Ventricular Fibrillation Cardiopulmonary Arrest Following Micra Leadless Pacemaker Implantation

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Abstract

Leadless cardiac pacemakers such as the Micra transcatheter leadless pacing system provide an alternative to traditional transvenous pacemakers. Implantation of leadless pacemakers, albeit safe may be associated with complications including cardiac tamponade, high capture thresholds, and rarely, ventricular arrhythmias. We report a case of ventricular fibrillation arrest following Micra leadless pacemaker implantation.

Introduction

Leadless cardiac pacemakers (PMs) are an alternative to conventional transvenous PMs designed to avoid the need for transvenous leads and pockets [1]. PM related adverse events remain substantial; they occur in 1 in 8 patients, despite advancements in pacing technology over the past six decades [2]. Transvenous PM leads can undergo dislodgment, insulation failure, and may act as a portal for infection into the vascular space, whereas pacemaker pockets are susceptible to hematomas and infections[3]. Thus, the development of a pacing system foregoing leads and the need for a surgical pocket is a progressive advancement in pacemaker technology. This has been achieved following advances in pacemaker battery, component design and chemistry that have led to leadless pacemakers small enough to be placed directly in the heart; which may lead to the reduction in complications associated with conventional transvenous leads and pockets [4].

Leadless cardiac PMs are completely self-contained, encapsulated in a small unit, and are affixed by nitinol tines to the myocardium in the right ventricle through a minimally invasive transcatheter approach via the femoral vein. Reynolds et. Al and Reddy et. Al have reported two multi-center studies which have found leadless pacemaker implantation to be a promising alternative to older transvenous systems[4,5].

The Micra transcatheter leadless pacing system (Medtronic, Minneapolis, MN); an example of such a leadless PM, has demonstrated high procedural success rates [6]. However, the procedure may be associated with complications, these include traumatic cardiac injury with cardiac perforation and pericardial effusion, high capture thresholds, and rarely, ventricular arrhythmias [7,8]. While some of these such as traumatic cardiac injury may be attributed to the learning curve of operators handling this novel technology, other complications such as arrhythmia may be secondary to implant position of the device [9].

Few cases of ventricular arrythmias due to Micra have been reported in the literature. We wish to add to the literature by presenting a case of ventricular fibrillation arrest temporally related to Micra implant.

Case

62-year-old female with history of hypertension, type 2 diabetes, atrial fibrillation and end stage renal disease (ESRD) was admitted to the hospital with methicillin-resistant staphylococcus aureus (MRSA) bacteremia. The source of her bacteremia was thought to be her arteriovenous graft, which was later excised for source

control. Her hospital course was complicated with complete heart block with narrow junctional escape rhythm. Further workup with a transesophageal echocardiogram demonstrated a small mobile echo density measuring 4 x 5 millimeters (mm) attached to the coumadin ridge. Cardiac computed tomography (CT) ruled out involvement of the aortic root i.e. aortic root abscess or pseudoaneurysm. No other reversible causes of her complete heart block could be identified. Subsequently a transvenous pacing (TVP) wire was successfully placed within the right ventricle.

Given her diagnosis of infective endocarditis and need for a prolonged course of antibiotics, decision was made to proceed with implantation of a permanent pacing system. Patient was planned to undergo Micra transcatheter leadless pacemaker implantation, due to her recent history of extraction of her potentially infected left upper extremity AV graft, and previously documented right subclavian vein occlusion. Subsequently, the patient underwent Micra implantation through the right femoral vein. After the device was deployed, the pull and hold test was performed to ensure adequate fixation. The post fixation electrical testing of the device demonstrated R wave sensing of 6.5 millivolts (mV), impedance 550 Ohms, and pacing threshold 1.3 V at 0.24 ms. The latter improved to under 1 mV at 0.24 ms before the end of the case. Hence, decision was made to cut the tethering suture and release the Micra device. Post-procedurally, patient remained stable and was transferred to medical floor.

Approximately 5 hours following Micra insertion, she developed ventricular fibrillation cardiac arrest. The telemetry strip for the event is shown in Figure 1. She received 7 shocks, 8 ampules of epinephrine in addition to intravenous amiodarone and lidocaine boluses. Return of spontaneous circulation (ROSC) was subsequently achieved and she was transferred to the cardiovascular intensive care unit (CVICU).

In the CVICU, she was started on norepinephrine and vasopressin for hemodynamic support. Her Micra interrogation showed normal device function with stable impedance, sensing, and slightly higher pacing threshold values. The latter, however remained below the programmed pacing output of the device. Electrocardiogram (EKG) post cardiac arrest showed ventricular-paced rhythm with occasional premature ventricular complexes which is depicted in figure 2. Transthoracic echocardiography did not show any evidence of pericardial effusion and her chest x-ray showed stable device position from implantation. Her serum electrolytes and blood counts were within normal limits and unchanged from admission. Given the lack of a clear explanation of her VF arrest and given the temporal association with the Micra device implantation, her VF was presumed to be secondary to myocardial irritation from the Micra device. Unfortunately, she developed worsening shock with increasing vasopressor requirements and was later transitioned to comfort care following family discussion and subsequently expired within 18 hours of original procedure.

Discussion

This case demonstrates potential Micra leadless PM induced ventricular fibrillation (VF) arrest in our patient. Despite extensive workup, the etiology of VF arrest in our patient remained unclear. Although local myocardial irritation from implantation of the Micra device as a trigger of VF is possible, it is unlikely given the difference in the morphology of the PVC that initiated VF vs. paced QRS complexes. Other case reports of ventricular arrhythmias following leadless PM device implantation have also been reported [9,10,11]. Our case sheds further light on this complication by adding to the existing literature.

Current studies show the Micra leadless PM to have an acceptable safety profile, however reports of peri and post-operative ventricular arrhythmias have been described. Ritter et. al originally described the early performance of Micra and its safety profile in a prospective multisite study; among the cohort of 140 patients undergoing Micra implantation, 3 individuals developed ventricular arrhythmias that were not associated with death, re-operation or hospitalization[12]. In a retrospective Swiss study evaluating the safety and efficacy of Micra implantation in 92 patients, one patient developed unstable ventricular tachycardia during implantation; two months later, he was hospitalized again with intractable ventricular tachycardia requiring ablation. During the ablation, the VT was mapped to be originating from close to the insertion site of the device[13]. In contrast, early results from the Micra Post Approval Registry (PAR), an ongoing global prospective observational registry evaluating the safety and efficacy of Micra implantation, show that none

of the 1801 patients who underwent the procedure developed ventricular arrhythmias [14].

Different mechanisms for the development of ventricular arrhythmias after Micra implantation have been proposed [9, 11, 12]. Amin et. al reported a case of PVC-induced polymorphic ventricular tachycardia resulting in episodes of near-syncope and dizziness in a 74-year-old patient one day after Micra LP implantation. The PVCs were hypothesized to be secondary to local irritation of the right ventricular myocardium at the site of Micra implantation. Similarly, in the Swiss study, the unstable ventricular tachycardia was attributed to a pro-arrhythmic effect of the nitinol fixation tines[13]. Another report describing polymorphic VT post-Micra implantation hypothesized that local inflammation via cytokine mediated cardiac remodeling likely contributed to VT in their case [15]. In contrast, Costa et. al described a case of cardiac arrest within hours following Micra implantation; the ventricular tachyarrhythmia occurred during ventricular pacing and not spontaneously, and pacing-related induction of ventricular fibrillation was considered a possibility[11]. Importantly, while some of these cases were managed conservatively, others have shown that retrieval of the LP results in resolution of the arrhythmias. In the case described by Amin et. al, the patient subsequently underwent a second Micra implantation with retrieval of the prior to alleviate symptoms[9]. A report by Olsen et. al describes cardiac arrest due to VF post-Micra implantation that only resolved after removal of the LP [10]. Similarly, the case of recurrent hemodynamically unstable ventricular tachycardia from the Swiss study demonstrated that despite management with amiodarone, beta blockers, verapamil, lidocaine, and external defibrillation, the arrhythmia ultimately resolved after surgical explanation of the Micra device[13]. In contrast to these three reports, the case of polymorphic VT after Micra implantation was managed with intravenous steroids and overdrive pacing, resulting in resolution of repolarization abnormalities [15].

After Micra LP implantation patients can abruptly develop ventricular arrythmias leading to significant morbidity and mortality. Although literature is currently limited to case reports following the initial device performance data, we believe further large studies will help to illustrate this relationship. These adverse events highlight the importance of close monitoring of patients in the postoperative period to minimize complications with timely intervention. We propose that patients undergoing Micra implantation should be closely monitored for ventricular arrythmias in the early post-operative period.

Conclusion

Leadless pacemakers require direct implantation into the myocardium and though promising, may be associated with life-threatening proarrhythmic effects in some patients. Patients with such devices may benefit from close post-procedure monitoring for arrhythmias and other complications. Larger studies are needed to further evaluate arrhythmias in patients with leadless pacing devices and optimize post-procedural management.

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Figure Legend

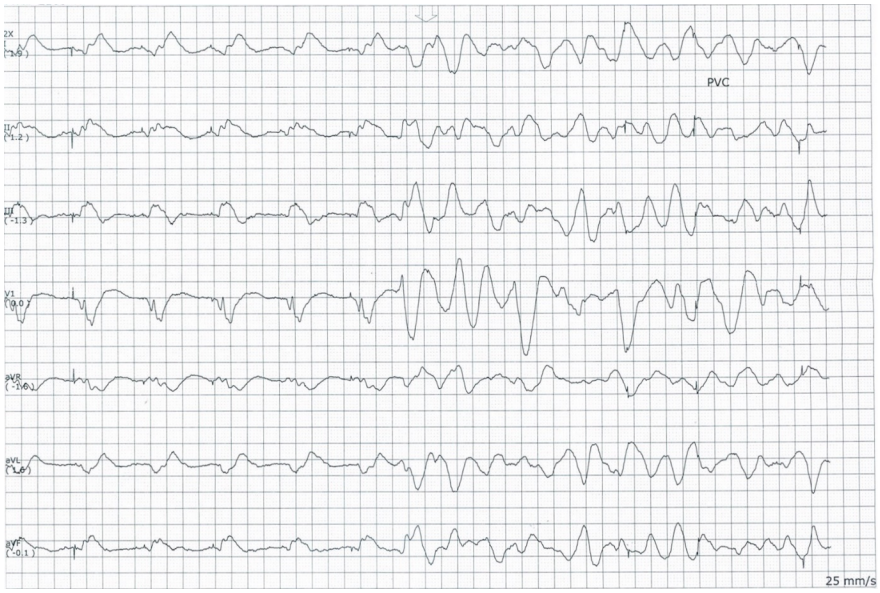

Figure 1: Ventricular Fibrillation following Micra implantation

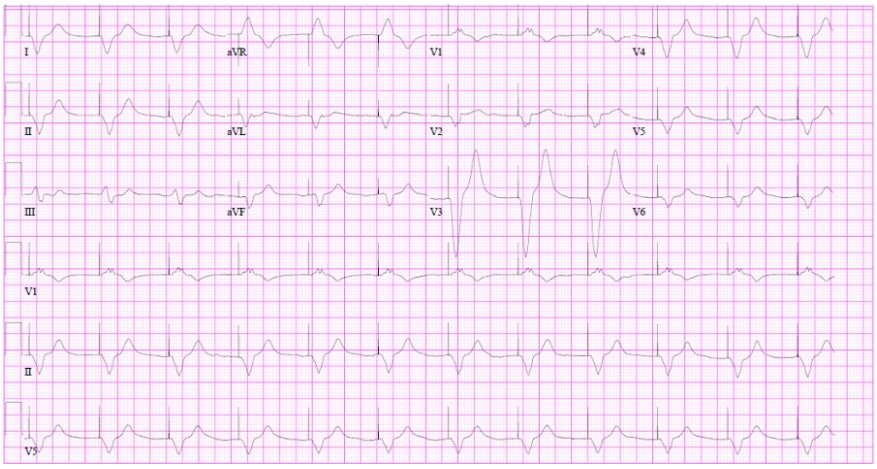

Figure 2: Ventricular paced rhythm following cardiac arrest

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