

First in Man Use of a Leadless Pacemaker with the Evoque® Tricuspid Valve

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Abstract

There is an increasing recognition of the importance of tricuspid valve disease. Surgical treatment has been less than optimal and medical therapy has poor results. Catheter based delivery has revolutionized the delivery of aortic valve prostheses and trials of catheter based tricuspid valve prostheses are ongoing. Like surgical tricuspid interventions, these procedures are associated with a significant risk of heart block, as expected from their anatomic location. The complexity of these valve prostheses makes placement of a standard transvenous system undesirable. We present a series of patients who had successful placement of a leadless pacemaker system through the valve orifice.

First in Man Use of a Leadless Pacemaker with the Evoque® Tricuspid Valve

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Brief Abstract:

There is an increasing recognition of the importance of tricuspid valve disease. Surgical treatment has been less than optimal and medical therapy has poor results. Catheter based delivery has revolutionized the delivery of aortic valve prostheses and trials of catheter based tricuspid valve prostheses are ongoing. Like surgical tricuspid interventions, these procedures are associated with a significant risk of heart block, as

expected from their anatomic location. The complexity of these valve prostheses makes placement of a standard transvenous system undesirable. We present a series of patients who had successful placement of a leadless pacemaker system through the valve orifice.

Introduction and Background:

Tricuspid regurgitation (TR) is a common valvular abnormality associated with cardiovascular morbidity and mortality[1-3]. Many patients with tricuspid regurgitation present for intervention with advanced disease, often after conservative medical management with diuretics and treatment of other cardiac co-morbidities as retrospective studies have failed to reveal a significant benefit in surgical treatment over medical management for isolated tricuspid regurgitation[4]. However, this delay can increase the surgical risk at the eventual time of intervention[5]. Transcatheter tricuspid valve placement has become a novel approach to address the clinical needs of these patients with initial approaches focusing on valve repair and more recent interventions focusing on valve replacement[6]. The EVOQUE® valve replacement system (Edwards Lifesciences, Irvine, CA) was originally described for percutaneous mitral intervention and subsequently adapted for percutaneous tricuspid intervention (EVOQUE TTVR)[7, 8]. Recently, a multicenter, observational, first-in-human study using the EVOQUE valve for severe TR demonstrated high technical success, acceptable safety and significant clinical improvement. In this series two of twenty-five patients (8%), subsequently required pacemaker implantation. This value appears in range with large, published cohort data for surgical tricuspid intervention, which revealed a need for pacemaker implantation in 5.2% of patients with tricuspid repair and 14.2% of patients with tricuspid replacement[7]. In the TRISCEND early feasibility study of the EVOQUE TTVR, of 132 patients (presented at the 2021 TCT Congress), 10.5% required a new pacemaker implant[9].

We present three cases of leadless pacemaker implantation following EVOQUE TTVR. Leadless pacemaker implantation has been reported following valve-in-valve transcatheter tricuspid valve intervention[10]. However, this case used a much less imposing valve. Our case series demonstrates the feasibility of leadless pacemaker placement following TTVR with the EVOQUE valve.

The EVOQUE valve replacement system utilizes a 28Fr delivery catheter, the prosthesis consists of a self-expanding Nitinol frame with bovine pericardial leaflets, an intra-annular sealing skirt, and ventricular anchors. The valve is available in three sizes: 44mm, 48mm, and 52mm chosen based on annular dimensions from transesophageal echocardiography (TEE) and cross-sectional CT rendering. Valve deployment is performed with direct 2D and 3D visualization from transesophageal echocardiography. Expansion of the valve along the tricuspid annulus is first achieved by unsheathing the 9 ventricular anchors and confirming their position beneath the leaflet segments. The atrial inflow portion of the valve is then exposed at the annular level with subsequent valve expansion and deployment. By its nature, the valve applies direct pressure on the basal septum of the right ventricle and potentially the triangle of Koch meaning that both the bundle of His and the compact AV node may be subject to injury. The long term safety of placing transvenous leads across this valve is unknown, and we have concerns about the potential for interaction with the lead's insulation given the complex Nitinol structure and ventricular anchoring mechanism of the prosthesis. Likewise, this valve is an imposing structure and our preconceived notion was that placement of a leadless pacemaker across it may be difficult. See figure 1a.

Given these concerns, and due to other patient factors, we chose to implant Micra® (Medtronic, Minneapolis, MN) leadless pacemakers in three patients undergoing EVOQUE TTVR. Our primary experience with leadless pacing has been with the Micra transcatheter pacing system and the safety and efficacy of these devices has been extensively studied[11-14]. The Micra is available in two forms: Micra VR and Micra AV, with the latter having the ability to incorporate mechanical atrial sensing algorithms to provide AV synchronous pacing[15]. The Micra is placed through a 23Fr delivery sheath with the goal of final deployment being along the mid to high RV septum.

Case Presentations:

The first patient is a 78 y.o. woman with persistent atrial fibrillation, hypertension, breast cancer, ischemic heart disease status-post coronary bypass, near-normal systolic function and mitral valve replacement with severe TR. She was not a surgical candidate and underwent TTVR with a 52mm EVOQUE. She developed complete heart block with a ventricular escape at 30 bpm immediately following valve deployment. A temporary pacemaker was placed via the right internal jugular vein. Heart block persisted and a MICRA VR was placed two days later. At the time of leadless placement implant both of the femoral sites were unacceptable due to cutaneous infections and the right internal jugular vein was used for a temporary pacemaker. We therefore used the left internal jugular vein was used for Micra placement using techniques that have been previously described[16].

The second patient is an 82 y.o. woman with hypertension, hyperlipidemia, prior pacemaker for sinus node dysfunction and now permanent atrial fibrillation who had undergone system extraction for MRSA bacteremia. After completion of antibiotic therapy she was found to have severe TR. She was not a surgical candidate and underwent TTVR with a 52mm EVOQUE. She developed complete heart block with a junctional escape at 59 bpm immediately following valve deployment. Given her stable rhythm, conservative management was initially employed. Although the patient recovered some degree of AV conduction (ventricular rates in the 40s) she had several ventricular pauses and multiple episodes of Torsades de Pointes. She underwent MICRA VR placement via a RFV approach seven days after TTVR.

The third patient is an 87 y.o. man with ischemic heart disease status-post coronary bypass with preserved left ventricular function, Parkinson's disease with modest dementia, chronic kidney disease stage III, and right sided heart failure with severe TR. He was not a surgical candidate and underwent TTVR with a 52mm EVOQUE. He developed complete heart block with a junctional escape at 50 bpm immediately following valve deployment. Notably, prior to TTVR implantation, he had first degree AVB with a PR of 395ms. Due to very low likelihood of conduction recovery, he underwent immediate MICRA AV placement via a left femoral vein approach. With optimization of his device he demonstrated > 90% AV synchrony 12 hours after device implantation and was able to discharged from the hospital the day after his combined procedure.

Technical Considerations and Discussion:

We report three cases of Micra implantation following 52mm EVOQUE TTVR. Based on our experience, MICRA leadless pacemaker following EVOQUE TTVR is feasible via either a femoral or jugular venous approach, though the jugular approach tends to force the Micra to the apex, an undesirable position. The primary technical consideration during MICRA delivery was atraumatic placement of the delivery sheath across the valve prosthesis. Multiple fluoroscopic views were used. The MICRA delivery catheter was directed toward the ventricle in a right anterior oblique view (RAO), prior to advancing the system across the valve. A steep left anterior oblique (LAO) view (typically greater or equal to 45 degrees) providing an appropriate oblique angle for alignment of the delivery catheter with the lumen of the EVOQUE TTVR centrally was then obtained (See figure 1 b). We then utilized an RAO view to advance the MICRA delivery system to the interventricular septum in a position where it would not interact with the ventricular anchors of the EVOQUE TTVR (See figure 1c and supplemental videos). During the first two cases there was significant interaction between the tether and the valve prosthesis (See figure 1d). Due to this experience, in the third case the delivery cone was not retracted beyond the valve prosthesis, which resolved the issue. Early experience placing leadless pacemakers across recently implanted surgical bioprosthetic tricuspid valves suggested similar fluoroscopic approaches[17]. MICRA implant for each of the patients in our case series was completed while the patient was on full dose anti-coagulation without any significant bleeding complications recognized. The procedural time from vessel puncture to closure was short (14 minutes) for the two cases that were accomplished from the femoral vein. The case that involved switching to a jugular approach obviously took longer (54 minutes). Electrical data for each of the devices implanted was excellent, with a predicted device longevity of at least 7 years with a 100% pacing burden. In one case Micra AV was utilized and, at least early after implant, AV synchrony was achieved.

The use of percutaneous tricuspid valve interventions is predicted to grow significantly in the coming years as there continues to be no class I indication for surgical treatment of isolated TR[1-3]. Conduction system abnormalities post-TTVR will continue to be an important consideration for patients[6]. Given the lack of short-term or long-term data regarding pacemaker leads across TTVR implants, leadless pacemakers may offer an ideal solution for pacing support in this population by preventing interaction with the valve leaflets and structure. Additionally, given the usual age, frailty, and co-morbidities of patients undergoing TTVR, reducing infection risk is a primary concern and may be further reduced with leadless pacing[15].

Conclusion:

Placement of a Medtronic MICRA[®] VR or AV pacemaker across the EVOQUE TTVR is feasible and, given the potential for interaction between transvenous leads and the valve structure, may be the optimal choice in this population.

Figure Legends:

Figure One

This figure depicts (a) the complexity of the Nitinol cage of the valve, (b) The micra passing through the valve orifice in a LAO projection, (3) The Micra in position for deployment in an RAO projection and (d) the tether being withdrawn.

Supplements Video

This video shows deployment of the Micra and then a echocardiogram displaying the association of the Micra and the valve.

References

1. Topilsky, Y., et al., *Clinical presentation and outcome of tricuspid regurgitation in patients with systolic dysfunction*. European Heart Journal, 2018. **39** (39): p. 3584-3592.
2. Topilsky, Y., et al., *Burden of Tricuspid Regurgitation in Patients Diagnosed in the Community Setting*. Jacc: Cardiovascular Imaging, 2019. **12** (3): p. 433-442.
3. Nath, J., E. Foster, and P.A. Heidenreich, *Impact of tricuspid regurgitation on long-term survival*. Journal of the American College of Cardiology, 2004. **43** (3): p. 405-9.
4. Axtell, A.L., et al., *Surgery Does Not Improve Survival in Patients With Isolated Severe Tricuspid Regurgitation*. Journal of the American College of Cardiology, 2019. **74** (6): p. 715-725.
5. Kilic, A., et al., *Trends and outcomes of tricuspid valve surgery in North America: an analysis of more than 50,000 patients from the Society of Thoracic Surgeons database*. Annals of Thoracic Surgery, 2013. **96** (5): p. 1546-52; discussion 1552.
6. Asmarats, L., et al., *Transcatheter Tricuspid Valve Interventions: Landscape, Challenges, and Future Directions*. Journal of the American College of Cardiology, 2018. **71** (25): p. 2935-2956.
7. Fam, N.P., et al., *Transfemoral Transcatheter Tricuspid Valve Replacement With the EVOQUE System: A Multicenter, Observational, First-in-Human Experience*. Jacc: Cardiovascular Interventions, 2021.**14** (5): p. 501-511.
8. Fam, N.P., et al., *Transfemoral Transcatheter Tricuspid Valve Replacement*. Jacc: Cardiovascular Interventions, 2020. **13** (10): p. e93-e94.
9. Kodali, S.K., *TRISCEND: six month outcomes of transfemoral triscupid valve replacement in patients with tricuspid regurgitation*.TCT proceedings, 2021.
10. Hale, B., Bradley, DJ, Zampi, JD, Whiteside, W, Cunnane, R,*First-in-human combined transcatheter tricuspid valve implantation with leadless VDD pacemaker via left internal jugular approach*.HeartRhythm

Case Reports, 2021: p. 1-5.

11. Roberts, P.R., et al., *A leadless pacemaker in the real-world setting: The Micra Transcatheter Pacing System Post-Approval Registry*. Heart Rhythm, 2017. **14** (9): p. 1375-1379.
12. Piccini, J.P., et al., *Contemporaneous Comparison of Outcomes Among Patients Implanted With a Leadless vs Transvenous Single-Chamber Ventricular Pacemaker*. JAMA Cardiology, 2021. **6** (10): p. 1187-1195.
13. Reynolds, D., et al., *A Leadless Intracardiac Transcatheter Pacing System*. New England Journal of Medicine, 2016. **374** (6): p. 533-41.
14. El-Chami, M.F., et al., *Updated performance of the Micra transcatheter pacemaker in the real-world setting: A comparison to the investigational study and a transvenous historical control*. Heart Rhythm, 2018. **15** (12): p. 1800-1807.
15. Steinwender, C., et al., *Atrioventricular Synchronous Pacing Using a Leadless Ventricular Pacemaker: Results From the MARVEL 2 Study*. JACC. Clinical Electrophysiology, 2020. **6** (1): p. 94-106.
16. Kolek, M.J., G.H. Crossley, and C.R. Ellis, *Implantation of a MICRA Leadless Pacemaker Via Right Internal Jugular Vein*. JACC. Clinical Electrophysiology, 2018. **4** (3): p. 420-421.
17. Morani, G., et al., *Leadless pacemaker through tricuspid bioprosthetic valve: Early experience*. Journal of Arrhythmia, 2021. **37** (2): p. 414-417.

