A rare complication of implantable cardiac defibrillator placement

CURRENT STATUS: POSTED

João Ferreira
Centro Hospitalar e Universitario de Coimbra EPE
joaoferreira29@gmail.com
ORCiD: https://orcid.org/0000-0002-4732-5545

Célia Marques Domingues
Centro Hospitalar e Universitario de Coimbra EPE

Susana Isabel Costa
Centro Hospitalar e Universitario de Coimbra EPE

Maria Fátima Franco Silva
Centro Hospitalar e Universitario de Coimbra EPE

Lino Manuel Martins Gonçalves
Centro Hospitalar e Universitario de Coimbra EPE

DOI:
10.21203/rs.2.21549/v1

SUBJECT AREAS
Cardiac & Cardiovascular Systems

KEYWORDS
Cardiac transplant, defibrillator, echocardiography, patent foramen ovale, cardiac pacing
Abstract

Background Implantable cardiac defibrillators (ICD) are a popular and effective option in heart failure with left ventricular systolic dysfunction patients. Although frequently underdiagnosed, inadvertent malposition can lead to endocardial damage and thrombotic events. As ICD implants tend to increase in the following years, the recognition of their complications is critical.

Case presentation The authors present a case of a 64-year-old woman with advanced heart failure and ICD malposition. This accidental discovery was denounced by the presence of a right bundle branch block pattern and later confirmed by echocardiography which showed the lead tip in contact with the mid segment of the left ventricular antero-lateral wall. As the patient hospitalisation was complicated with refractory ascites and cardiogenic shock, she underwent cardiac transplantation, with no recurrence of heart failure symptoms.

Conclusions An electrocardiogram showing a right bundle branch block pattern during VVI pacing should arise the suspicion of inadvertent placement of a pacing/ICD lead. The many facets of echocardiography should be used for the diagnosis of this complication, as they were paramount in this case, as highlighted.

Background

Implantable cardiac defibrillators (ICD) are a well-established treatment of heart failure patients with left ventricular systolic dysfunction who are at risk for life-threatening ventricular arrhythmias. As indications for its placement widen, the number of ICD implants also increases and complications arise. The inadvertent malposition of an ICD lead in the left ventricle is a rare complication and may remain undiagnosed for many years. As this lead position may end up in endocardial damage and thrombotic events, its recognition should be prompt. Here, we present a challenging case of a patient with a previous ICD implant who arrived at our department with an electrocardiogram showing a right bundle branch block pattern during VVI pacing. The many facets of echocardiography were paramount to the diagnosis of the complication, as highlighted in this case.

Case Presentation

A 64-year-old woman with multiple previous hospitalizations for acute heart failure was admitted for shortness of breath, peripheral oedema and increasing abdominal size in her local hospital emergency
department with subsequent hospitalisation. She had a past history of idiopathic dilated cardiomyopathy with severe biventricular systolic dysfunction, secondary severe mitral and tricuspid regurgitation and permanent atrial fibrillation. As part of the sequence of heart failure therapies, the patient also had a previous implant of an ICD for primary prevention 5 years before. During hospitalization the patient developed diverse infectious complications which contributed to a slow resolution of acute heart failure, with need of many days of inotropic and vasopressor support and subsequent sub optimization of heart failure therapy. As the patient was recognized as having criteria for advanced heart failure, she was referred and transferred to our advanced heart failure centre.

Following admission to our hospital, an electrocardiogram (ECG) was performed, showing ventricular pacing with right bundle branch block (RBBB) pattern in V1 through V5 leads and negative QRS in I and aVL leads (Figure 1), which raised suspicion of ICD lead malposition. Chest radiography was performed also showing an abnormal lead path, suggestive of implantation of the lead in the left ventricle (Figure 2). In order to confirm our suspicion, our patient then performed a transthoracic echocardiogram, which showed biventricular dilatation with moderate systolic dysfunction, severe mitral and tricuspid regurgitation and signs of right ventricular pressure overload with plethoric inferior vena cava and abnormal septal motion with systolic “flattening” towards the left ventricle. Peak systolic gradient between right ventricle and the right atrium was normal, probably underestimated because of right ventricular dysfunction and severe enlargement of the right atrium. However, the implanted ICD appeared to pass through the interatrial septum, with its lead tip in contact with the mid segment of the left ventricular antero-lateral wall (Figure 3, panel A to D). Our patient also underwent a transoesophageal echocardiogram in order to better clarify valvular regurgitations and the behaviour of the ICD lead at the level of the interatrial septum (Figure 4, panel A to D).

Initially, our patient registered an important decrease in body weight and improvement in symptoms, however, after many days of stay her hospitalisation was complicated with refractory ascites and cardiogenic shock, with fast progression in INTERMACS classification. As our patient reached
INTERMACS level 2, we launched a desperate appeal for cardiac transplantation, as neither extracorporeal membrane oxygenation nor left ventricular assist devices were available at our center at the time. After a couple of days, we got contacted as there was an available heart, and our patient was promptly transferred to our cardiac surgery unit where she underwent successful orthotopic heart transplantation. Immediate post-operative course was favourable with extubation after 24 hours, requiring inotropic support with dobutamine for 2 days with no need for mechanical support. The patient was discharged after 72 days after transplantation, and to this day remains symptom-free with no further hospitalizations.

Discussion And Conclusion

Cardiac implantable electronic devices are a safe and effective way of treating arrhythmias, with increasing number of implants as indications widen and, as more devices are used, subsequent increase in generator replacements. ICD and pacemaker leads are conventionally placed in the right ventricle and right atrium with the leads coursing the subclavian vein and superior vena cava. However, in some cases, there can occur lead malposition, which remains underdiagnosed as patients can be asymptomatic and fluoroscopic guidance during implantation can be misleading.

Furthermore, lead thresholds are not always helpful in the diagnosis, as they can be perfectly normal during patient follow-up, which was the case of our patient. As the ICD lead is expected to be implanted in the right ventricular apex, pacing is expected to produce a left bundle branch block pattern. As in the case of our patient, the presence of a paced RBBB pattern must rise suspicion of lead malposition. Sites reported to be associated with the pattern are left ventricular malposition, coronary sinus implantation, lead perforation and pseudo-RBBB even in right ventricular lead placement. Chest radiography is routinely performed after lead placement, generally in order to rule out pneumothorax and malposition of the lead. A correctly implanted lead is expected to a right lateral course through the right atrium in posteroanterior view, with the lateral view showing anterior location of the lead tip. In our patient, radiography revealed more superior and to the left positioning on posteroanterior view, with lateral view showing a more posterior location of lead tip, suggesting
lead malposition in the left ventricle. Two-dimensional transthoracic echocardiography is the imaging test of choice in order to confirm lead malposition, as it is a readily available exam quickly performed at bedside. Transoesophageal echocardiography, as performed in our case, can also accurately delineate the course of the lead especially at the level of the interatrial septum, elucidating if we are in the presence of a patent foramen ovale or other types of atrial septal defect.

Complications of left ventricular lead position include valvular damage and thromboembolic events\textsuperscript{7}. A recent trial, ALternate Site Cardiac ResYNChronization (ALSYNC) study, aimed to evaluate the feasibility and safety of left ventricular endocardial pacing (LVEP) using a pacing lead implanted via pectoral access by an atrial transeptal lead delivery system\textsuperscript{8}. Left ventricular endocardial pacing was successful in 118 cases, and all patients received effective anticoagulation with warfarin, with target INR range 2.5-3.5. A total of 5 patients had a post-procedure stroke, however, none of the events led to permanent disability as defined by Rankin class 3 or greater. However, thrombo-embolic episodes may occur in up to 40\% of affected patients, at any time after the procedure\textsuperscript{2}. Factors such as timing of implantation, adherent thrombus and age of patients can influence the management of these cases. If the diagnosis is made shortly after implantation, percutaneous lead extraction can reduce embolic events and need of lifelong anticoagulation, however, the procedure carries some risk of systemic embolization from lead manipulation, especially with laser sheaths\textsuperscript{9}. In the patients where diagnosis is delayed, warfarin seems a reasonable option, as thromboembolic events were rare or absent in patients with INR in the range of 2.5-3.5\textsuperscript{3,8}. However, it does not address the problem of valvular trauma and increased lifelong anticoagulation complications. As such, percutaneous extraction may be considered because it is a definitive solution for the problem. Surgical lead extraction is also an option, especially if cardiac surgery is warranted.

In our case, as the patient underwent cardiac transplantation for reasons not related to lead malposition, lead extraction did not constitute a problem for patient management. However, if we had to extract the lead, it would probably prove problematic as the lead was implanted 5 years before. When a paced RBBB pattern is seen in a patient with previous ICD implantation, lead malposition in
the left ventricle should be suspected. ECG is a very useful diagnostic tool and should be performed while under pacing, if necessary forcing it with a magnet, in order to clarify the position of cardiac stimulation, paramount for clinical suspicion in our case. Chest radiography with posteroanterior and lateral views can also help with the diagnosis, showing an abnormal lead path. However, it can be insufficient because left ventricular position can be mistaken for coronary sinus position. Therefore, echocardiography is crucial to diagnose lead malposition and its complications, as a readily available diagnosis tool capable of locating lead position and following its course. Computed tomography scan may be needed when other exams fail to diagnose lead malposition and suspicion remains high\textsuperscript{10}.

Declarations

**Ethics approval and consent to participate**
Not applicable

**Consent for publication**
Consent for publication was obtained from the patient

**Availability of data and materials**
Not applicable

**Competing interests**
The authors declare that they have no competing interests

**Funding**
The authors received no specific funding for this work

**Author contributions:**
JF participated in the concept/design and drafting of the article
CD participated in the concept/design and drafting of the article
SC participated in the concept/design and critical revision of the article
FF participated in the critical revision of the article
LG participated in the critical revision of the article and approval of the article
All authors have read and approved the final manuscript.

**Acknowledgements**
Not applicable

**References**

1. Raatikainen MJP, Arnar DO, Merkely B, et al. A Decade of Information on the Use of Cardiac Implantable Electronic Devices and Interventional Electrophysiological Procedures in the European Society of Cardiology Countries: 2017 Report from the European Heart Rhythm Association. *Europace*. 2017;19(2):ii1-ii90.
doi:10.1093/europace/eux258
2. Gelder BM, Bracke FA, Oto A, et al. Diagnosis and Management of Inadvertently Placed Pacing and ICD Leads in the Left Ventricle: A Multicenter Experience and Review of the Literature. *Pacing Clin Electrophysiol.* 2000;23(5):877-883. doi:10.1111/j.1540-8159.2000.tb00858.x

3. Vanhercke D, Heytens W, Verloove H. Eight years of left ventricle pacing due to inadvertent malposition of a transvenous pacemaker lead in the left ventricle. *Eur J Echocardiogr.* 2008;9(6):825-827. doi:10.1093/ejechocard/jen187

4. McManus DD, Mattei ML, Rose K, Rashkin J, Rosenthal LS. Inadvertent lead placement in the left ventricle: A case report and brief review. *Indian Pacing Electrophysiol J.* 2009;9(4):224-228.

5. Okmen E, Erdinler I, Oguz E, et al. An electrocardiographic algorithm for determining the location of pacemaker electrode in patients with right bundle branch block configuration during permanent ventricular pacing. *Angiology.* 2006;57(5):623-630. doi:10.1177/0003319706293146

6. Gupta A, Parakh N, Juneja R. Right bundle branch block pattern after uncomplicated right ventricular outflow tract pacing in a patient with a left sided superior vena cava and corrected tetralogy of Fallot. *Indian Pacing Electrophysiol J.* 2018;18(1):39-41. doi:10.1016/j.ipej.2017.11.005

7. Raghavan C, Cashion WR, Spencer WH. Malposition of transvenous pacing lead in the left ventricle. *Clin Cardiol.* 1996;19(4):335-338. doi:10.1002/clc.4960190411

8. Morgan JM, Biffi M, Gellér L, et al. ALternate Site Cardiac ResYNChronization (ALSYNC): A prospective and multicentre study of left ventricular endocardial pacing for cardiac resynchronization therapy. *Eur Heart J.* 2016;37(27):2118-2127. doi:10.1093/eurheartj/ehv723

9. de Cock CC, van Campen CMC, Kamp O, Visser CA. Successful percutaneous
extraction of an inadvertently placed left ventricular pacing lead. *Europace*. 2003;5(2):195-197. doi:10.1053/eupc.2002.0290

10. Zeisloft J, Pedrick R, Adelmann J, Benson J. Defibrillator wire leads traversing an atrial septal defect. *J Diagnostic Med Sonogr*. 2011;27(5):225-228. doi:10.1177/8756479311416506

Figures

![Figure 1](image)

**Figure 1**

Twelve-lead electrocardiogram showing underlying atrial fibrillation with ventricular pacing resulting in right bundle branch block morphology of the paced QRS complex.

![Figure 1](image)

**Figure 1**

Twelve-lead electrocardiogram showing underlying atrial fibrillation with ventricular pacing resulting in right bundle branch block morphology of the paced QRS complex.
Figure 2

Posteroanterior chest radiograph suggesting an abnormal course of the ICD lead.
Posteroanterior chest radiograph suggesting an abnormal course of the ICD lead.
Transthoracic echocardiography findings. A. 4-chamber apical view showing lead course through interatrial septum, mitral valve and tip placed at the antero-lateral wall. B. Dilated right ventricle with tricuspid valve coaptation defect. C. Severe tricuspid and mitral regurgitation. D. Systolic “flattening” of the interventricular septum suggesting right ventricular pressure overload.
Figure 3

Transthoracic echocardiography findings. A. 4-chamber apical view showing lead course through interatrial septum, mitral valve and tip placed at the antero-lateral wall. B. Dilated right ventricle with tricuspid valve coaptation defect. C. Severe tricuspid and mitral regurgitation. D. Systolic “flattening” of the interventricular septum suggesting right ventricular pressure overload.
Figure 4

Transoesophageal echocardiography findings. A. Bicaval view showing lead course through the interatrial septum. B. Mid-oesophageal 2-chamber view showing severe mitral regurgitation. C. Modified mid-oesophageal aortic valve short-axis view showing a small left-right shunt suggestive of patent foramen ovale. D. Transgastric 2-chamber view showing lead tip at the antero-lateral wall.
Figure 4

Transoesophageal echocardiography findings. A. Bicaval view showing lead course through the interatrial septum. B. Mid-oesophageal 2-chamber view showing severe mitral regurgitation. C. Modified mid-oesophageal aortic valve short-axis view showing a small left-right shunt suggestive of patent foramen ovale. D. Transgastric 2-chamber view showing lead tip at the antero-lateral wall.