Transesophageal echocardiography: a simple method for monitoring the patency of ventriculoatrial shunts

Technical note

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A new method for evaluating the patency of a ventriculoatrial shunt is described, and early experience with it is reported. Transesophageal echocardiography can demonstrate a cerebrospinal fluid leak in the right atrium through the atrial tip of a shunting device. This capability was an incidental discovery, and since then the accuracy of the technique in evaluating the patency of a ventriculoatrial shunt has been prospectively studied in 20 observations of 16 patients. The method proved to be accurate in 90% to 100% of cases. It is concluded that transesophageal echocardiography offers a rapid and accurate assessment of ventriculoatrial shunt function, is well tolerated, and is easy to perform.

Key Words • ventriculoatrial shunt • shunt monitoring • echocardiography

In shunt-dependent hydrocephalic patients, the neurosurgeon often has to confirm the patency of the shunt. Monitoring of shunt function in the outpatient clinic is usually based on clinical examination and palpation of the pump. Unfortunately, the assessment is not always easy and often “pumping” is unreliable. For ventriculoatrial (VA) shunts, a more sophisticated examination, such as the injection of contrast medium or radionuclides, is used; however, repeated puncture of a shunting device can damage the valve.

Shunt patency can also be evaluated by injection of radioactive isotopes into the ventricles. The method of bladder scanning after introduction of 131I-labeled hippurate into the ventricles has often been used. This method is easy to perform in neonates but requires the creation of burr holes in adult patients. It is certainly not a noninvasive method.

With the transesophageal echocardiography approach, modern ultrasound technology has provided us with a new and superior method for the dynamic imaging of dorsal cardiac structures such as the right atrium and the superior vena cava in adults. The leakage of cerebrospinal fluid (CSF) out of the atrial tip of a VA shunt was demonstrated by one of us (J.V.) in an adult patient in whom transesophageal echocardiography was performed to assess mitral valve disease. The leak presented as scattered echos around the atrial tip, which increased at each inspiration and became even more pronounced on performing a Valsalva maneuver. Impressed by the clearness of the images and the possible clinical implications of this novel technique, we performed a prospective and partly blinded study (the person conducting the study was unaware of the clinical and investigational data of the patient) to assess the accuracy of transesophageal echocardiography in examining the patency of VA shunts. This report describes the method and the initial results.

Technique

Transesophageal echocardiography was performed on 20 occasions in 16 consecutive patients (nine women and seven men with a mean age of 46.9 years [range 16 to 77 years]). These patients were suspected of having an obstructed VA shunt or had placement of a new shunt. The person conducting the study was unaware of the clinical or investigational data of the patient. A commercially available 6-MHz anular array probe was used, mounted on the tip of a gastroscopic 16 mm thick. The probe was connected to a commer-
Transesophageal echocardiography for shunt patency

Fig. 1. Ultrasound image obtained with a 6-MHz transesophageal probe in a patient with a ventriculotraumatic shunt. The atrial tip of the shunt is correctly positioned in the middle of the right atrium. A cloud of scattered echoes emerges from the tip into the right atrium (RA) and represents the mixing of cerebrospinal fluid with blood in the right atrium. The timing of respirations can be derived from the motion of the septum primum at the level of the fossa ovalis.

Illustrative Case Reports

The information obtained by this simple method in 16 patients is illustrated by the following two cases.

Case 1

This 55-year-old man was operated on for a benign tumor in the posterior fossa. Postoperatively, he needed placement of a VA shunt. He recovered and was without neurological complaints. Five years later he consulted a cardiologist for evaluation of cardiac symptoms. Transesophageal echocardiography showed the tip of the catheter in the right atrium and at each inspiration a scattering appeared around the tip of the catheter corresponding to a release of CSF in the atrium. This patient was obviously shunt-dependent and the device was patent.

Case 2

This 26-year-old man was referred to us with the clinical picture of a syringomyelia. This condition was confirmed by magnetic resonance imaging, which also showed a Chiari II malformation and severe hydrocephalus. A VA shunt was placed before treatment of the syringomyelia and the Chiari malformation. Several weeks later, we requested confirmation of the patency of the shunt because the patient was still complaining of headache. With the aid of transesophageal echocardiography we were able to see the tip of the catheter slipping intermittently through the tricuspid valve. Pumping the shunting device caused a scattering of CSF to appear mostly in the right ventricle. Thus, although the system was patent, it was working inadequately because the atrial catheter was too long.

Summary of Cases

The results in this series and the comparison between echographically established shunt patency and the ultimate clinical estimation of patency in these 16 patients (20 observations) can be summarized as follows. In 14 routine observations, a good clinical evaluation correlated with a good position of the catheter and patency of the device on transesophageal echocardiography. In three observations in which the patient's clinical condition was poor, transesophageal echocardiography showed that the catheter was correctly placed but that the device was not patent. At surgery in these cases the drain proved to be obstructed. In two instances the patients were clinically unchanged after a shunting procedure, and on transesophageal echocardiography the device proved not to be patent in both cases. In one of these patients the position of the catheter was incorrect; this patient was operated on and the drain proved to be obstructed. The other patient died from a nonsurgical problem before reoperation could be performed. One patient (Case 2) had a catheter that slipped intermittently through the tricuspid valve; the catheter was patent but too long.

It is obvious that the ultimate decision to evaluate the patency of a shunt surgically should be based on clinical criteria. Furthermore, in the absence of a noninvasive "gold standard," the method described here could not be compared with other techniques in cases of shunt patency. Thus, the shunt was considered to be patent if the clinical course and the investigational data did not suggest obstruction of CSF drainage, and was

* Echo-Doppler instrument manufactured by Vingmed, Horten, Norway.
considered to be obstructed if at surgical replacement of the device obstruction was present.

Based on the data in this series, the value of transesophageal echocardiography in examining the patency of a VA shunt can be described in the following terms. If patients with unchanged clinical symptoms are considered as having a poor outcome, then the accuracy level (number of true-positive and true-negative tests) was 20 (100%) of the 20 tests performed. If, however, patients with unchanged clinical symptoms are considered as having a good outcome, then the accuracy level was 18 (90%) of the 20 tests performed. Furthermore, an incorrect position of the catheter with prolapse in the right ventricle was evidenced in two patients.

Discussion

Although our experience is thus far limited to 20 observations in 16 patients, we feel justified in claiming that it is possible to assess correctly, by means of transesophageal echocardiography, both the position and the patency of a VA shunt. Although for some awake patients the method can be inconvenient, it is well tolerated by most. In fact, as air insufflation and suction are not used, most patients tolerate it better than a gastroduodenoscopy.

The complication rate of transesophageal echocardiography is extremely low and can be expected to be lower than the 8.1% rate of upper endoscopy.1 We hope to have fewer complications due to the fact that we use no air insufflation, suction, sclerotherapy, or biopsy. It should be stressed, however, that the probe should be inserted with gentle force by an experienced surgeon and that, in case of resistance, the procedure should be stopped. Pharyngeal and esophageal pathology, such as tumors, diverticula, and hepatic cirrhosis with esophageal varices, are absolute contraindications to the use of this technique.

A major limitation to the method is its inconvenience in children. In fact, although pediatric probes exist, they are not used in children below a body weight of 10 kg; furthermore, general anesthesia is needed. In view of these limitations, we perform the procedure only in patients aged 15 years or over. Another problem is that this method only enables one to check shunt patency; it cannot localize an obstruction or quantify the rate of flow.5

Ventriculoatrial shunting is increasingly being abandoned in Belgium in favor of ventriculoperitoneal shunting; however, both techniques have advantages and disadvantages. Now that the intra- or postoperative monitoring of a VA device can be performed so easily with transesophageal echocardiography, we are again attracted to this type of shunt for adult patients.

References


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