had an I.D. of 1.0 mm and O.D. of 2.2 mm and those dislocated were substituted with a same-sized catheter since a more rigid/thicker catheter could favor endothelial and intimal injury and thromboembolic events. Further dislodgements of the atrial catheter were not observed during follow-up. For this reason, we consider migration of the atrial catheter to be a rare event that can occur in relationship to the anatomical characteristics and blood flow streams in the brachiocephalic vein and superior vena cava. In patients with recurrent symptoms, surgical substitution of the atrial catheter should be mandatory. In asymptomatic patients, a wait-and-see policy it is advisable. Subdural hygroma is another complication associated with VA shunts. In a previous study, a series of adult patients with INPH treated with VA shunts displayed no cardiovascular complication attributable to shunt placement [7]. However, 33% of those cases developed a subdural collection, which was managed by adjusting the programmable valve in eight patients and by changing the valve system in two patients. In the present study, we reduced the cerebrospinal fluid outflow during the postoperative period in fourteen patients who had experienced postural headache or had subdural effusions detected on a control CT scan. This finding should never be underestimated. Therefore, with the atrial shunt, we always use relatively high settings (160–180 mm H_2O) at the insertion of the programmable valve to allow cautious cerebrospinal outflow. The cerebrospinal outflow can be adjusted at the periodical checkups, based on the patient's clinical condition.

5. Conclusion

This study showed that the VA shunt was a safe, effective procedure for treating hydrocephalus in adult patients with suspected counteracting internal pressure or an altered absorbing surface in the abdominal compartment. Based on our results, we recommend that when the atrial catheter tip exhibits persistent retrograde migration in the brachiocephalic vein, superior vena cava, or internal jugular vein with a symptomatic course, the atrial catheter should be surgically substituted, without changing the valve settings.

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Declarations of interest

None.

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