Int J Cardiovasc Sci. 2022; 35(5), 676-680

CASE REPORT

Pacemaker Implantation without Fluoroscopy and Guided by Anatomical Mapping

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Introduction

Cardiogenic syncope is an uncommon pathology in the context of pregnancy,[1] and an associated transient atrioventricular block is even more rare. The harmful effects of radiation exposure for fetus are already well-known.[2] Thus, alternative guiding techniques are being proposed as an alternative in order to avoid radiation exposure. Previous reports have described the use of intracardiac echocardiography or three-dimensional (3D) electroanatomical mapping.[3] Despite efforts to develop non-fluoroscopic approaches, cardiac device implantation still requires some fluoroscopic imaging. Each hour of fluoroscopic imaging is estimated to increase the lifetime risk of developing a fatal malignancy by up to 1%, as well as being an increased risk of a genetic defect in up to 20 in every 1 million births.[4,5]

With technological advancement, the use of less invasive techniques, together with short procedure times and less radiation exposure is essential. Therefore, repurposing technologies, which were originally developed for other applications, but that have been proven to be safe, should be encouraged. In this light, the present study advocates the use of the CARTO system technology (Biosense Webster, INC., Diamond Bar, CA) to delineate right atrium and right ventricle geometry so as to allow the pacemaker lead to be identified as a catheter to navigate the cardiac cavity without fluoroscopic exposure.

Keywords

Artificial Pacemaker; Fluoroscopy; Pregnancy.

Case report

A 35-year-old female, in the 28th week of pregnancy, was admitted for the second time to the emergency department due to syncope. This condition is characterized by a rapid onset, short duration, and spontaneous complete recovery associated with light-headedness. The baseline electrocardiogram showed a sinus rhythm at 65 beats per minute and a first-degree atrioventricular (AV) block. During her initial admission, the symptoms were associated with reflex (neural-mediated) syncope. During her second admission, the patient was referred for an external loop recorder, which was installed, and the patient was discharged. Three days later, the patient returned to the emergency department with the same complaint of syncope. An analysis of the loop recorder revealed a transient high-degree atrioventricular block (Figure 1) coinciding with the syncopal episode. The patient has no other known comorbidities and no significant family history. A transthoracic echocardiogram revealed a normal left ventricular ejection fraction (68%), normal heart valves, and normal right ventricular size and function. The electrolytes and thyroid function were normal. In addition, an exercise electrocardiographic stress test was normal. She was therefore referred for a pacemaker implantation, and given her ongoing pregnancy, an alternative technique was applied.

The patient was brought to the electrophysiology laboratory, and prior to commencing the procedure, a fetal heartbeat monitor was installed, and the entire procedure was followed by an obstetrician. The patient was sedated, using propofol, and both the right groin as well as the left pectoral region were ??? and draped using alcoholic chlorhexidine. Under local anesthesia, with 2% lidocaine 10cc, the right femoral vein was

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DOI: https://doi.org/10.36660/ijcs.20210005

Manuscript received January 24, 2021; revised manuscript October 11, 2021; accepted February 09, 2022.

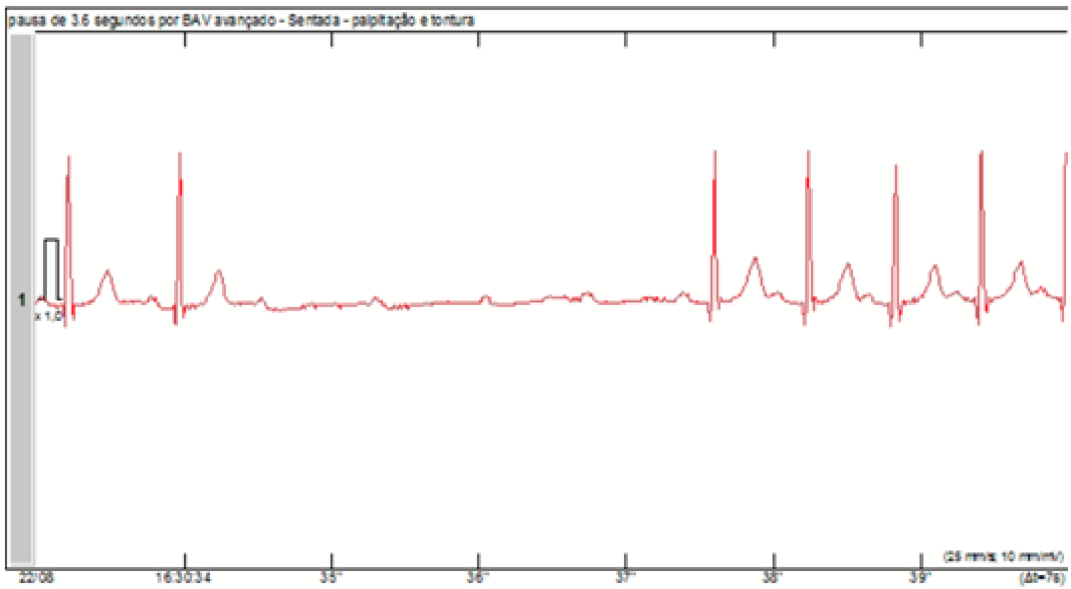

Figure 1 – Looper recorded showing an intermittent high-degree AV block with 3.6 seconds related with Syncope episode.

accessed using an 8F sheath. A deflectable mapping catheter – 4mm-tip quadripolar steerable (Biosense Webster, Inc., Diamond Bar, CA) – was then advanced and used to create 3D electroanatomic mappings of the right atrium and right ventricle using only the navigation system and bipolar electrogram tracings, usingthe CARTO system (Biosense-Webster). Set points were captured and marked by points to delineate areas of interest such as the His bundle position, superior vena cava, inferior vena cava, right ventricle outflow tract, the entire tricuspid ring, and the right ventricle. The geometry mapping of the His showed a prolonged HV interval (HV=80ms) (Figure 2). After the right atrium and ventricle geometry was completed, the ablation catheter was pulled back to the inferior vena cava.

After local anesthesia injection, 2% lidocaine 10cc, by left subclavian venous access, was obtained, using anatomical landmarks and ultrasound without the aid of fluoroscopic guidance. A 7-F sheath was advanced into the left subclavian vein using the modified Seldinger technique. The intracavitary lead (Capsure- Fix model 4076, Medtronic, Inc., Minneapolis, MN) was connected by means of alligator clips to the CARTO-3 system as a bipolar connection that allowed one to view the lead tip on the electroanatomic map. The lead tip was advanced into the right ventricle following the 3D mapping. A curved stylet was used to lead the electrode to the right ventricular outflow tract. This was relatively simple with the help of the navigation system, which allows the operator to continuously confirm if the electrode is inside the ventricle or not. From the right ventricular outflow tract, the electrode was slowly pulled back, now with a straight stylet, until the electrodes dropped to the low septum following the 3D mapping. The intracavitary signal was followed until an acceptable R wave amplitude was obtained, associated with an R-wave injury pattern before engaging the screw. After placing the screw with 10 loops, impedance, sensing, and threshold tests were performed (Figure 3). The following results were obtained: impedance of 644 ohms, R-wave amplitude at 11.2mV, and pacing threshold at 0.75ms at 0.4V. Lead slack was estimated using the created map and measuring the distance from the access point to the final lead position, and then comparing to the lead marker. The lead was then connected to a permanent VVI pacemaker (Medtronic Attesta SR MRI ATSR), which was lodged in a subcutaneous pocket with the wound securely sutured. The catheter from the right femoral vein was removed with the sheath and a compressive dressing was placed for 4 hours after the procedure. Upon follow-up after delivery, the patient is doing very well and all pacemaker parameters are the same. The patient is using less than 2% of pacing due to sinus rhythm at baseline with only intermittent high-degree AV block. Therefore, there has

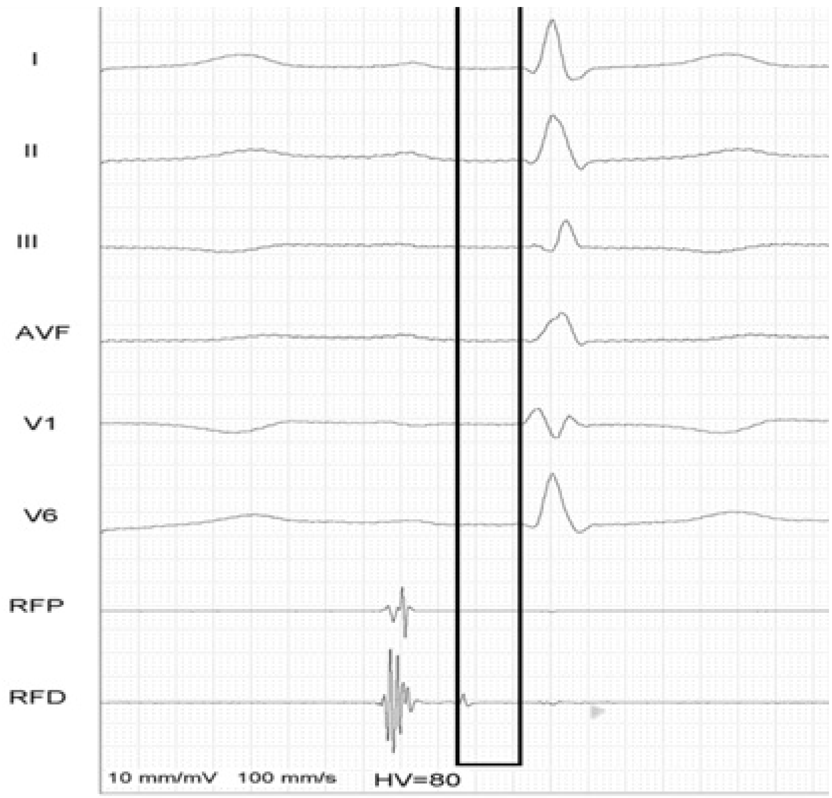

Figure 2 – Intracavitary measurements revealed a prolonged HV interval.

been no need to upgrade to a dual chamber pacemaker. A chest X-ray was performed after pregnancy and the lead slack is quite satisfactory.

Discussion

The present case report describes a patient who required a permanent pacemaker implantation during pregnancy due to a transient atrioventricular block and syncope. A single chamber pacemaker was implanted at that time as the best strategy for a rapid procedure with minimal complications. The patient will be reassessed after the pregnancy to assess the need for an upgrade, if necessary.

The CARTO system works by using ultralow intensity magnetic fields emitted from coils in a locator pad beneath the laboratory table. The magnetic field strength from each coil is different and is detected by a location sensor embedded proximal to the tip of the specialized mapping catheter. The locator pad interacts with a magnetic field generator locator pad (placed beneath the operating table), an external reference patch (fixed on the patient's back), a deflectable 7 Fr quadripolar mapping-ablation catheter with a 4- or 8-mm tip and proximal 2-mm ring electrodes, location sensors inside the mapping-ablation catheter tip (the three location sensors are located orthogonally to each other and lie just proximal to the tip electrode, fully embedded within the catheter), a reference catheter, a data processing unit, and a graphic display unit to generate the electroanatomic model of the chamber being mapped.[6]

The CARTO system can create an imaginary catheter using the electrode measurements and tip; connecting the electrode to the patient interface unit helps it to recognize the lead as a catheter. This configuration in a bipolar setting allowed it to be enabled when connected to the patient interface unit (connection between the patient and CARTO) and the location pad positioned under the table. The tip of the lead was connected using the usual alligator clips with the red color in the proximal position and black portion at the distal electrode connections.

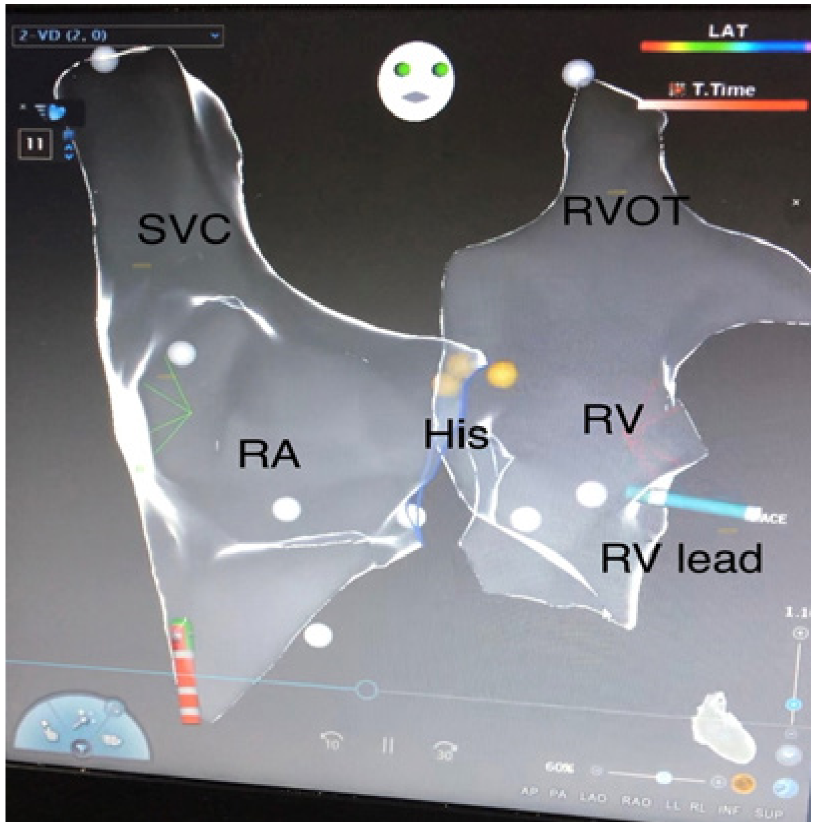

Figure 3 – Electroanatomic mapping showing the right atrium and right ventricle. Blue catheter showing the RV pacemaker lead. Red catheter showing the mapping catheter.

A similar case was performed by Payne et al.,[7] which used the St. Jude NavX mapping system, with a minimal fluoroscopy time to confirm the lead position.

The radiation risks throughout pregnancy are related to the stage of pregnancy and the absorbed dose.[5] These risks are more significant during organogenesis and in the early fetal period, somewhat less in the second trimester, and least in the third trimester. Malformations, typically associated with central nervous system disorders have a threshold of 100 to 200 mGy or higher, which can be reached through a fluoroscopy guided pacemaker implantation.[8]

The possible effects on pregnancy on a congenital complete heart block have been previously postulated.[9] These patients have a high stroke volume and bradycardia due to the hypervolemia related to pregnancy, as well as vagal stimulation related to a gravid uterus. Vagal mediated bradycardia is also common. However, our patient was in the 3rd trimester of pregnancy, and this was an unlikely mechanism. Furthermore, during right atrial mapping, the HV intervals revealed a prolonged HV related to the intermittent intraventricular block. Moreover, there has been a higher rate of Stokes-Adams attacks documented during pregnancy in these patients.[10] This approach can be considered the first option in pregnant patients in order to avoid fluoroscopy exposure, since the procedure appears safe and with a similar procedural duration, 20 minutes longer than the usual pacemaker implantation, though this would likely decrease with experience. The use of 3D anatomic mapping has proven to significantly reduce fluoroscopy time and fluoroscopy dose during routine device implantation,[11] as well as being a safe and effective approach.[12]

Some limitations of this approach should be mentioned. With this technique, final lead position and lead slack, which is important in young patients, could not be easily determined. Therefore, this technique should only be used in selected patients who would derive the greatest benefit, such as pregnant patients.

Conclusion

This study presented a case report on a totally non-fluoroscopic transvenous pacemaker implantation in a pregnant patient with syncope related to high-degree atrioventricular block. This technique enabled the use of the CARTO system to demarcate the right atrium and ventricle geometry, as well as the visualization of the pacemaker lead in order to ensure the proper location in the right atrium and ventricle as a guide to find the best position to place a right ventricular lead endocardial fixation. The clinical benefit of this approach requires further investigation and validation.

Author contributions

Conception and design of the research: Montemezzo M. Acquisition of data: Montemezzo M, Jakolinski M. Analysis and interpretation of the data: Montemezzo M. Writing of the manuscript: Montemezzo M, AlTurki A. Critical revision of the manuscript for intellectual content: Montemezzo M, AlTurki A, Jorge JCM.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Sources of Funding

There were no external funding sources for this study.

Study Association

This study is not associated with any thesis or dissertation work.

Ethics approval and consent to participate

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

Erratum

Int J Cardiovasc Sci. 2022 Issue vol 35(5), pages 676-680.

In Case Report "Pacemaker Implantation without Fluoroscopy and Guided by Anatomical Mapping", with DOI number: https://doi.org/10.36660/ijcs.20210005, published in International Journal of Cardiovascular Science, 35(5) in page 676-680. Correct, in the 4th paragraph, the phrase: "The patient was sedated, using propofol, and both the right groin as well as the left pectoral region were ??? and draped using alcoholic chlorhexidine." to "The patient was sedated, using propofol, and both the right groin as well as the left pectoral region were draped using alcoholic chlorhexidine."

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