

Near-zero fluoroscopy implantation of dual-chamber pacemaker in pregnancy using electroanatomic mapping



Jason Payne, MD,^{*} Monica Lo, MD,^{*†} Hakan Paydak, MD, FACC, FHRS,^{*} Waddah Maskoun, MD, FACC, FHRS^{*}

From the ^{*}Cardiology Department, University of Arkansas for Medical Sciences, Little Rock, Arkansas, and [†]Arkansas Heart Hospital, Little Rock, Arkansas.

Introduction

Complete heart block rarely occurs in patients <50 years of age and is less common during pregnancy. It is important to establish that symptoms are related to the heart block, and the management of the condition may be challenging. We present a case of symptomatic complete heart block developing during pregnancy and a treatment strategy minimizing fetal exposure to ionizing radiation.

Case Report

We present a case of a 27-year-old female patient who is known to have paroxysmal atrial fibrillation, which had been diagnosed at age 22 and for which she had previously taken propafenone, but she had taken no antiarrhythmic medications for 2 years. She also has a history of first-degree atrioventricular (AV) block that was previously asymptomatic. Her only significant family history was that of a brother who died because of tricuspid atresia. She presented to us during pregnancy at 11 weeks gestational age with a 5-week history of symptoms that included easy fatigue, dizziness, and severe dyspnea with minimal exertion. She denied any syncope. Her initial examination revealed a blood pressure 110/60 mm Hg and heart rate of 44 beats per minute. Her height was 5 ft 5in, weight 235 pounds, and body mass index 39.1. The results of her cardiovascular examination were normal except for bradycardia. Her initial electrocardiogram revealed sinus bradycardia with a PR interval of 260 ms (Figure 1).

At this time, it was unclear whether her symptoms were related to pregnancy or due to an underlying dysrhythmia, so

KEYWORDS 3D electroanatomic mapping; Complete heart block; Congenital heart block; Near-zero fluoroscopy; Pacemaker, Pregnancy (Heart Rhythm Case Reports 2017;3:205–209)

Conflicts of interest: Dr Monica Lo is a consultant for St. Jude Medical. Dr Waddah Maskoun has a research grant from Medtronic. None of these potential conflicts of interest were relevant to this study. **Address reprint requests and correspondence:** Dr Waddah Maskoun, Cardiology Department, University of Arkansas for Medical Sciences, 4301 W Markham Street, Little Rock, AR 72205. E-mail address: waddahmaskoun@gmail.com.

she underwent an initial evaluation with a treadmill electrocardiogram to evaluate for chronotropic dysfunction and to evaluate AV conduction with exercise. A Holter monitor was obtained as well to evaluate for any atrial fibrillation episodes. Both tests showed episodes of second- and third-degree AV block (Figure 2). She was able to achieve only 4 metabolic equivalents on her treadmill stress test, an outcome that was associated with her severe dyspnea.

The patient's electrolyte levels and thyroid function were normal. Echocardiography results were normal except for mild left atrial enlargement. Based on the development of third-degree heart block with severe symptoms during minimal exercise, we recommended a dual-chamber pacemaker.¹ She underwent dual-chamber pacemaker placement using minimal fluoroscopy by mapping the atria and ventricle using the St. Jude NavX mapping system (St. Jude Medical, St. Paul, MN).

First, ultrasonography-guided femoral access was obtained, and then a Bard coronary sinus catheter (Murray Hill, NJ) was placed in the coronary sinus to be used as a reference. A deflectable quadripolar catheter was used to build geometry and the shell of the coronary sinus, right atrium, right atrial appendage, right ventricle, and the His area.

Second, a pocket was fashioned for the pulse generator in the subcutaneous space of the left upper chest. With the aid of ultrasonography guidance, the axillary vein was punctured within the pocket and a guidewire was placed. A sheath was placed, and then 2 guidewires were placed inside the sheath; the sheath was removed and then 2 new sheaths were placed (1 for each guidewire). The ventricular lead was positioned in the right ventricular (RV) low septum using 3-dimensional (3D) mapping. The pace sense part of the lead was connected to the NavX system junction box by using a small alligator clip with safety connect so the lead could be visualized by the mapping system.

Subsequently, the RV lead was screwed into place; satisfactory pacing thresholds and R waves were obtained (sensing: 8.9 mV, pacing threshold: 0.8 V at 0.5 ms, and impedance of 538 Ω). The atrial lead was then similarly

KEY TEACHING POINTS

- Implantable devices can be safely implanted in pregnancy using a zero fluoroscopy technique with 3-dimensional electroanatomical mapping for class I indications.
- New-onset complete heart block is uncommon in pregnancy and may be coincidental or related to pregnancy.
- The diagnosis may be missed if complete heart block is transient, as symptoms may be similar to symptoms of pregnancy.
- Complete heart block can be unmasked by noninvasive tests during pregnancy.

positioned and screwed into place within the right atrial appendage using 3D mapping, and satisfactory pacing thresholds and P waves were obtained (Figure 3). Minimal fluoroscopy was used to confirm that there was enough slack and that the helix was extended completely with <10 seconds for total fluoroscopy time and <1 mGy for total radiation dose. The implanted device (Model A2DR01, Medtronic, Minneapolis, MN) was compatible with magnetic resonance imaging. The leads model was 5076.

The patient was seen in clinic 1 week after the procedure for device and wound check. She reported substantial improvement of her shortness of breath. At her 6-week device check, all her parameters remained normal and she

continued to feel well. She was 25% ventricular paced, and her underlying PR interval was 400 ms. She successfully delivered her baby at full term. There was no cardiac complication during delivery. Both mother and baby are doing well. A cardiac magnetic resonance image was considered as part of the workup to exclude infiltrative disorders; the patient elected to have this scan done in the postpartum period.

Discussion

We present a case of a young female patient who was known to have asymptomatic mild conduction system disease. This condition was diagnosed in her early adulthood, and no known reversible causes were present. Atrioventricular nodal block usually occurs in the population >50 years of age and most often in men. It is plausible that the patient in this case may have congenital complete heart block with a late presentation. The criteria require documentation of complete heart block, low pulse rate at an early age, and no known etiology or reversible cause. These patients, particularly those with nonimmune congenital heart block, typically will present with symptoms later in childhood to adolescence and may have transient or lesser degrees of heart block in the early stages.^{2,3} Furthermore, acquired complete heart block is relatively uncommon in pregnancy. The patient did not have previously documented complete heart block. It is possible that her AV block progressed during pregnancy (related or unrelated to her pregnancy). The possible effects on pregnancy of congenital complete heart block have been previously postulated.⁴ These patients have a high stroke

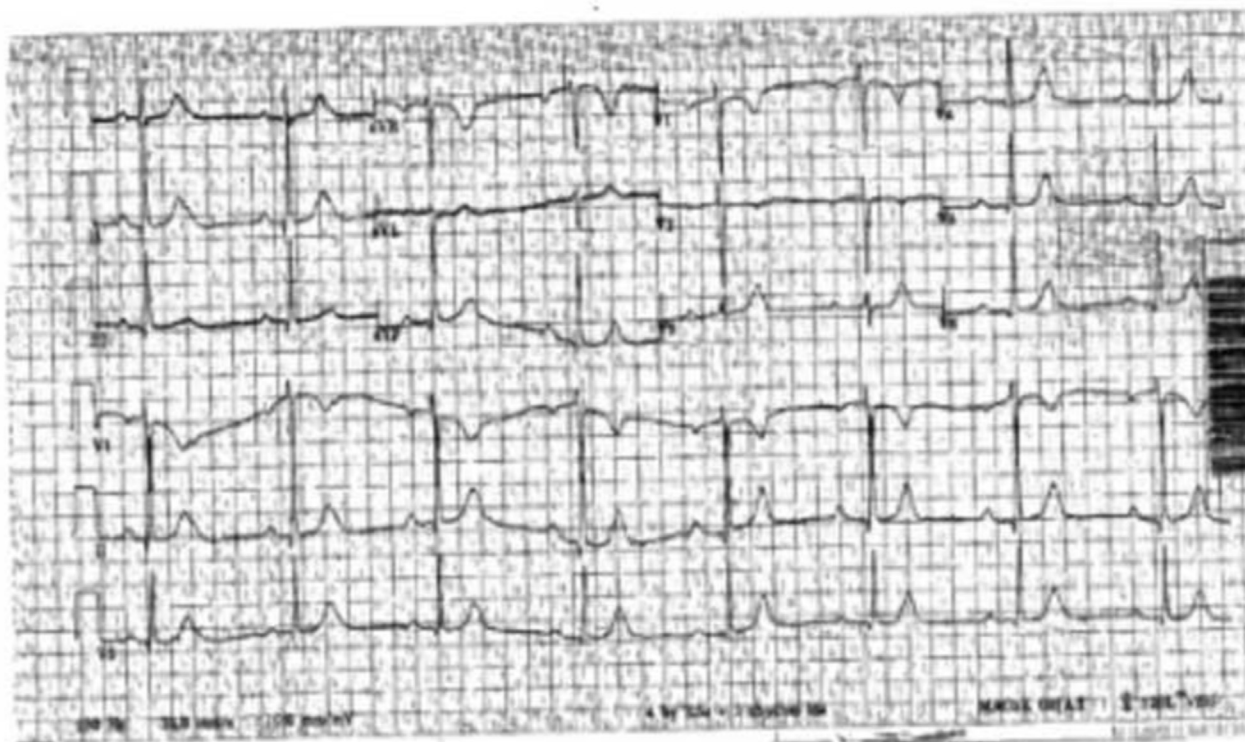


Figure 1 Baseline electrocardiogram showing sinus bradycardia and first-degree atrioventricular block.

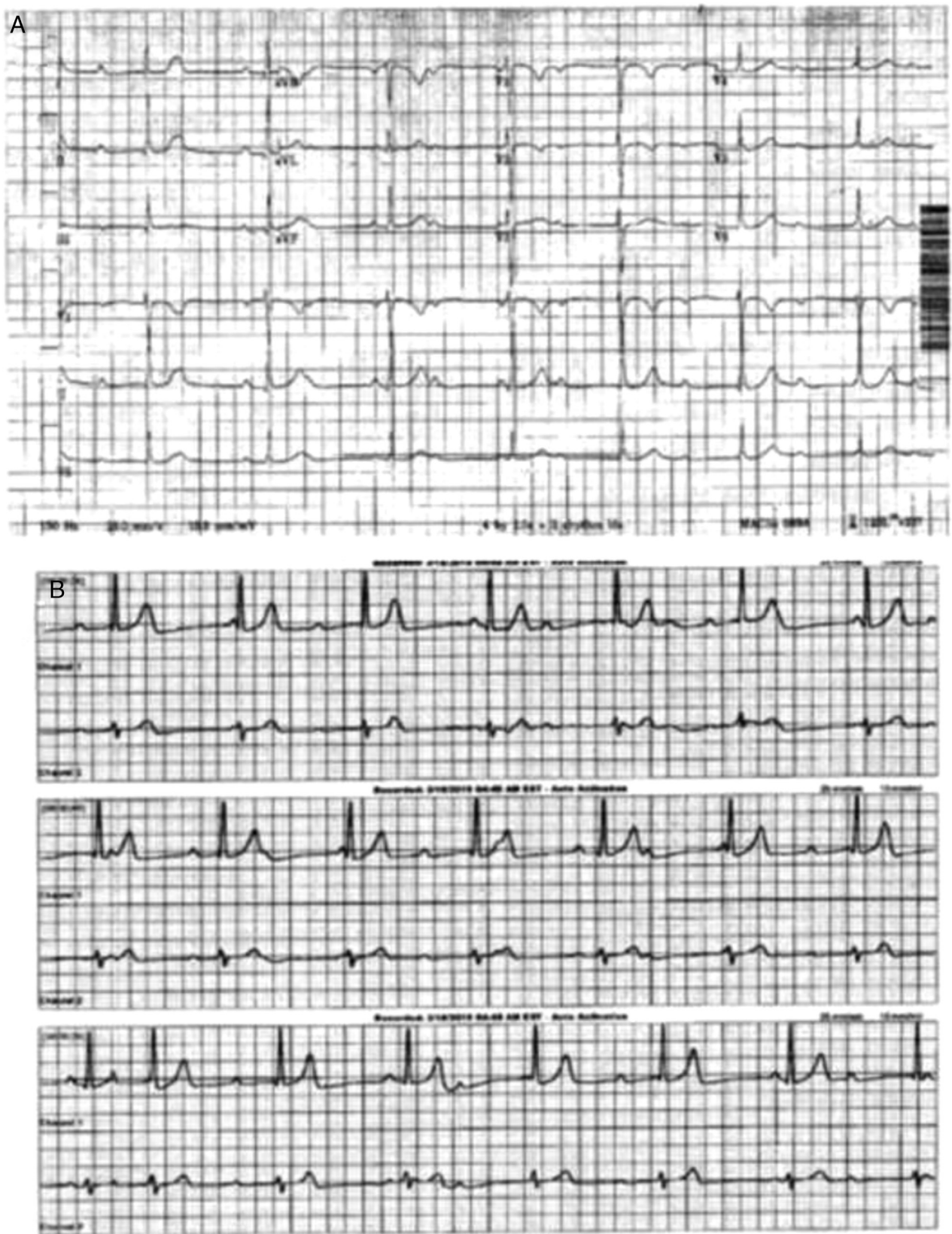


Figure 2 A: Excerpt from the event monitor during a symptomatic episode, showing complete heart block. B: Excerpt from the treadmill electrocardiogram showing complete heart block.

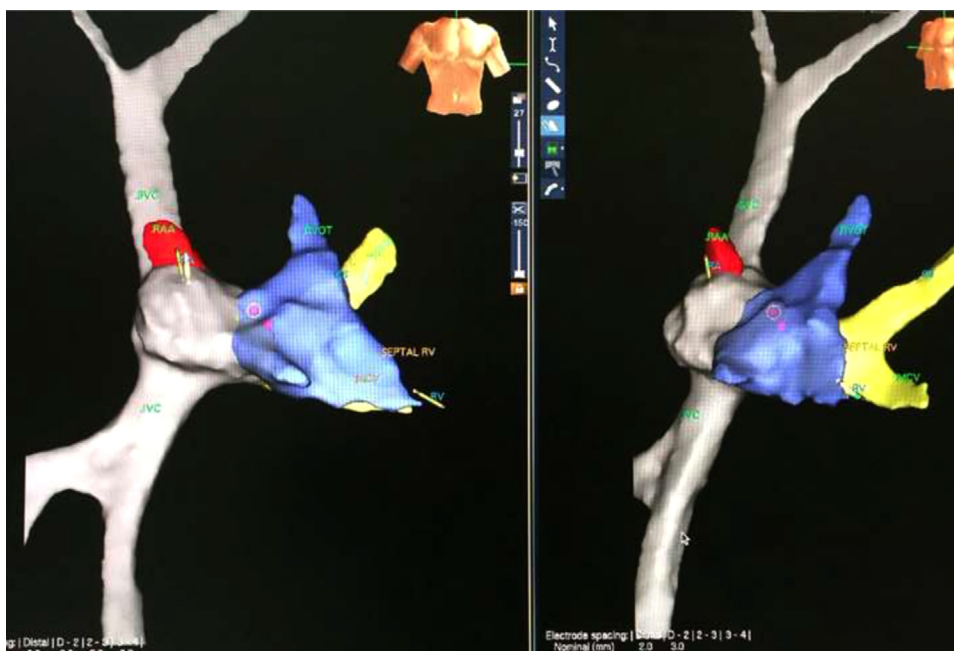


Figure 3 Electroanatomic map. The right atrial pacemaker lead (RA) is placed successfully in the right atrial appendage (RAA). The right ventricular pacemaker lead (RV) is placed in the right ventricular apex. CS = Bard coronary sinus lead; IVC = inferior vena cava; RVOT = right ventricular outflow tract; SVC = superior vena cava.

volume and bradycardia due to the hypervolemia related to pregnancy as well as vagal stimulation related to a gravid uterus, and vagal-mediated bradycardia is common.

However, our patient was in the first trimester of pregnancy, and this was an unlikely mechanism. Moreover, there has been a higher rate of Stokes-Adams attacks documented during pregnancy in these patients.⁴

Management of complete heart block in pregnancy has the additional complexity due to risk of radiation exposure at the time of implantation in addition to the typical implantation complications. Each hour of radiation exposure increases the lifetime risk of malignancy by 1% and increases the risk of genetic defects, neurologic problems, and congenital malformations. The effects of radiation exposure are significant even in late pregnancy.⁵ However, labor can be complicated by Valsalva maneuver–induced syncope and convulsions. The options for management include expectant management with placement of a temporary pacemaker at the time of labor and a permanent pacemaker thereafter, or placement of a permanent pacemaker during pregnancy. To minimize the radiation exposure of the fetus, nonfluoroscopy implantation techniques have been employed previously, including placement of a permanent pacemaker using either echocardiographic guidance or 3D electroanatomic mapping (EAM).

Transthoracic echocardiography may provide sufficient guidance for placing ventricular leads; however, placement of atrial leads requires additional imaging of the atrial appendage, which can be done with transesophageal echocardiography and 3D echocardiography. Further, in obese patients such as our patient, the quality of transthoracic echocardiograms is reduced. Transesophageal echocardiography often requires general

anesthesia and has additional disadvantages related to the risk of aspiration due to gastric retention, which is common in pregnancy, and the risk of provoking more bradycardia and AV nodal block during manipulation of the transesophageal probe.⁶ It also requires some technical expertise to correctly identify all the relevant structures. Despite limitations, this approach has been successfully used in a number of cases during pregnancy.⁷ In a prospective single-center observational study of fluoroscopy-guided vs echocardiography-guided pacemaker insertion, procedure times and overall complication rates were lower (22 mins vs 43 minutes, $P = .01$ and 15% vs 28%, $P = .02$, respectively) in patients whose implants were placed via echocardiographic guidance. In that study, patients were selected not on the basis of the need to reduce radiation exposure but rather by the operator based on personal experience and clinical setting.

With the development of 3D EAM, this technique has also been used to guide ablations without the use of fluoroscopy.^{8,9} This has mainly been used in the area of ablation but has also been employed successfully in a few cases of device placement. There are many advantages to using ultrasonography-guided access and 3D EAM over fluoroscopy in addition to minimizing radiation exposure. No contrast is used, and selective site pacing and 3D rendering allow for adaptation to variations in anatomy, which may be considerable. During pregnancy specifically, there have been case reports of successful single-chamber implantable cardioverter defibrillator implantation using the St. Jude Ensite NavX.¹⁰ There are a few case reports of single-lead pacemaker implantation^{11,12} and 2 case reports of dual-chamber pacemaker implantation using nonfluoroscopy 3D mapping.^{13,14} In a retrospective analysis at a single center

by a single operator, 10 patients who underwent biventricular implantation guided by fluoroscopy were compared with 10 patients who received their implants with the aid of EAM. The operator was already very experienced in using a near-zero fluoroscopy approach to ablation procedures. Fluoroscopy time was reduced by an average of 12 minutes, contrast use was reduced by 54 mL, and procedure time was reduced by 16 minutes in the EAM-guided group. Effective resynchronization therapy was achieved with similar response in ejection fraction and change in New York Heart Association class, despite a smaller reduction in QRS duration.¹⁵

Conclusion

We present a very unusual case of a patient who presented with complete heart block that developed during pregnancy and who was successfully treated with a dual-chamber pacemaker placed with 3D EAM guidance.

References

1. Epstein AE, DiMarco JP, Ellenbogen KA, et al. ACC/AHA/HRS 2008 Guidelines for Device-Based Therapy of Cardiac Rhythm Abnormalities: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the ACC/AHA/NASPE 2002 Guideline Update for Implantation of Cardiac Pacemakers and Antiarrhythmia Devices) developed in collaboration with the American Association for Thoracic Surgery and Society of Thoracic Surgeons. *Heart Rhythm* 2008;5(6):e1–e62.
2. Baruteau AE, Fouchard S, Behaghel A, et al. Characteristics and long-term outcome of non-immune isolated atrioventricular block diagnosed in utero or early childhood: a multicentre study. *Eur Heart J* 2012;33(5):622–629.
3. Jaeggi ET, Hamilton RM, Silverman ED, Zamora SA, Hornberger LK. Outcome of children with fetal, neonatal or childhood diagnosis of isolated congenital atrioventricular block. A single institution's experience of 30 years. *J Amer Coll Cardiol* 2002;39(1):130–137.
4. Kenmure AC, Cameron AJ. Congenital complete heart block in pregnancy. *Br Heart J* 1967;29(6):910–912.
5. Damilakis J, Theocharopoulos N, Perisinakis K, Manios E, Dimitriou P, Vardas P, Gourtsoyiannis N. Conceptus radiation dose and risk from cardiac catheter ablation procedures. *Circulation* 2001;104(8):893–897.
6. Stoddard MF, Longaker RA. The safety of transesophageal echocardiography in the elderly. *Am Heart J* 1993;125(5 Pt 1):1358–1362.
7. Jordaens LJ, Vandenbogaerde JF, Van de Bruaene P, De Buyzere M. Transesophageal echocardiography for insertion of a physiological pacemaker in early pregnancy. *Pacing Clin Electrophysiol* 1990;13(8):955–957.
8. Bigelow A, Crane S, Khoury F, Clark J. Catheter ablation of supraventricular tachycardia without fluoroscopy during pregnancy. *Obstetrics Gynecol* 2015;125(6):1338–1341.
9. Tuzcu V. A nonfluoroscopic approach for electrophysiology and catheter ablation procedures using a three-dimensional navigation system. *Pacing Clin Electrophysiol* 2007;30(4):519–525.
10. Tuzcu V, Kilinc OU. Implantable cardioverter defibrillator implantation without using fluoroscopy in a pregnant patient. *Pacing Clin Electrophysiol* 2012;35(9):e265–e266.
11. Ruiz-Granell R, Ferrero A, Morell-Cabedo S, Martinez-Brotons A, Bertomeu V, Llacer A, García-Civera R. Implantation of single-lead atrioventricular permanent pacemakers guided by electroanatomic navigation without the use of fluoroscopy. *Europace* 2008;10(9):1048–1051.
12. Ruiz-Granell R, Morell-Cabedo S, Ferrero-De-Loma A, García-Civera R. Atrioventricular node ablation and permanent ventricular pacemaker implantation without fluoroscopy: use of an electroanatomic navigation system. *J Cardiovasc Electrophysiol* 2005;16(7):793–795.
13. Velasco A, Velasco V, Rosas F, Cevik C, Morillo C. Utility of the NavX® electroanatomic mapping system for permanent pacemaker implantation in a pregnant patient with Chagas disease. *Indian Pacing Electrophysiol J* 2013;13(1):34–37.
14. Tuzcu V, Gul EE, Erdem A, Kamali H, Saritas T, Karadeniz C, Akdeniz C. Cardiac Interventions in Pregnant Patients without Fluoroscopy. *Pediatr Cardiol* 2015;36(6):1304–1307.
15. Mina A, Waecke N. Near zero fluoroscopic implantation of BIV ICD using electro-anatomical mapping. *Pacing Clin Electrophysiol* 2013;36(11):1409–1416.