Pediatric Cardiology (2018) 39:844–847
https://doi.org/10.1007/s00246-018-1832-9

CASE REPORT

Leadless Pacemaker Implantation in a Pediatric Patient with Prolonged Sinus Pauses

Shai Tejman-Yarden[1,2,4] · Eyal Nof[2,4] · Roy Beinart[2,4] · Nadav Ovadia[3] · Yuval Goldshmit[3] · Jonathan Buber[1,2,4] · Hagith Yonath[5,6] · Eitan Keizman[1] · Michael Glikson[2,4]

Received: 28 October 2017 / Accepted: 14 February 2018 / Published online: 8 March 2018

Abstract
Permanent cardiac pacing is the only effective solution for patients with symptomatic bradycardia and heart block. About 10% of patients undergoing implantation of the conventional pacing system develop complications related to the subcutaneous pocket or the leads and in pediatric patients lead problems may rise in up to 30% of the patients. The leadless pacemaker devices were developed in order to minimize some of those complications. We present a case of an 11-year-old patient who presented after the sudden death of his older brother, with recurrent episodes of syncope and documented prolonged sinus pauses. The patient underwent percutaneous implantation of a leadless Micra™ pacemaker device with optimal results.

Keywords Pacemaker · Leadless · Pediatric

Abbreviation
VT Ventricular tachycardia

Introduction

For more than five decades permanent cardiac pacing remains the only effective solution for patients with symptomatic bradycardia and heart block. The conventional cardiac pacing systems consist of a pacemaker, which is surgically implanted in a subcutaneous pocket in the chest or in the abdominal wall, and a set of one or more leads that conduct the pacing either intravenously to the endocard or surgically implanted as epicardial leads [1–3]. Throughout the decades, devices have shrunk in size and grown in their sophistication, but despite the incredible advancements in cardiac pacing systems, pacemaker—related adverse events still occur in 10% of patients and up to 30% children [3, 4]. These complications are mainly related to the subcutaneous pocket, such as hematoma, infections, endocarditis, and septicemia; others are lead-related complications such as pneumothorax, bleeding and hemothorax, cardiac perforation, and venous occlusion; and long-term complications such as tricuspid regurgitation, thromboembolism, and lead malfunction [2, 3].

The implanted leadless pacemaker device, which was recently developed, was proved to be safe and possesses the potential of reducing many of the above complications [5]. The leadless pacemaker is a miniaturized single-chamber pacemaker system that is delivered via a catheter through the femoral vein and implanted directly inside the right ventricle (RV). This new technology is feasible thanks to advances in miniaturization (high-density battery), low-power electronics, advanced catheter delivery systems, and electrodes being directly placed on the pacemaker capsule. This device eliminates the need for a subcutaneous pocket and insertion of a pacing lead, thereby eliminating an important source of complications associated with traditional pacing systems while providing similar benefits [1, 5].

The leadless pacing systems have been proved useful in the adult population [1–3, 5]. We present a case of leadless

✉ Shai Tejman-Yarden
tegmanya@gmail.com

1 The Edmond J. Safra International Congenital Heart Center, Sheba Medical Center, Ramat Gan, Israel

2 Davidai Arrhythmia Center, The Heart Center, Sheba Medical Center, Ramat Gan, Israel

3 Medtronic Ltd, Tel Aviv, Israel

4 Sackler School of Medicine, Tel Aviv University, Tel Aviv, Israel

5 Department of Internal Medicine, Sheba Medical Center, Ramat Gan, Israel

6 The Genetic Institute, Sheba Medical Center, Ramat Gan, Israel

pacemaker implantation in an 11-year-old patient with recurrent syncope episodes and documented prolonged sinus pauses.

Case Presentation

Our patient, OA, was presented to the pediatric electrophysiology clinic at the age of 9 years for the evaluation after the sudden death of his older brother at the age of 14 years. The brother passed away unexpectedly while playing a video game on his computer with a remote friend 1 week after an episode of post-exercise syncope on a hot day. Prior to that episode the boy was completely healthy. Initial evaluation included repeated electrocardiograms (ECG), several Holter ECG monitors, and a stress test which were all concluded normal at the time. He also underwent an Epinephrine challenge test that showed bidirectional ventricular tachycardia (VT) as soon as a 0.01 mcg/kg bolus was given. It shortly organized into a uniform monofocal VT and resolved spontaneously shortly after. A thorough neurological consultation was concluded normal. Furthermore, the family and the deceased tissues underwent a thorough cardiogenetic consultation but no arrhythmic predisposition was found.

Treatment with beta-blockers was initiated due to the findings of the epinephrine test, which lead to a possible diagnosis of long QT syndrome albeit the genetic consultation, and during the following year repeated Holter ECG monitors and stress tests were normal. However, at the age of 10 the patient had a syncope event during class at school-time and subsequently, following a normal tilt test, a subcutaneous Reveal LINQ™ insertable cardiac monitor (Medtronic, plc Dublin, Ireland) was implanted. The patient continued his regular life and 6 months later, the insertable monitor recorded an asymptomatic 9 s sinus pause during sleep. The patient was asymptomatic and his treatment has not changed at that time.

Several months later, being almost 11 years old, the patient had experienced a syncope episode again during class. The patient was sitting quietly studying, suddenly stood up saying he was feeling bad and lost consciousness for several seconds with no convulsion, without any other symptoms. He recovered quickly and returned later to his regular condition. During that episode the insertable monitor showed an 18 s sinus pause; the tracings are presented in Fig. 1. In light of the patient's family history, and considering that no other arrhythmia was ever documented or suspected, we recommended pacing, and the option of Micra was offered.

As the boy was young but physically large weighing 65 kg and having 165 cm height, the decision was to implant a leadless pacemaker. Under general anesthesia, an introducer was placed in the right femoral vein. An initial contrast

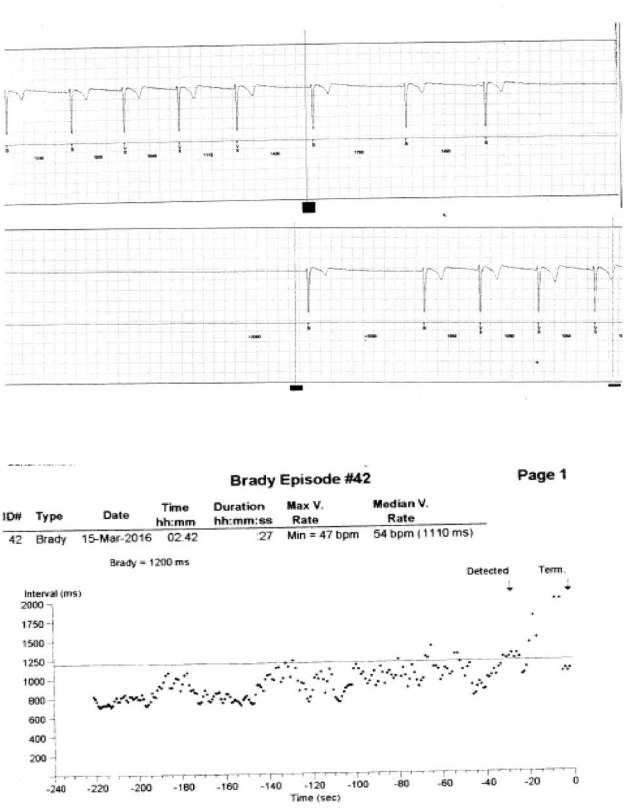

Fig. 1 Documentation of the bradyarrhythmia depicted during a syncope event during class by the insertable cardiac monitor. The device records a 27 s event though the longest pause was 18 s

fluoroscopy estimated the inferior vena cava diameter at 11 mm, which was compatible with the 27F delivery system. Then, under fluoroscopic guidance Micra™ transcatheter pacing system (TPS, Model MC1VR01, Medtronic plc, Mounds View, MN, USA) device was placed at the apex of the RV. Once three of the tines were shown to be attached to the endocardium with good sensing and pacing thresholds, the device was released. Pacing was set at VVI 40, the minimal pacing needed. The insertable cardiac monitor was left in place and set to record under 45 beats per minute. Figure 2 shows the two devices in the boy's chest, and their relative position.

The patient was discharged home 1 day after the procedure and has been feeling well with no vascular sequelae at the pacemaker insertion site at 6 months' time. Interestingly, several months after the implantation, the insertable cardiac monitor depicted an event of bradyarrhythmia counting 40 bpm. Figure 3 shows the episode in which the patient had bradyarrhythmia and pacing was documented. Clinically the patient's parents reported OA complained during that day of a short episode of fatigue, he rested in the living room for a few minutes, and shortly after resumed his daily activities. The episode correlated chronologically to the episode

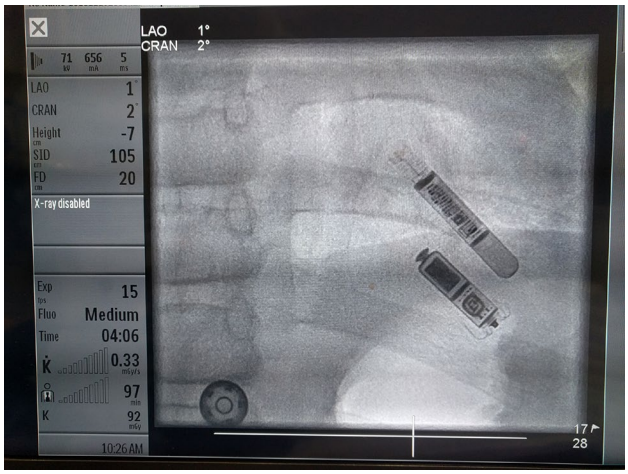

Fig. 2 An AP fluoroscopy cine of the patient's chest after the leadless pacemaker implantation showing the subcutaneous insertable cardiac monitor more superior and anterior and the leadless pacemaker inferior and posterior

documented in Fig. 3 and we presume he had a vagal episode and syncope was prevented by pacing. It should be noted that the device measurements such as threshold and sensing were unchanged during that time after implantation.

Discussion

Even though vagal syncope is known to be a self-limiting phenomenon with no sequelae later in life, due to the worrisome patient's family history a pacemaker implantation was recommended in this case. However, with the idea of minimizing the possible complications of conventional cardiac pacemaker systems, we opted for a leadless pacemaker implantation despite the patient's young age.

This device has proven in the past its safety and efficiency in treating adult patients, reducing the complications rate while achieving the therapeutic goals [2, 4]. Among the pediatric population, the major complications occurring with implantation of conventional pacemakers include lead fracture, vascular injury, and pocket infections [4, 6]. The

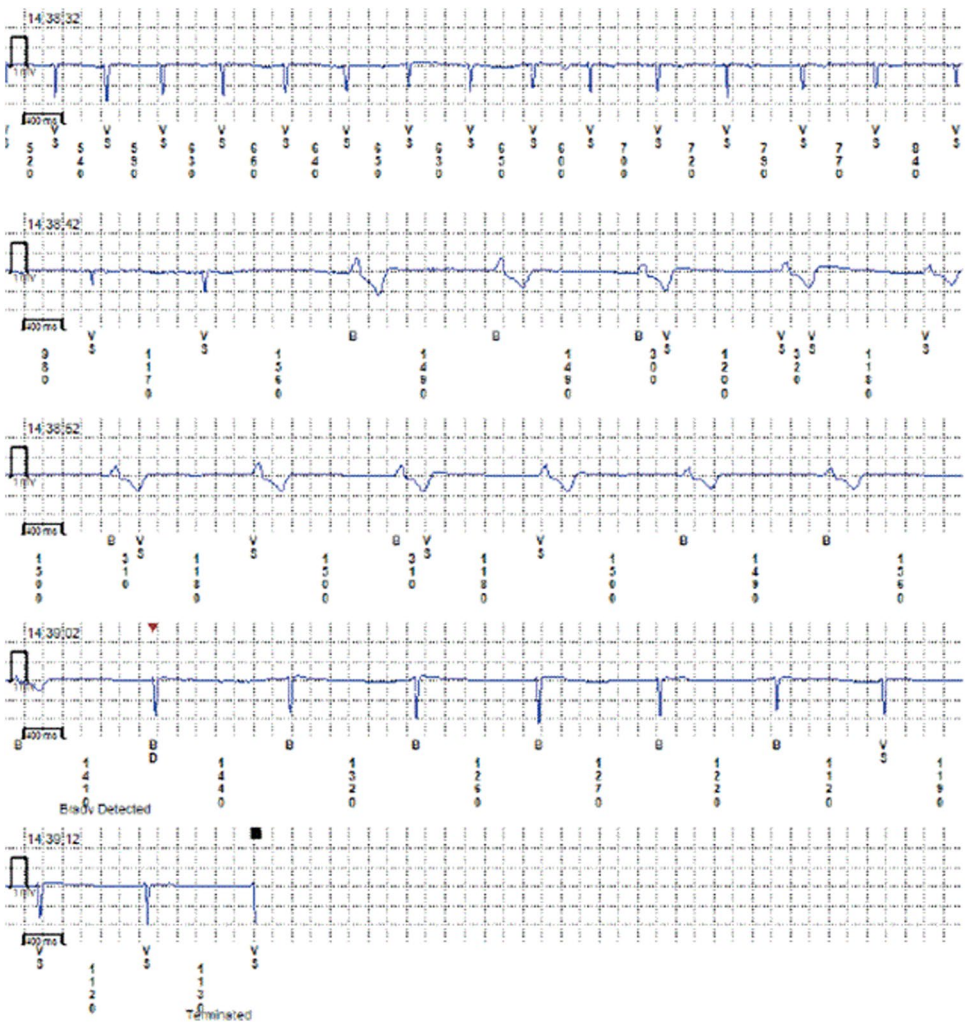

Fig. 3 Documentation of the a bradyarrhythmia episode in which the pacemaker started pacing

Micra™ small size enabled the pacemaker to be implanted in the young, sparing of the veins during puberty and allowing normal participation in sports without movement restrictions, thus avoiding the above complications while protecting the child during severe vagal episodes. Furthermore, avoiding the subcutaneous surgical scar probably has some better psychological effects over the child, sparing body image complications and allowing the child to take of his shirt freely with no inconvenience.

Conclusion

The implantation of a leadless pacemaker device in the pediatric population is a good and feasible solution and should be considered in children with suitable body dimensions.

Compliance with Ethical Standards

Conflict of interest The authors have no conflicts of interest to disclose.

Research involving human and animal participants This article does not contain any studies with human participants or animals performed by any of the authors.

References

1. Reynolds D, Duray G, Omar R, Soejima K (2016) A leadless intracardiac transcatheter pacing system. N Engl J Med 374:533–541
2. Ritter P, Duray G, Steinwender C, Soejima K (2015) Early performance of a miniaturized leadless cardiac pacemaker: the Micra transcatheter pacing study. Eur Heart J 36:2510–2519
3. Reddy V, Exner D, Cantillon D, Doshi R (2015) Percutaneous implantation of an entirely intracardiac leadless pacemaker. N Engl J Med 373:1125–1135
4. Wilhelm BJ, Thöne M, El-Scheich T, Livert D, Angelico R, Osswald B (2015) Complications and risk assessment of 25 years in pediatric pacing. Ann Thorac Surg 100(1):147–153
5. Duray G, Ritter P, El-Chami M, Narasimhan C (2017) Long-term performance of a transcatheter pacing system: 12-month results from the Micra Transcatheter Pacing Study. Heart Rhythm 14:702–709
6. Fortescue F, Berul C, Cecchin F, Walsh E, Triedman J, Alexander M (2004) Patient, procedural, and hardware factors associated with pacemaker lead failures in pediatrics and congenital heart disease. Heart Rhythm 1(2):150–159