Noncontrast transcatheter pacing system implantation guided by trans–internal jugular vein approach intracardiac echocardiography

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Introduction

Although total major complications with the transcatheter pacing system (TPS) is lower than that with conventional transvenous pacing systems, cardiac perforation or effusion is reportedly more likely to occur with TPS than with the latter in early studies.[1,2] In these studies, the percentage of apex implantation was high.[1] TPS implantation on the septal aspect of the right ventricle may lower the risk of perforation, when compared to implantation on the true apex, which includes the thin free wall of the right ventricle.[3] To understand the anatomic feature, fluoroscopy-guided implantation with contrast media injection through the delivery catheter is recommended.[4,5] For patients who cannot be injected with contrast media substances, such as patients with chronic kidney diseases or allergies to contrast media, TPS implantation guided by intracardiac echocardiography (ICE) is an alternative to ensure appropriate myocardial apposition.

KEY TEACHING POINTS

- Transcatheter pacing system (TPS) implantation on the septal aspect of the right ventricle may lower the risk of perforation, when compared to implantation on the true apex, which includes the thin free wall of the right ventricle.
- Intracardiac echocardiography (ICE) enables clear visualization of the positional relationship between the tip of the TPS catheter and the right ventricular septum. Therefore, we can push the catheter to the right ventricular septum with certainty.
- ICE-guided TPS may be recommended for patients with complex heart structures, such as elderly patients with small and rotated hearts, as well as patients with iodine allergy and renal dysfunction.

Case report

An 80-year-old man with a congestive heart failure caused by 2:1 advanced atrioventricular block was admitted to our institution. He underwent an aortic valve replacement for an aortic stenosis 6 years ago. Micra™ TPS (Medtronic, Minneapolis, MN) implantation was selected because he had a moderate dementia and he refused a painful conventional transvenous pacemaker implantation "surgery." Contrast media usage should be minimized for his stage IV chronic kidney disease. An ICE-guided TPS implantation was chosen owing to the safety concerns. ICE was performed using the ACUSON P500 ICE Edition (Siemens Medical Solutions, USA, Inc, Mountain View, CA) and an 8F ACUSON AcuNav™ diagnostic ultrasound catheter (Siemens Medical Solutions, USA, Inc). Typically, the ICE catheter is introduced via the femoral vein and then advanced into the right atrium.[6] Alternatively, ICE, specifically inserted through the trans–internal jugular vein, was chosen to avoid interference from both the ICE and TPS catheters via the femoral vein (Figure 1). The ICE catheter was introduced via the internal jugular vein and then advanced via the superior vena cava to the right atrium. From the right atrium, the long axis of the right atrium was visualized with the tricuspid valve, the right ventricle, and the right ventricular septum (Figure 1). Figure 2 shows the right ventricular septum curved upwards in the right ventricle. TPS was implanted in the middle of the right ventricular septum by measuring enough distance from the junction of the right ventricular wall to the right ventricular septum (Figure 2). ICE showed distinct pictures in which the tip of the TPS catheter was shifted from the junction of the right ventricular free wall and the right ventricular septum to the middle of the right ventricular septum (Supplemental Figure S1, Supplemental Video 1). Additionally, the TPS catheter was

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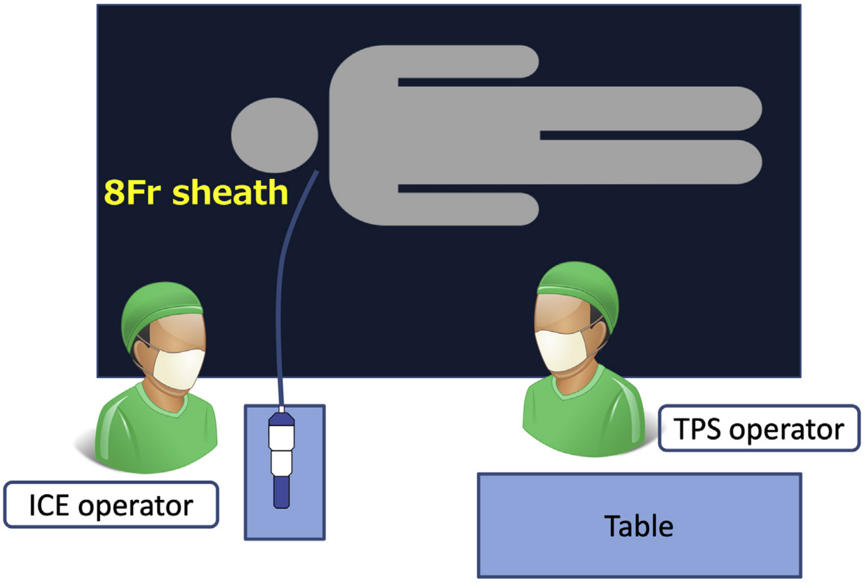

Figure 1 Trans–internal jugular vein approach intracardiac echocardiography (ICE). ICE, specifically inserted through the trans–internal jugular vein, was chosen to avoid interference from the ICE and transcatheter pacing system (TPS) catheters via the femoral vein. The ICE catheter was introduced via the internal jugular vein and advanced via the superior vena cava to the right atrium.

pushed to the septum with enough pressure to be held at a "gooseneck" position (Supplemental Figure S2, Supplemental Video 2), and the TPS body was released from the cup of the catheter and the TPS body was deployed to the middle of the right ventricular septum (Supplemental Figure S3, Supplemental Video 3). ICE pictures also showed the pull and hold test being done (Supplemental Figure S4, Supplemental Video 4) and the tether subsequently being pulled (Supplemental Figure S5, Supplemental Video 5). The TPS implantation was successful, with no contrast and no complication. Total procedural time and fluoroscopy time were 55 minutes and 12 minutes, respectively. Satisfactory sensing (6.5 mV) and pacing threshold (0.38 V / 0.24 ms) values were obtained.

Discussion

To the best of our knowledge, this is the first case report of the ICE-guided TPS implantations. TPS implantation at the

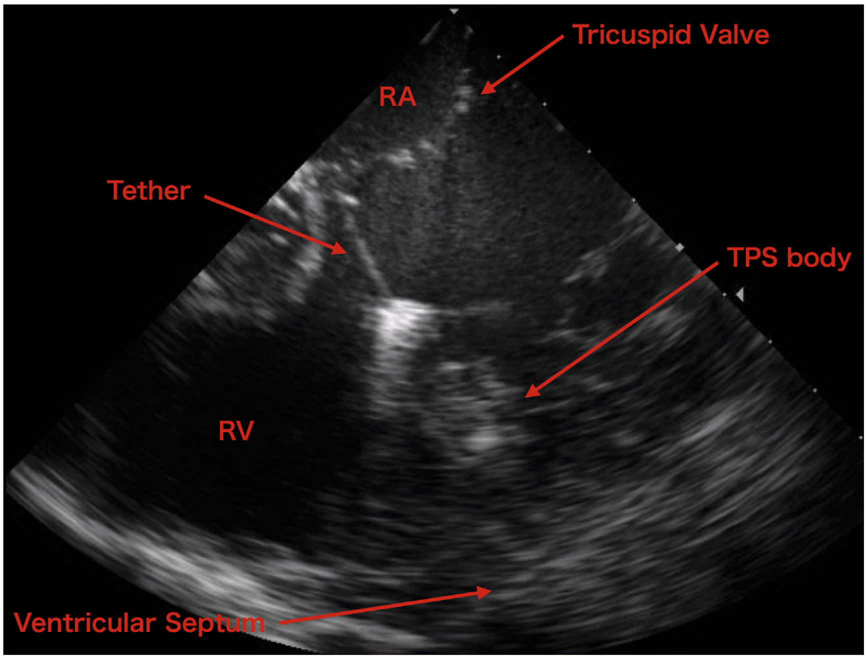

Figure 2 Intracardiac echocardiography. From the right atrium (RA), the long axis of the RA was visualized with the tricuspid valve, the right ventricle (RV), and the right ventricular septum. TPS = transcatheter pacing system.

junction of the thin right ventricular free wall and the right ventricular septum including the true apex should be avoided to prevent the cardiac perforation.[3] As cardiac geometry changes with aging,[7,8] we may exclusively lose our orientation with the fluoroscopy guide, especially in elderly patients. With access to real-time actual imaging of the heart structure, ICE-guided TPS implantation is safer than TPS implantation guided by fluoroscopic "shadow." There are several advantages of ICE-guided procedures. First, ICE enables clear visualization of the positional relationship between the tip of the TPS catheter and the right ventricular septum. Therefore, we can push the catheter to the right ventricular septum with certainty. Second, ICE demonstrates the pull and hold test distinctly. In this regard, we can confirm that the device is deployed to the ventricular wall. These aspects ensure sufficient electrical performance and avoid device dislodgments. Third, we can avoid the use of contrast media. ICE-guided TPS may be recommended for patients with complex heart structures, such as elderly patients with small and rotated hearts, as well as patients with iodine allergy and renal dysfunction.

Despite these advantages of ICE guidance, we do not recommend routine use of ICE with TPS implantation owing to possible ICE-related complications and the financial implications of expensive ICE catheters.

Among the possible ICE-related complications are bleeding, arrhythmia, stroke, vascular complications, and cardiac perforation/tamponade.[9–12] It is obvious that transthoracic echocardiography (TTE) is less invasive than ICE. We once tried to identify the TPS catheter by TTE during the procedure. Although TTE can clearly show the body of the TPS catheter, the tip of the TPS catheter tends to be invisible owing to artifacts.

Once we tried TPS implantation with a femoral vein approach ICE, but the ICE and the TPS catheter interfered with each other and the ICE catheter finally dropped from the right atrium. The most apparent limitation of the transfemoral vein approach for ICE-guided TPS implantation is the interference of both catheters in the same vessel. In this regard, ICE, specifically inserted via the trans–internal jugular vein, seems favorable for TPS implantation. Several centers perform transjugular Micra implantation,[13,14] so transjugular TPS implantation with transfemoral ICE is an alternative choice.

Risk factors of contrast-induced acute kidney injury are congestive heart failure, hypotension, estimated glomerular filtration rate, age $>$75 years, diabetes, anemia, and contrast volume.[15] Eligible patients for TPS trend to be high risk for contrast-induced acute kidney injury. We should minimize the use of contrast media.

Conclusion

For patients with chronic kidney diseases or allergies to contrast media, a noncontrast TPS implantation guided by ICE is very useful and safe.

Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2021.01.018.

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