Implantation of a dual-chamber permanent pacemaker in a pregnant patient guided by intracardiac echocardiography and electroanatomic mapping

Kelvin C. M. Chua, MBBS, Eric T. S. Lim, MBBS, Daniel T. T. Chong, MBBS, Boon Yew Tan, MBBS, Kah Leng Ho, MBBS, Chi Keong Ching, MBBS, FHRS

From the Department of Cardiology, National Heart Centre Singapore, Singapore, Singapore.

Introduction

Fluoroscopy has traditionally been the primary cardiac imaging modality to guide transvenous permanent pacemaker (PPM) implantations. This entails radiation exposure, which is often at a modest dose for individual patients but can be potentially hazardous to operators after cumulative doses. In patients who are pregnant, fluoroscopy is considered contraindicated. Many authors have previously described using transesophageal echocardiography (TEE), transthoracic echocardiography (TTE), or electroanatomic mapping (EAM) to guide device lead implantations. We report a case of a complete heart block following myocarditis presenting at 5 weeks of gestation and describe the use of intracardiac echocardiography (ICE) and EAM to guide a safe and successful dual-chamber PPM implantation.

Case report

We present a case of a 27-year-old woman who first presented a year ago with chest pain and fever. She was found to be in complete heart block with a junctional escape rhythm at 40 beats per minute (bpm) and in cardiogenic shock with elevated troponins and markedly impaired left ventricular ejection fraction (LVEF) of 15%–20%. She was diagnosed with acute myocarditis and was stabilized with an intra-aortic balloon pump, temporary transvenous pacing wire, and pharmacotherapy. She improved dramatically but remained in complete heart block. On day 10 of admission, she declined further treatment and discharged herself against medical advice and did not return for follow-up. She presented to the Obstetrics service this year at 5 weeks of gestation and was found to be in complete heart block, now with a wide complex escape rhythm at 35 bpm. A repeat TTE found that her LVEF had normalized to 64%. After a multidisciplinary discussion and after explaining to the patient and her family regarding potential risks involved, we decided to proceed with a PPM implantation after her first trimester.

At 14 weeks of gestation, she was admitted electively for a PPM implantation. Following moderate sedation, 2 separate femoral venous accesses were obtained. A decapolar catheter (Livewire steerable decapolar, 6F medium sweep, St Jude Medical, St Paul, MN) was advanced into the right atrium (RA) fluorolessly using the St Jude Ensite NavX EAM system (St Jude Medical, St Paul, MN) as guidance. An ICE catheter (Viewflex Xtra 9F ICE catheter, St Jude Medical, St Paul, MN) was also advanced fluorolessly into the RA. Next, 3-dimensional geometries of the RA and right ventricle (RV) were created using the EAM system, paying particular attention to identify the RA appendage (RAA), tricuspid annulus (TA), RV septum, and RV outflow tract (RVOT).

An infraclavicular subcutaneous pocket was then created and 2 separate axillary venous punctures were made using direct ultrasonographic guidance. Guidewires were advanced through the axillary vein to the RA and visualized on ICE to confirm venous accesses. Two separate safe sheaths were then advanced over the guidewires. A bipolar pace-sense active fixation lead (Tendril STS, 52 cm, St Jude Medical, St Paul, MN) was connected to the EAM system junction box using alligator connectors to be visualized on the EAM system. This lead was then advanced past the TA and wedged along the RVOT septum using a curved stylet using both EAM and ICE guidance (Figure 1A and B) with reasonable R-wave amplitudes and current of injury observed. The retractable helix was then deployed and the curved stylet was switched to a straight one without any macro-dislodgement seen on ICE. The lead was interrogated and found to have stable parameters: R-wave sensing at 5.5 mV, pacing threshold at 0.7 V @ 0.4 ms, and impedance of 475 ohms. Following this, a second bipolar pace-sense active fixation lead (Tendril STS, 46 cm, St Jude Medical, St Paul, MN) was similarly connected and visualized on the EAM system. This lead was advanced into the RA and wedged into the RAA with a J-shaped stylet using both EAM and ICE guidance (Figure 1C–E). There were reasonable P-wave

KEYWORDS Intracardiac echocardiography; Fluoroless; Permanent pacemaker implantation; Pregnancy; Real-time electroanatomic mapping
(Heart Rhythm Case Reports 2017;3:542–545)

Address reprint requests and correspondence: Dr Kelvin C.M. Chua, National Heart Centre Singapore, 5 Hospital Dr, Singapore 169609, Singapore. E-mail address: kelvinchuacm@gmail.com.

https://doi.org/10.1016/j.hrcr.2017.09.003

KEY TEACHING POINTS

- It is important to appreciate the different fluoroless techniques for pacemaker implantation, particularly in a pregnant patient.
- Intracardiac echocardiography is a valuable tool in guiding anatomic pacemaker lead placement.
- A multipolar electrophysiology catheter is useful in creating a 3-dimensional electroanatomic map and this real-time map can be used to guide pacemaker lead placement.

amplitudes and current of injury observed and the retractable helix was deployed in this position. This lead was also interrogated and found to have stable parameters: P-wave sensing at 2.9 mV, pacing threshold at 0.6 V @ 0.4 ms, and impedance of 480 ohms. The slack on both leads was visualized on ICE to be appropriate and the mapping decapolar catheter was then removed safely under direct ICE visualization without any lead dislodgement (Figure 1F and G). The leads were reconnected to the EAM system and confirmed to be in a stable position (Figure 2A). A single snapshot of fluoroscopy with appropriate shielding of the fetus was performed to confirm the slack and complete extension of both lead helices (Figure 2B). Total fluoroscopy time was 1 second with only 0.05 mGy (dose area product 7 mGy/cm^2) of radiation

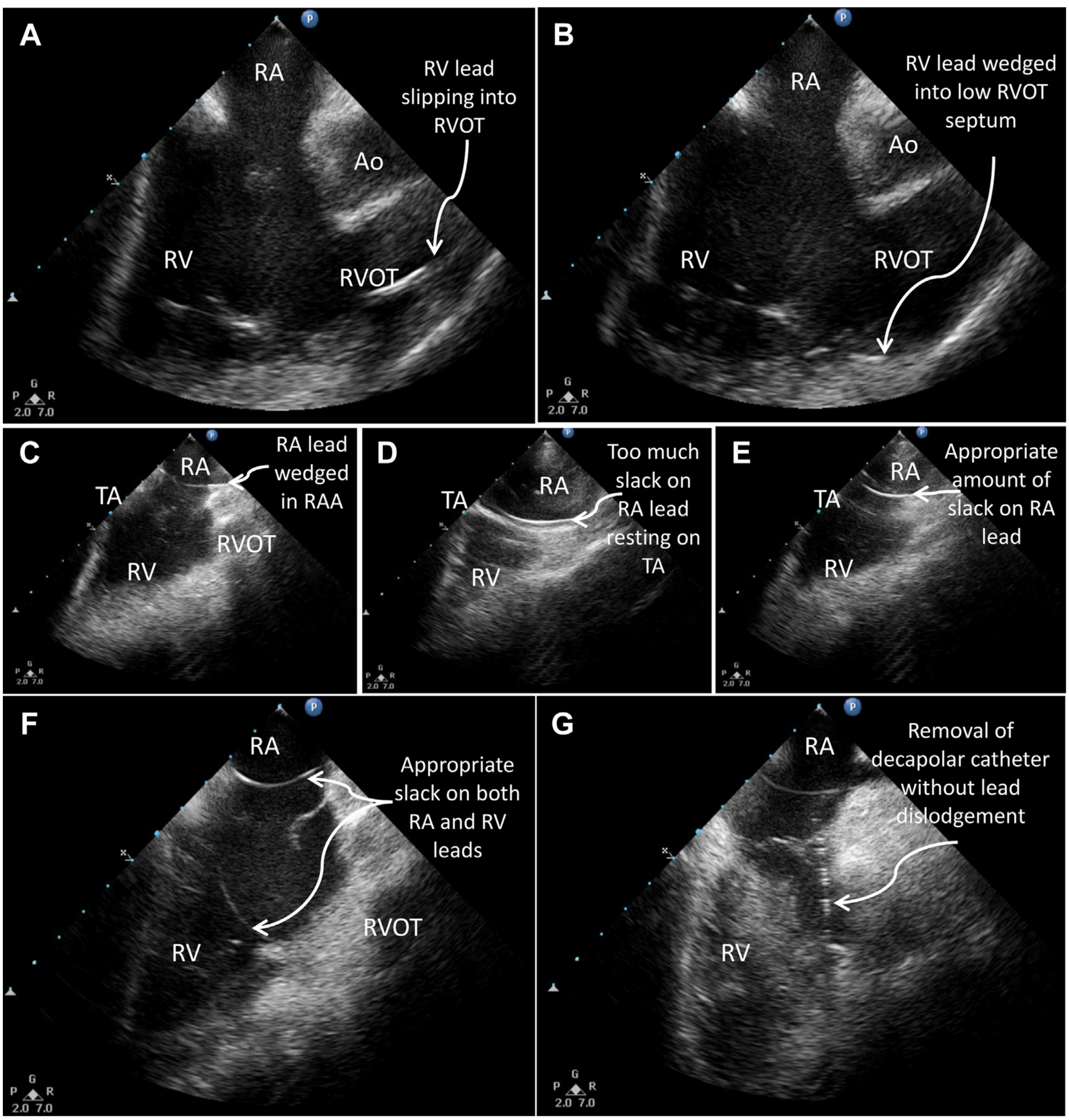

Figure 1 Right ventricular (RV) lead placement using intracardiac echocardiography as guidance. **A:** The RV lead slipping into the RV outflow tract (RVOT), confirming RV access. **B:** The RV lead wedged in a low RVOT septal position. **C:** The right atrial (RA) lead wedged into the right atrial appendage. **D:** The RA lead with too much slack with its loop resting on the tricuspid annulus (TA). **E:** The RA lead with an appropriate amount of slack, with its loop well above the TA. **F:** An appropriate amount slack on both RA and RV leads. **G:** The safe removal of decapolar mapping catheter without causing any lead dislodgement. Ao = aorta; RA = right atrium; RAA = right atrial appendage; RV = right ventricle; RVOT = right ventricular outflow tract; TA = tricuspid annulus.

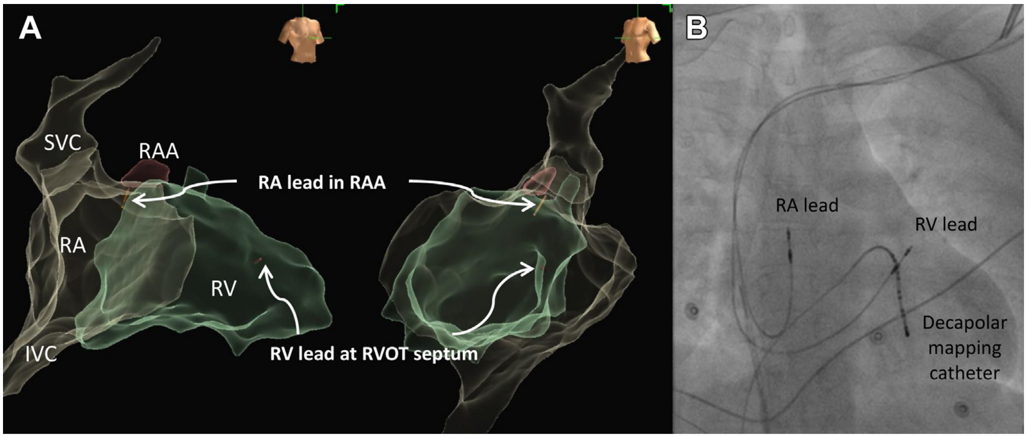

Figure 2 **A:** Electroanatomic map with a right anterior oblique and left anterior oblique projection of the cardiac chambers, and **B:** anteroposterior fluoroscopy of the cardiac silhouette showing appropriate positions of the right atrial and right ventricular leads with extended lead helices. IVC = inferior vena cava; RA = right atrium; RAA = right atrial appendage; RV = right ventricle; RVOT = right ventricular outflow tract; SVC = superior vena cava.

exposure. Both leads were then anchored to the floor of the pocket and connected to a pulse generator (Endurity Core, St Jude Medical, St Paul, MN). The patient returned in the following week for a device and wound check. She was pacing dependent with 100% ventricular pacing and all device parameters remained stable.

Discussion

We report a unique case of a young pregnant woman who developed complete heart block after myocarditis and declined treatment initially but presented herself again in early gestation. A successful dual-chamber pacemaker implantation was performed predominantly using ICE and EAM as guidance.

To the best of our knowledge, this is the first case report describing the use of ICE to guide device implantation. Device implantations have conventionally relied on fluoroscopy as the primary imaging modality to guide anatomic lead placement. In a pregnant patient, however, radiation exposure to the fetus increases the lifetime risk of malignancy, genetic effects, neurologic issues, and congenital malformations, which are not restricted to the first trimester.[1] Moreover, although radiation exposure can be negligible for individual patients, cumulative doses can have detrimental effects on operators.[2] There have been numerous reports using EAM, TEE, and TTE to guide device implantations in select patient cohorts, and some have reported minimizing fluoroscopy without any increase in procedural times.[3–8]

The use of TTE can be limited by inadequate visualization of the RAA, whereas TEE entails additional risks of aggravating atrioventricular conduction with probe manipulation, oroesophageal trauma, and aspiration, especially in a pregnant patient. Even with the use of dedicated EAM systems, a single shot of fluoroscopy is still required to determine adequate slack in the leads.[5,7,9] The use of ICE in this patient illustrates a unique opportunity in which, in addition to visualizing the lead tips wedged against the endocardium, the lead slack for both leads can be well appreciated without fluoroscopy. As this is our first case experience using ICE, we performed a single-shot fluoroscopy to confirm lead slack.

The potential downside to the use of ICE is the need for a large-bore femoral venous access, often 8F–10F, along with its potential risks of vascular injury and cardiac trauma from catheter manipulation. However, the risks of such complications are considered low. As we progress toward fluoroless ablation procedures with more experience using EAM and ICE,[10] we will continue to hone our proficiency on nonfluoroscopic tools and possibly eliminate the use of fluoroscopy completely in the near future.

Conclusion

We report a unique case of a young woman with postmyocarditis complete heart block presenting in early pregnancy who underwent a successful dual-chamber PPM using predominantly ICE and EAM guidance.

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