Leadless pacemaker implantation in the presence of the bioprosthetic tricuspid valve: Case presentation and literature review

Majid Haghjoo[1], Mahsa Mohammadi[1], Mohammadreza Iranian[1], Sedigheh Saedi[1], yaser tolouei[1], and amirfarjam fazelifar[1]

[1]Rajaie Cardiovascular Medical and Research Center

April 18, 2024

Introduction

Postoperative atrioventricular block (AVB) has been reported in 1% to 6% of patients after cardiac surgery and 25% to 60% of these patients will finally need a permanent pacemaker (PPM).[1-4]To avoid tricuspid valve (TV) malfunction, implantation of transvenous pacing leads is generally not preferred in presence of the tricuspid bioprosthesis.[5]

Leadless pacemakers (LLP) have recently become popular in treatment of heart blocks and bradyarrhythmia due to their proven safety and efficacy.[6,7] LLPs have advantages of avoiding complications encountered with conventional transvenous pacemakers including infection, lead malfunction, and tricuspid valve regurgitation.[8,9] Epicardial pacemaker is the standard recommendation in the setting of prior tricuspid valve surgery. However, prior cardiac surgeries are usually associated with significant pericardial adhesion and most surgeons prefer not to implant epicardial leads in this setting due to impaired electrical properties of pericardial leads in the setting of pericardial adhesions. Therefore, LLPs can be a safe choice for patients with TV surgeries and postoperative AVB. There is a few data about the LLP implantation in presence of the bioprosthetic TV (BTV).[10-12] In this report, we described a case of Micra-VR implantation across the BTV in a patient with repaired congenital heart disease.

Case History

A 21-year-old male, known case of pulmonary valve atresia, large ASD and PDA who underwent pulmonary valvotomy and PDA closure shortly after his birth, presented with exacerbation of dyspnea and peripheral edema. Right heart catheterization and transesophageal echocardiography revealed moderate RV enlargement, severe pulmonary insufficiency, severe secondary tricuspid regurgitation (due to large ASD and RV enlargement), and large secondum atrial septal defect (ASD) with significant bidirectional shunt. He underwent simultaneous bioprosthetic replacement of pulmonary valve (Perimount 25) and tricuspid valves (Magna Ease 31) and ASD closure.

One week after surgery, he became bradycardic, and electrocardiogram showed complete AVB . Considering the persistence of AVB for more than a week, it was decided to implant a permanent pacemaker. As he had undergone recent BTV replacement, insertion of conventional transvenous pacemaker was not preferred. So, the options were placement of epicardial pacemaker, coronary sinus (CS) lead, or a leadless pacemaker. As the patient has undergone multiple cardiac surgery with resultant pericardial adhesion, cardiac surgeon refused to implant an epicardial lead. Implantation of a CS lead was impossible due to absence of proper cardiac vein. Finally, it was decided to implant a leadless pacemaker (Micra, Medtronic Inc).

Methods

The procedure was performed according to the standard technique. however, electrical measures were not acceptable. Finally, acceptable position was obtained in mid RV septum. Electrical measurements showed R wave amplitude of 10 mV, pacing impedance of 830 Ω, and pacing threshold of 1.0 V @ 0.24 ms. Pull and hold test was acceptable. Finally, tether was cut, and delivery and introducer sheath were removed, and access site was closed using figure-of-eight suture. Patient was transferred into ward with good and stable condition.

Fluoroscopic oblique views was essential for a correct engagement of the tricuspid ring without injuries to the BTV. Left anterior oblique (LAO) view 40° was helpful to visualize the tricuspid annulus as a clock to be crossed exactly in the center. Right anterior oblique (RAO) view 30 was used to establish the correct advancement of the Micra delivery system across the tricuspid valve and to evaluate the proper distance of implantation site from the valve (Figure 1).

Results

The day after the implantation, interrogation of the Micra AV revealed satisfactory parameters with a sensed R wave of 11.4 mV, the impedance of 820 Ω, and threshold of 0.63 V @ 0.24 ms and -> 0.24 ms and. Chest radiography showed proper Micra location in the mid-RV septum (Figure 2). Transthoracic echocardiography showed no pericardial effusion. During 7-month follow-up, the patient was asymptomatic and free of any complications.

Discussion

In this report, we presented successful Micra implantation through BTV in a patient with repaired congenital heart disease. The procedure was straightforward without any complications. During follow-up, the patient was asymptomatic and the Micra interrogation showed proper functioning.

Tricuspid valve surgery carries a significant risk of conduction disorders requiring PPM implantation. The implantation rate decreased over time from 13-22% before 2000[13] to 5-11% in the recent years.[14] The PPM implantation after TV surgery involves technical challenges that must be acknowledged by the implanters to select the best technical option in each patient.

Several approaches have been reported: epicardial leads, standard transvenous leads, his-bundle pacing, leadless pacing, or coronary sinus leads.[15]

1) Although epicardial PPMs are proven to provide adequate pacing, the reliability of endocardial leads has been shown to be superior to the epicardial systems.[16] This is especially true if patients already had multiple cardiac surgeries with resultant pericardial adhesion, since surgeons may have a tough time to find a ventricular site with acceptable pacing thresholds.

2) Transvenous leads can interfere with the function of tricuspid valves, leading to a significant morbidity and mortality through hemodynamic impairment. The presence of transvenous lead was an independent predictor of tricuspid regurgitation (TR) during follow-up.[17] Although there is no clear evidence of increased TR after transvenous lead implantation in the presence of BTV, most operators prefer to avoid transvenous lead in these patients.

3) His-bundle pacing (HBP) is a more physiologic form of pacing compared to ventricular pacing. This could be an interesting alternative for treating AVBs after TV surgeries, especially as the block site is nodal in most cases. HBP has been described to be feasible in small series (n=10) of patients after TV repair but none with TV replacement.[18] In these settings, the TV ring may act as a radiographic marker of the his-bundle and facilitate the implantation.

4) Since cardiac resynchronization therapy emerged as a cornerstone treatment for advanced heart failure patients, rare data have been published in the literature regarding CS pacing after TV surgery. Only one small series of 17 patients (11 TV repairs and 6 TV replacements) was published.[19] Due to the right atrial dilatation and resulting malposition of the CS ostium, CS catheterization and lead placement may be more challenging in this specific situation compared to typical CRT patients.

5) There are currently no large data about the safety and efficacy of leadless pacemakers in patients after TV surgery. To date, there is a few reports on Micra implantation after TV repair and BTV surgery.[10-12, 20, 21] The procedures were performed successfully with no complications and patients did not have any valvular dysfunction after the procedure.

.

LLP implantation is an emerging technology validated in clinical studies and real-world setting with the potential advantage of overcoming some of the limits of the traditional transvenous pacing lead such as need for extraction after battery depletion. LLPs overcome this limit and don't need extraction after battery depletion; because LLP is endothelialized into ventricle and according to the existing studies, up to 3 LLP (with battery longevity of 10-12 years) can be placed inside the RV. Therefore, there is no need to remove the previous LLP and a new one can be implanted in the RV[22].so it prevents further open surgeries and the risk of post operation complications .LLP implantation after BTV might represent an ideal option in this setting by eliminating the risks connected with the presence of the lead across the bioprosthetic valve, including valve dysfunction and valvular endocarditis[, 8,23,24]. In conclusion, our case demonstrates that a leadless pacemaker is an ideal option in patients developing persistent conduction disorders after BTV.

AUTHOR CONTRIBUTIONS

Majid Haghjoo: Conceptualization; data curation; supervision;

writing –review

and editing.

Mahsa Mohammadi: Conceptualization; data curation; supervision;

writing –original

draft; writing –review

and editing.

Mohammadreza Iranian: Data curation; writing –review

and editing.

Sedigheh Saedi :Data curation; writing –review

and editing.

Yaser Toloueitabar: Data curation; writing

–original

draft; writing –review

and editing.

Amirfarjam Fazelifar: Data curation; writing –review

and editing.

FUNDING INFORMATION

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

CONSENT TO PARTICIPATE

Written informed consent was obtained from the patient to publish this report in accordance with the patient consent policy of the Clinical Case Reports journal.

References

1.Romer AJ, Tabbutt S, Etheridge SP, et al. Atrioventricular block after congenital heart surgery: Analysis from the Pediatric Cardiac Critical Care Consortium. *The Journal of Thoracic and Cardiovascular Surgery* . 2019;157(3):1168-1177.e2.

2.Del DF, Nishimura SC, Lau CC, Sever J, Goldman BS. Cardiac Pacing Following Surgery for Acquired Heart Disease. 1996;11(5):332-340.

3.AYYILDIZ P, KASAR T, OZTURK E, et al. Evaluation of Permanent or Transient Complete Heart Block after Open Heart Surgery for Congenital Heart Disease. *Pacing and Clinical Electrophysiology* . 2015;39(2):160-165.

4.Ashida Y, Ohgi S, Kuroda H, et al. Permanent cardiac pacing following surgery for acquired valvular disease. *Ann Thora*