

Percutaneous solution for a frequent complication after transcatheter aortic valve replacement: A case of atrioventricular leadless pacemaker implantation after transcatheter aortic valve replacement



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Introduction

Transcatheter aortic valve replacement (TAVR) is an established treatment option for patients with severe symptomatic aortic stenosis (AS) who are high surgical risk. Conduction abnormalities frequently occur following TAVR, requiring implantation of a permanent pacemaker, ideally with preservation of atrioventricular (AV) synchrony. There is no consensus on the placement of permanent pacemakers and no current guidelines exist for the use of leadless pacemakers in this setting. We present a case of an immunocompromised patient with a history of multidrug-resistant infections who developed complete heart block post TAVR and underwent successful implantation of a leadless pacemaker.

Case report

A 71-year-old man with a history of hypertension, type 2 diabetes mellitus, coronary artery disease, and severe AS was admitted to the coronary care unit for TAVR. Eight months prior to this admission he underwent liver and kidney transplantation for nonalcoholic cirrhosis and renal failure, maintained on tacrolimus and mycophenolate mofetil for immunosuppression. His postoperative course was complicated by prolonged respiratory failure requiring tracheostomy placement and sepsis with multidrug-resistant *Pseudomonas aeruginosa*. Three months after transplant, the patient was admitted for palpitations and chest discomfort and was found to have a regular wide complex tachycardia with an incomplete right bundle branch block (RBBB) morphology, which converted to sinus rhythm following

KEY TEACHING POINTS

- Transcatheter aortic valve replacement as a minimally invasive treatment strategy for inoperable patients with aortic stenosis has survival benefit over medical therapy alone.
- The procedure is often associated with conduction abnormalities requiring pacemaker placement.
- In immunocompromised patients leadless pacemakers are a good option, given the increased risk of poor wound healing and transvenous lead and pocket complications.
- The insertion of atrioventricular leadless pacemakers for high-degree atrioventricular block developing after transcatheter valve placement has the potential of becoming a widely adopted strategy.

administration of adenosine. Owing to the frequency of the tachycardia while on metoprolol in combination with severe associated symptoms, he underwent radiofrequency ablation of the slow pathway of the AV node. Transthoracic echocardiogram showed severe aortic sclerosis and suspected low-flow, low-gradient AS with preserved left ventricular ejection fraction of 60%–65%. Subsequently, the patient had multiple admissions for respiratory failure secondary to pulmonary edema. Cardiac catheterization was performed, revealing moderate AS with a mean gradient of 12 mmHg and aortic valve area of 1.2 cm². He also required placement of drug-eluting stents to the mid left anterior descending artery, proximal first diagonal branch, and 2 overlapping stents to the mid right coronary artery. Cardiothoracic surgery was consulted but the patient was viewed to be a high surgical risk owing to his multiple comorbidities. TAVR was recommended

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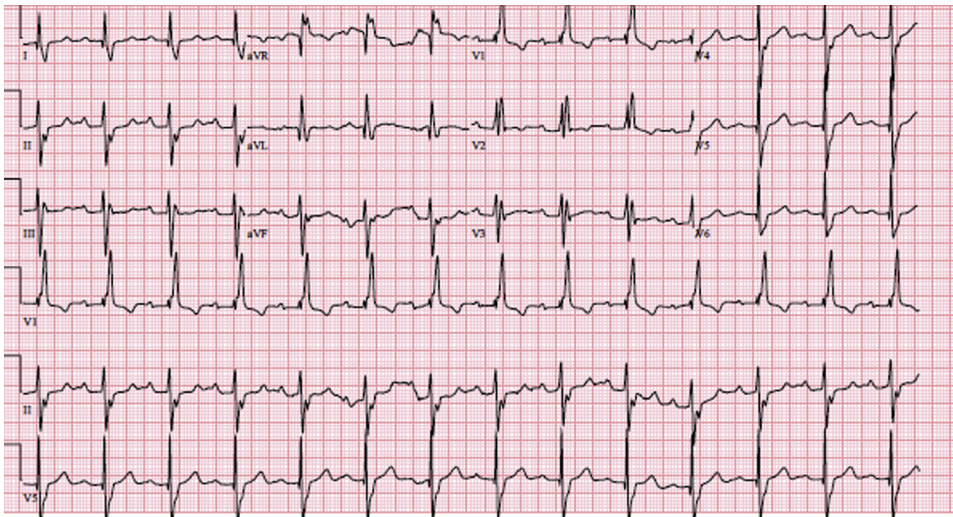


Figure 1 Electrocardiogram done prior to transcatheter aortic valve replacement showing first-degree atrioventricular block, right bundle branch block, and left anterior fascicular block

owing to severity of symptoms, which limited his ability to participate in rehabilitation. The patient was optimized for the procedure from a pulmonary and infectious standpoint and underwent admission to the coronary care unit. Prior to TAVR he was hemodynamically stable with an unremarkable physical examination except for the presence of incompletely healed abdominal incision sites. Electrolytes and liver function tests were within normal limits. Admission electrocardiogram (ECG) showed first-degree AV block, RBBB, and left anterior fascicular block, placing the patient at high risk for requiring permanent pacemaker placement after TAVR, as demonstrated in [Figure 1](#). A temporary venous pacing wire was positioned in the right ventricle before deploying a Sapien S3 #29 mm aortic valve (Edwards Lifesciences LLC, Irvine, CA) from left transfemoral access. After valve deployment the PR interval prolonged further and intermittent complete heart block was noted. The temporary pacemaker was left in place and electrophysiology was con-

sulted. The decision was made to place a leadless AV Micra (Medtronic Inc, Mounds View, MN), given his immunosuppressed state with an increased risk of infection and delayed wound healing. Postprocedural ECG showed atrial sensed, ventricular paced rhythm with prolonged AV conduction, demonstrated in [Figure 2](#).

Discussion

AS has a prevalence of approximately 5% in people aged 75 years and older.¹ Given that many patients begin to have symptoms of AS later in life and often have multiple comorbid conditions that preclude surgical correction, TAVR is an important minimally invasive treatment option. High-risk surgical candidates, who were once limited to medical therapy, now have the opportunity to experience survival rates similar to their surgical counterparts because of the advent of TAVR. With increasing numbers of TAVRs being

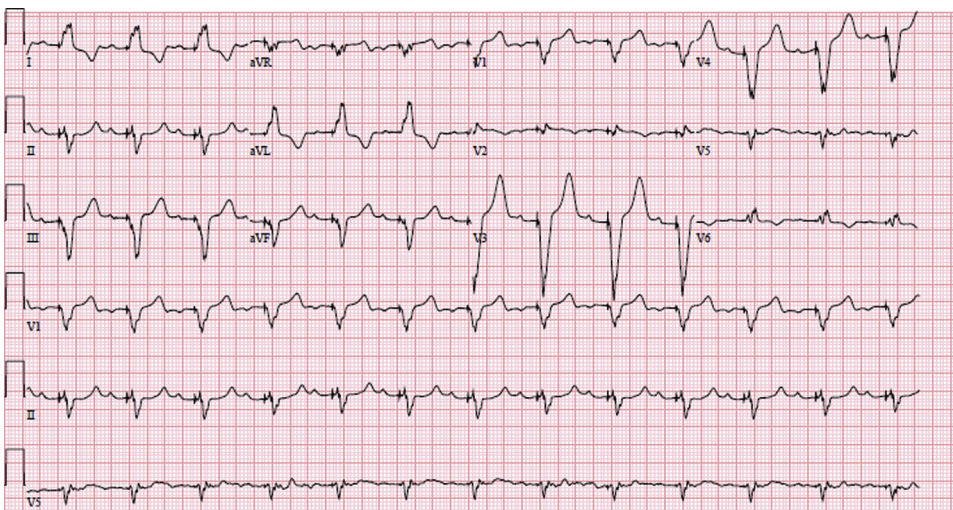


Figure 2 Electrocardiogram post transcatheter aortic valve replacement with implantation of AV Micra (Medtronic Inc, Mounds View, MN) showing atrial sensed ventricular paced rhythm with prolonged atrioventricular conduction.

done, the complications are well defined. AV conduction abnormalities are one of the most common complications owing to the intimate anatomical relation of the aortic valve to the specialized conduction system.¹ The compact AV node is located anterior to the coronary sinus ostium and directly superior to the septal leaflet of the tricuspid valve, at the apex of the triangle of Koch. The AV bundle, or His bundle, emerges from the compact AV node and penetrates the membranous ventricular septum to give rise to the infranodal conduction system. This pathway is closely related to the noncoronary and right coronary leaflets of the aortic valve. The prosthetic valve is placed in an intra-annular position, close to the AV node and the left bundle branch.¹ Conduction abnormalities usually arise owing to direct mechanical insult. In addition, AS is associated with conduction abnormalities at baseline, likely owing to calcium deposition on the conduction system and left ventricular dysfunction associated with the condition.¹ New left bundle branch block (LBBB) is the most common conduction abnormality post TAVR, occurring in 4%–57% of patients, with up to 51% of those requiring permanent pacemaker placement.¹ Factors that have been associated with a higher risk of conduction abnormalities after TAVR include the use of self-expanding valves, depth of the implant, and baseline conduction abnormalities such as a wide QRS complex, particularly RBBB on ECG.¹ A single-center study demonstrated that using a patient-specific minimizing depth according to the membranous septum (MIDAS) resulted in a lower rate of permanent pacemaker placement (3.0%) and new-onset LBBB (9.0%).² This approach involves using preprocedural computed tomography scan to measure the length of the membranous septum and target valve implantation to a depth less than the membranous septum.² Other patient factors such as previous coronary artery bypass graft, diabetes, and the amount of calcium on the valve also increase the risk of LBBB after TAVR. Many of these factors were present in the patient presented in this case. The self-expanding Medtronic transcatheter prosthesis (35%–65%) has been associated with higher incidence of new LBBB than balloon-expandable Sapien valves (3%–30%).³ Although it has been reported that 20% of patients with new LBBB post TAVR are transient, approximately 28% of patients require permanent pacemaker placement after insertion of CoreValve vs 6% of patients after placement of the SAPIEN valve.³ Regardless, pre-existing RBBB places patients at highest risk for complete heart block regardless of the device used, and the recommendation is to place a temporary pacing wire in these patients for postoperative monitoring. Permanent pacemaker placement has been shown to improve survival in patients with complete heart block.³

Traditional pacemakers have pulse generators that are placed above the pectoral fascia and the pacing leads are placed through the venous system, usually in the upper extremity veins.⁴ Immediate complications at the time of implantation include traumatic injury such as pneumothorax or cardiac perforation, and this occurs in approximately 1%–3%

of patients.⁴ Lead dislodgement at the time of placement and within 30 days occurs in about 3%–4%.⁵ Long-term complications associated with transvenous leads include fracture (1%–4%), moderate-to-severe tricuspid regurgitation (5%), venous obstruction (8%–21%) and infection (1%–5%).⁵ Surgical site infections usually occur within 1 year after implantation or later as lead endocarditis. Pocket infections involve the subcutaneous pocket that holds the device and the subcutaneous lead segments. Rates are 1%–2% for the first implant and 3%–4% after battery changes.⁵ The deeper infection involves the transvenous lead segment and includes vegetations that may occur on the intracardiac segments of the leads or device-related endocarditis. Transvenous lead-associated endocarditis carries mortality rates reported between 12% and 31%.⁵ These infections can be difficult to diagnose and manage. Immunocompromised patients, such as the patient in this case, are more susceptible to common and opportunistic pathogens. Infection in these patients often runs an insidious course, with minimal signs and atypical features. Given the high mortality associated with pacemaker lead endocarditis, delayed diagnosis is even more detrimental.

The Micra Transcatheter Pacing System is 26 mm long and 6.7 mm in diameter, delivered through a femoral vein sheath fixed to a delivery catheter that is used to guide it to the apex of the right ventricle.⁵ The device is then secured to the endocardium by a tine-based fixation system consisting of 4 nitinol fixation tines at the distal end of the device. Once in the desired position, the sheath is retracted and the nitinol tines engage the myocardium, thus eliminating the need for a subcutaneous pocket or a chest incision.⁵ The leadless pacemaker therefore eliminates the risk of pocket infections, hematomas, lead dislodgement, lead fracture, tricuspid regurgitation, and venous obstruction and has improved cosmetics. Given the decreased risk of infection, it is a good alternative for immunocompromised patients.

As an important limitation, the first generation of leadless device was unable to maintain AV synchrony and was only capable of ventricular demand pacing. The loss of AV synchrony may lead to adverse hemodynamics associated with a normally functioning pacing system, resulting in overt symptoms, described as “pacemaker syndrome.”⁶ It has been mostly indicated for patients with permanent atrial fibrillation and slow ventricular response.

In January 2020, the U.S. Food and Drug Administration approved the use of AV synchronous leadless pacemakers, which is an ideal pacing strategy for such patients. There is a large potential for this approach to become a standard practice in the context of TAVR, given the benefits of less procedure-related morbidity, decreased length of hospital stay, and the ability to effectively address a common complication.

Conclusion

The use of TAVR as a minimally invasive treatment strategy for patients with high surgical risk has survival benefit over medical therapy alone. However, this procedure is often

associated with the risk of conduction abnormalities and AV block requiring pacemaker placement. There are known predisposing factors that increase the need for permanent pacemaker placement, yet controversy still exists on the optimal timing. These features include the use of self-expandable devices, deeper implantation within the left ventricular outflow tract, and pre-existing RBBB. In immunocompromised patients, given the high risk for lead and pocket complications, a leadless AV synchronous pacemaker is a good option. With the Micra AV, some of the adverse hemodynamic electrophysiologic consequences of asynchronous right ventricular pacing (pacemaker syndrome) can be mitigated. There is a large potential for the use of AV synchronous leadless pacemakers to become the standard of practice once high-degree AV block develops in the context of TAVR. It allows the ability to address a frequent but unpredictable complication with less procedure-related

morbidity involving an already frail cohort of patients, therefore decreasing the length of hospital stay.

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