Title

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Journal

Indian Pacing and Electrophysiology Journal, 20(3)

ISSN

0972-6292

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Publication Date

2020

DOI

10.1016/j.ipej.2020.03.006

Peer reviewed

Indian Pacing and Electrophysiology Journal 20 (2020) 132–134

Contents lists available at ScienceDirect

Indian Pacing and Electrophysiology Journal

journal homepage: www.elsevier.com/locate/IPEJ

Micra leadless pacemaker retrieval in a pediatric patient

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ARTICLE INFO

Article history:
Received 9 February 2020
Accepted 22 March 2020
Available online 25 March 2020

Keywords:
Pediatric
Leadless pacemaker removal

ABSTRACT

We present a case of a 13-year old patient with partially reversibly post-operative heart block who underwent leadless pacemaker placement. After post-anesthesia wretching/gagging episode she developed device microdislodgement and increased/intolerable capture thresholds. The device was removed and another placed with adequate thresholds for good longevity.

1. Introduction

Leadless cardiac pacemakers (LCPs) have emerged in recent years as an alternative to the conventional transvenous and epicardial pacemaker in select patients. The use of LCPs in pediatrics is recent and the data available in this population is scarce. Here we present an extraction of an LCP in a pediatric patient, which has not yet been reported.

2. Case presentation

A 13-year-old, 50kg, female born with congenital pulmonary valve stenosis underwent balloon valvuloplasty as an infant. She developed severe pulmonary valve insufficiency with right ventricular enlargement and underwent surgical placement of a 25mm bioprosthetic valve. She also had tricuspid valve insufficiency for which she underwent tricuspid valve repair in the same operation. Unfortunately, she developed complete heart block (infrahisian block with a ventricular escape of 20–30 bpm and with pauses > 10s) in the post-operative period. She was treated with a 5-day-course of methylprednisolone IV at a dose of 2mg/kg/day and temporary pacing (DDD 70bpm). However, there was no resolution of the heart block.

On postoperative day 13, after failed attempt at right atrial localization of his bundle, she had a St Jude PM3562 Quadra Allure cardiac resynchronization device placed using coronary sinus Quartet (and right atrial (2088 Tendril) leads only (plugged right ventricular port) with effective dual chamber pacing. The only coronary sinus location large enough to fit the lead was a posterolateral branch but with scant middle cardiac vein and no other acceptable coronary sinus tributaries. Initially she had 4 effective pacing vectors (D1-M2, D1-M3, D1-can and M2-can) without diaphragmatic stimulation and with adequate thresholds (and no diaphragmatic stimulation during pacemaker placement with D1 or M2 poles with some at higher output utilizing M3), with improvement and M3-M2 and M3-can developing as an adequate vector by week 6 post-implantation. By week 10 post-implantation, she presented with complaints of diaphragmatic stimulation after participating in acrobatic water skiing (although she was advised to avoid this particular activity). A chest x-ray at that time showed no macro-dislodgement of the coronary sinus lead nor obvious fracture, but clearly micro-dislodgement had occurred given her now constant diaphragmatic stimulation and loss of capture in the M3 pole. At this point, pacemaker interrogation demonstrated diaphragmatic stimulation with 5 vectors and loss of capture from 3 vectors. Thus, after a month of attempted weekly reprogramming to reasonable safety margins, a decision was made to schedule pacemaker revision.

In the meantime, given family's refusal for epicardial lead placement, lack of other coronary sinus vein locations and return of sinus rhythm with 1:1 conduction at rates of 40–60bpm, the pacemaker mode was transitioned to VVIR (60–160 bpm) to evaluate the clinical impact of her AV desynchrony and underlying rhythm. After a few weeks of follow up, she showed no symptoms or signs of end-organ mal-perfusion and normal cardiac function with VVIR pacing at 40% at VVIR 50. Pacemaker interrogation also showed a atrioventricular conduction at rates in the 40–60 bpm range, without pauses. Thus, considering lack of likely high pacing need, and given patient's adamant refusal for epicardial placement

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Peer review under responsibility of Indian Heart Rhythm Society.

https://doi.org/10.1016/j.ipej.2020.03.006

and with recently repaired tricuspid valve, she underwent placement of a LCP (Medtronic Micra™). Using standard technique, deployment was achieved into the high septal location successfully on the 3rd attempt with a threshold of 0.63mV at 0.24 ms, R wave of 6.3mV, impedance of 600 Ω (first two attempts yielded higher thresholds than tolerable ie. 1.63V at 0.24 ms). The trans-venous pacemaker device and leads were easily removed from the pocket by standard procedure without complications. Patient was admitted overnight for monitoring. Two days after the procedure she presented with vomiting and nausea with subsequent bleeding from her left femoral vein site, requiring a figure-of-8 stitch for management. At that point, the Micra™ output threshold was 1V at 0.24 ms, prior to termination of vomiting/retching episodes. On day 10 post-implantation, the Micra™ output threshold had increased to 4.5V at 1 ms with approximated battery longevity of 9 months (estimated 30% pacing programmed VVIR 40bpm). Given the known eventual device fibrous encapsulation within 6 months [1], it was decided to replace the device before this could complicate the recapture of the device and given intermittent loss of capture when she turned to her left side (while taking a big breath). Discussion again included epicardial pacemaker placement as an option, but this was again refused.

3. Procedure

Access was obtained and dilated up to 27 Fr outer sheath via the right femoral vein. Introducer sheath was advanced into the right atrium, at which point, a heparin dose of 1000 u/kg was given IV. A solution of heparinized saline was continuously infused during the case. Micra™ delivery catheter (27Fr) was inserted. After fluoroscopic and echocardiographic (transthoracic) guidance, the new Micra™ was delivered in an apical-septal location with a ventricular threshold of 0.88V at 0.24 ms, impedance of 490 Ω and an R-wave 12mV.

Subsequently, the Micra™ deployment catheter was removed and a 7mm 175cmEV3 Microsnare was threaded through the Micra™ delivery catheter. Under biplane fluoroscopic guidance and with the assistance of one of our interventional cardiologist, the Micra™ delivery catheter was advanced near the high septal Micra™ tail. The Micra™ delivery catheter was moved distally to secure the snare around the Micra™ tail. Then, the Micra™ catheter was moved toward the snared Micra™ and the device was recaptured (Fig. 1). The system as a whole was moved back into the Micra™ sheath. At this point due to clean break of the snare, the device moved out of the Micra™ catheter but was secure in the Micra delivery sheath (27F) in the inferior vena cava. The broken EV3 snare catheter was removed and replaced within the Micra sheath. Successful snare/recapture was performed without complication. The catheter and captured Micra™ were then removed from the Micra™ sheath and the patient's body. Subsequent follow-up yielded adequate capture threshold and only 18.9% pacing with atrioventricular synchrony and conduction at 40-60bpm at rest with loss of AV conduction at higher rates (Fig. 2). One-month follow-up ultrasounds of the femoral veins noted bilateral patency with similar diameters to prior to procedures.

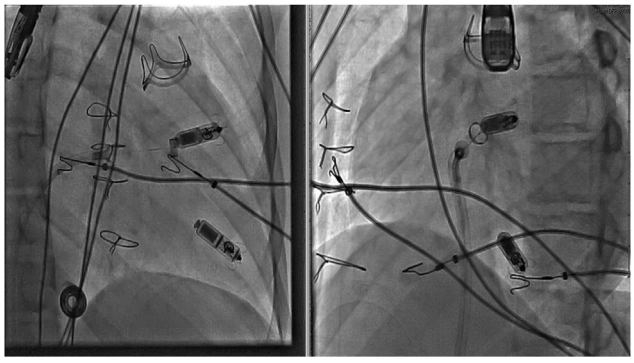

Fig. 1. Right anterior oblique (left) and left anterior oblique (right) projections of the Micra recently implanted (inferior in apical septal position) and the Micra being removed (high septal position).

4. Discussion

We present a case with initial endovascular pacing leads that had micro-dislodgement after participating in acrobatic water skiing. Given the lack of additional coronary sinus locations and likelihood of patient re-participation in restricted activities, the refusal for epicardial pacemaker, no attainable His pacing from the right atrium, and given return of sinus rhythm and atrioventricular synchrony at rest, an LCP was used. The patient now only requires 20% ventricular pacing and her device has a longevity similar to other devices (device currently only reports >8 years but much likely longer given low output required) that might have been placed if crossing the tricuspid valve had been an available choice. Obviously, had the patient needed more pacing and had not had return of sinus rhythm at resting rates, then this would not have been a reasonable option. There is limited data available about the use of LPCs in pediatrics and a recently published collection of 9 pediatric patients included one where the patient's leadless system was abandoned at close to 1 year of follow-up due to concern for removal [5]. Since removal at 3 weeks may not exactly mimic removal at 1 year, perhaps if there is early concern for high thresholds such as in other reported cases and which in a pacemaker-dependent patient may greatly limit the longevity of the device, perhaps early removal should be considered and with careful 2-French serial dilations, vein patency subsequently (without stenosis) can be achieved [5,6]. And although, to our knowledge this is the first reported case of removal in a pediatric patient, adult data would suggest that removal may be feasible at longer intervals, which may make this a more attractive option for some pediatric patients, given VDD pacing with Micra is now available [2,3].

Our case presented with delayed progressive rise of capture threshold (adequate initial thresholds), was probably due to loss of contact with the myocardium, caused by the rapid changes in intrathoracic pressure and forces experienced during the episodes of retching and vomiting. Successful extraction of the Micra™ leadless pacemaker was first described in humans in 2016 [2] and early retrieval of the Micra™ LCP has been proven to be feasible with low risk for complications in adults with high capture threshold, infection, embolization, or need for upgrade to implantable cardioverter-defibrillator [3]. However, the current manufacturer recommendation is to abandon a malfunctioning or end-of-life device. We consider that pediatric patients pose a particular scenario in which, given the ventricular size, leaving a device abandoned could interfere with the ventricular or valvar mechanics, especially if we contemplate duration of a device in a pediatric patient in their lifetime [4]. And in our particular case, 9 months of longevity with intermittent loss of capture while laying on her left side, limited the device use and earlier intervention seemed prudent. Since using a snare through the Micra delivery sheath is the manufacturer's recommendation for retrieval, as well, this was performed and limited risk of tine-induced tricuspid valve damage to the recently repaired tricuspid valve, as compared to other forms of removal such as with an Agillis sheath.

We recommend a second person for the retrieval, as one person needs to direct the Micra™ catheter and the other attempts to

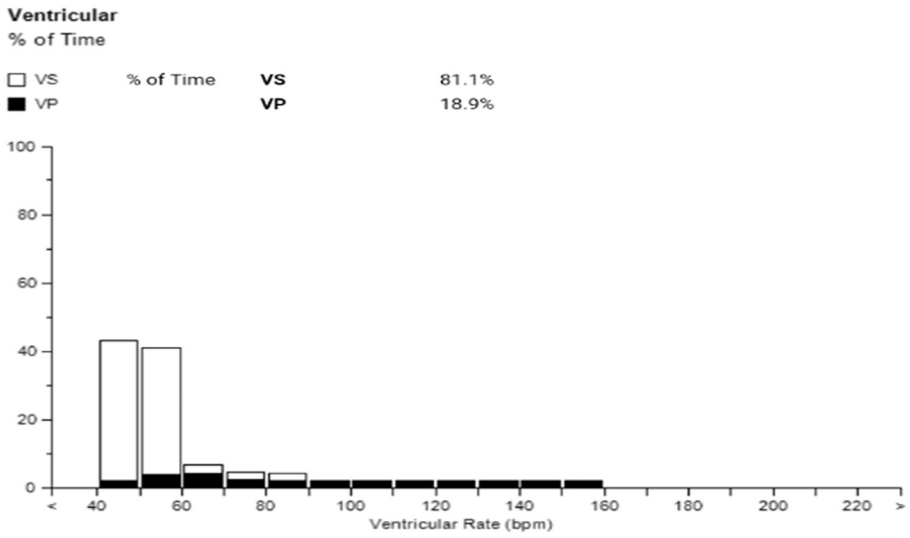

Fig. 2. Ventricular pacing and sensing over time (dark color is paced, light is ventricular sensed) with ventricular rate on X-axis and percentage of time on Y-axis.

snare. In our case, interventional cardiology was involved, as typically, they are also well trained to snare. There were no complications, however, traction on the device prior to the catheter being completely coaxial can lead to snare break (which we believe happened in our case). Special care and slow retrieval should be performed once the device is snared using the coaxial system of Micro-snare and Micra delivery system.

5. Conclusion

Early retrieval of the Micra™ LCP can be feasible in the pediatric population and with advancing atrioventricular synchrony options in Micra, should be explored further in patients where later retrieval may be needed.

Declaration of competing interest

There are no conflicts of interest.

Acknowledgements

None.

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