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# Inadvertent Lead Malposition in the Left Ventricle during Permanent Ventricular Pacing about One Case

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## Abstract

Inadvertent Lead Malposition in Left Ventricle is a rare and underdiagnosed incident, which may occur during implantation of cardiac electronic devices and may remain asymptomatic. We reported the case of a 71-year-old man who was implanted with a ventricular single-chamber pacemaker for a slow atrial fibrillation with syncope and whose routine transthoracic echocardiography 23 months after implantation displayed a malposition of the pacemaker lead into the Left Ventricle through a patent foramen oval. The patient was asymptomatic. The electrocardiogram showed right bundle branch block QRS-paced morphology with a positive QRS pattern in V1, a median paced QRS axis on the frontal plane at −120˚, a Precordial transition on V5. At the lateral Chest X-ray the lead curved backwards to the spine. Given the age of this old patient who already received oral anticoagulant for Atrial Fibrillation and the Lead malposition discovered 23 months after pacemaker's implantation, we decided to maintain the lead in LV and continue anticoagulation.

## Keywords

Lead Malposition, Left Ventricle Lead, Right Bundle Branch Block, Ventricular Pacing, Transthoracic Echocardiography

## 1. Introduction

Inadvertent lead malposition in the Left Ventricle (ILMLV) is a rare and underdiagnosed incident, which may occur during implantation of Pacemakers (PM) or Implantable cardioverter-defibrillator (ICD). The first case was reported in 1969 by Stillman and Richards [1], and since then only relatively few additional

cases have been published. We present a case of malposition of a PM lead into Left Ventricle (LV) as an unexpected finding during transthoracic echocardiography (TTE).

## 2. Case Report

A 71-year-old man was referred in July 2023 to our echocardiography laboratory. The patient had a history of arterial Hypertension and suffered in the past from symptomatic slow Atrial Fibrillation (AF) with syncope. Therefore, in August 2021, he was implanted with a ventricular single-chamber (VVI) PM with prescription of rivaroxaban. At our TTE examination, in parasternal long-axis view an echo bright linear structure was seen in left atrium passing through mitral valve and leaning against posterior LV wall; in short-axis and apical views it was seen to cross the interatrial septum (Figure 1(A), Figure 1(B)). Furthermore, a left-to-right shunt was displayed at this level. Inappropriate lead placement in LV was diagnosed with the lead passing through a patent foramen ovale (PFO), then moving into the Left Atrium and through the mitral valve orifice into the LV (Figure 1(A), Figure 1(B)). No thrombi were detected attached to the lead. At the PM control, ventricular pacing was 82%; electrical parameters were in normal ranges (threshold 0.5 V at 0.4 ms; sensing 15.6 mV, and lead impedance 465 ohms). The electrocardiogram (ECG) showed right bundle branch block (RBBB) QRS-paced morphology with a positive QRS pattern in V1, and a negative QRS pattern in DI. The median paced QRS axis on the frontal plane was −120˚. Precordial transition was on V5 (Figure 2). A Chest X-ray was taken: the lead seemed correctly positioned on the postero-anterior (PA) view, while it curved backwards at right atrium (RA) level on the 30˚ OAG view, thus suggesting electrode misplacement into LV (Figure 3(A), Figure 3(C)). The

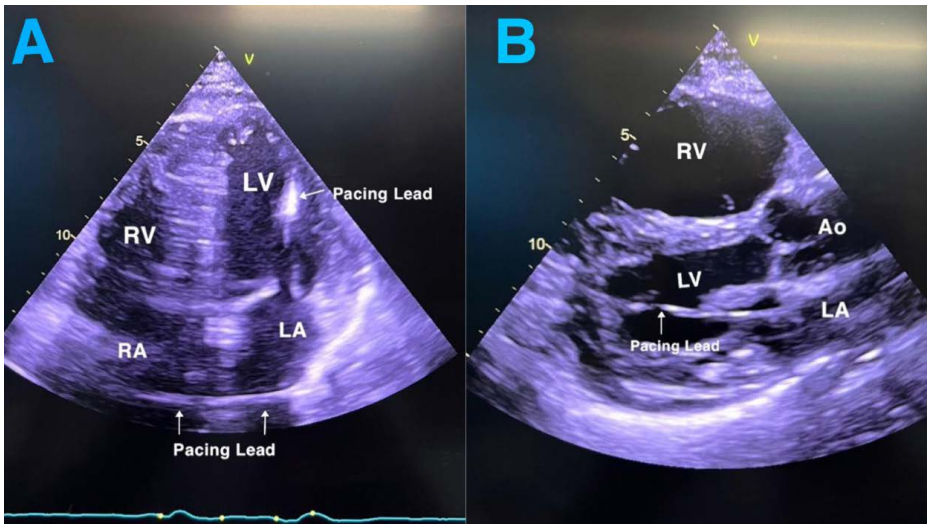


Figure 1. Composite image of Transthoracic Echocardiographic images from the apical window (A) and parasternal long axe (B). The pacing Lead can clearly be seen passing from right atrium (RA) to Left Atrium (LA) through the patent foramen ovale and then into the Left Ventricle (LV). Aorta (Ao), Right Ventricle (RV).

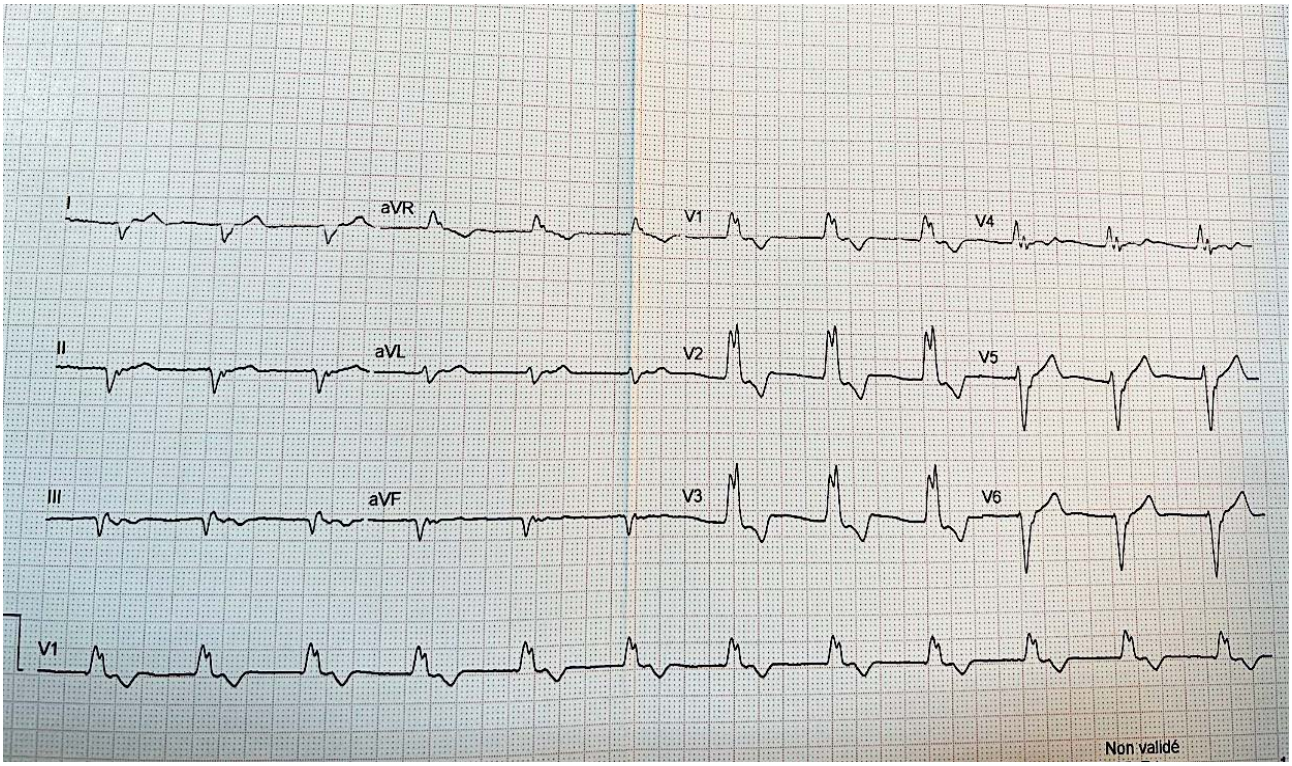


**Figure 2.** 12-Lead Electrocardiogram (ECG) during ventricular pacing showing right bundle branch block (RBBB) morphology of the QRS complex with a frontal plane axis of −120˚. Transition on V5.

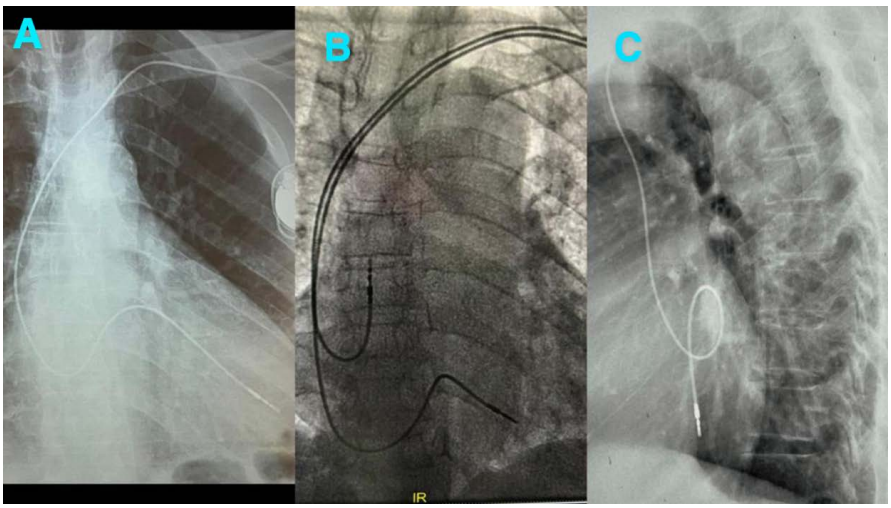


**Figure 3.** Our Patient's Chest X-ray: posteroanterior (A) and lateral (C) views indicating the pathway of the lead in the two projections. (A) The ventricular lead is positioned higher in the postoanterior view (A) than the standard position in Right ventricle of a patient without lead malposition (B); (C) Malpositioned LV lead is characteristically steered toward the spine and appear posterior, close to the spine.

patient was asymptomatic at the time of diagnosis of ILMLV. Two treatment strategies were then addressed: maintenance of the lead in the LV position with continuation of anticoagulant versus lead extraction. Given the age of our 71-year-old patient who already received oral anticoagulant for Atrial Fibrilla-

tion and the Lead malposition discovered 23 months (730 days) after pacemaker's implantation, we decided to maintain the lead in LV and continue anticoagulation with warfarin 5 mg with a target international nominal ratio of 2.5 - 3.5.

## 3. Discussion

ILMLV is a rare complication, which may occur during implantation of cardiac electronic devices; in a cohort of over 2579 patients receiving a cardiac stimulator between 2007 and 2012, a lead malposition was found by Ohlow and al in 0.34% of patients in a single-center study [2]. ILMLV may be recognized either during the procedure or at a variable time distance spanning from days to years. [3] [4]. The median time from implantation to diagnosis was 365 (30 - 1642) days according to a systematic review of published cases of inadvertent lead malposition inside the left atrium or the left ventricle [3]. Anatomic variations largely account for lead misplacement into LV during the implantation of a cardiac device [1] [2] [3] [4] [5]. The most common route is through the interatrial septum, and PFO is the most frequent cause, as in our patient. ILMLV has been also associated with ventricular septal defect [1] [6] [7], atrial or ventricular septal perforation or arterial puncture [3] [7]. If the malposition is diagnosed after discharge from hospital, which may occur in up to 40% of cases, the diagnosis can be driven by a variety of clinical complications [3] [6]. However, this condition might remain silent even for a very long time [3] [6]. In a systematic review, 46% of patients with ILMLV were asymptomatic at the time of diagnosis [3]. However, possible complications of a malpositioned lead into the LV are systemic thromboembolic events such as ischemic strokes at around 37% which may occur from 6 months to 6 years after implantation of the lead [6]. One early-symptomatic case of ischemic stroke with left homonymous hemianopia one day post-insertion of a dual-chamber permanent pacemaker was presented by Primero *et al.* [8]. Other significant complications of ILMLV included perforation of the mitral valve or of the LV wall, mitral valve regurgitation due to the malpositioned lead bending the valve leaflets, risk of aortic and mitral valve infectious endocarditis [9], and higher probability of diaphragmatic pacing and loss of capture [4]. Fortunately, none of these complications occurred in our patient whose malpositioned lead was diagnosed by chance during a routine TTE. Many other cases of ILMLV were displayed by a routine follow-up transthoracic echocardiogram [3] [5] [10]. TTE is the imaging tool of choice to confirm the exact position of the lead and trace its route [9] [10] [11] [12] or to show a thrombus adherent to the lead. Transesophageal echocardiography (TEE) should be done if TTE is not clarifying [3] [10] [11]. In our case, the malpositioned lead was clearly detectable by TTE.

Malposition may also be diagnosed through ECG or Chest X-ray [3] [5]. Most of the patients with LMLV have a RBBB pattern at ECG, a QRS transition after V3, a median paced QRS axis on the frontal plane around −120˚ [5] [10]. Typical QRS morphology during RV stimulation has most of the time a left bundle

branch block pattern and a RBBB pattern may suggest a LMLV but an atypical RBBB pattern may also be related to myocardial scar (with consequent conduction block). It may also be due to pseudo-fusion in patients with underlying RBBB [3] [13]. Furthermore, a "pseudo-RBBB pattern" in V1 - V2 has been described (8% - 20% of the patients during RV pacing) [14] [15]. Indeed, by lowering V1 and V2 to the fifth intercostal space, known as the Klein's maneuver, the RBBB pattern disappears and results in inscription of a QS complex when the pacing electrode has been correctly positioned [15]. This may be due to a "true" non-apical RV stimulation, but it may also be related to RV morphology/orientation (*i.e.* RV dilatation). Furthermore, a precordial transition at or before the lead V3 essentially rules out inadvertent LV pacing, situation in which the transition is after V3. [13]. The ECG of our patient was consistent with this algorithm suggesting LV activation with a precordial transition at V5. The postoperative Chest Radiograph is also a valuable aid for identifying lead malposition [5] [16]: 40˚ LAO or RAO projection is the clarifying view. On the 40˚ LAO view the tip of a malpositioned LV lead is characteristically steered toward the spine and it will appear posterior, close to the spine in RAO. On the posteroanterior (PA) chest X-ray the lead malpositioned in the LV may be hardly distinguishable from the one correctly implanted in the RV. Careful analysis of the chest X-ray before discharge can allow identification of LMLV in most patients, because the tip of the malposed lead is displaced more superiorly and leftward in the antero-posterior view compared to the standard position in the right-sided chambers [6] [16]. Only a PA X-ray view was taken after the implantation of our patient and this might explain the missed diagnosis at discharge.

Management of ILMLV is not well defined due to limited data and absence of international guidelines; Therefore, the treatment of these patients remains controversial [6] [7] [8] [9] [17]. There are two possible options: remove the catheter from the LV and place it in the RV, or leave it in place and start lifelong anticoagulation treatment [2]. The behavior depends on the implantation time, the age of the patient, the clinical presentation and occurrence of complications. If diagnosis is made during or immediately after implantation, immediate percutaneous lead removal is suggested without the need for lifelong anticoagulation [17]. When diagnosis is delayed, after discharge of hospital, lead extraction has been suggested as the most reasonable therapy, and it can be performed either percutaneously or surgically [3] [7] [17]. A multidisciplinary team approach is key in choosing the most appropriate treatment [8] [17]. Percutaneous lead extraction has been reserved for high surgical risk patients or those with recently implanted leads (less than one year) and has been performed successfully up to 9 months or up to 12 months after implantation, according to studies, after a search for thrombus adherent to the lead by TTE or better by TEE [3] [4]. Surgical lead extraction might be the preferred strategy when leads are old, more than one year or show a high thrombotic burden and when concomitant defects need surgical correction or if cardiac surgery is needed for other reasons [7]

[10]. The patients who are old (more than 70 years), who remain asymptomatic may opt for lifelong anticoagulation with warfarin with maintain of international nominal ratio between 2.5 and 3.5, which can protect against risk of stroke and transitory ischemic attack [3] [6] [10] [16] [17]. The use of direct oral anticoagulants has not been explored in this setting [7] [8]. Antiplatelet therapy does not seem to be effective for the prevention of cerebrovascular events in case of ILMLV [3] [6] [8]. If cerebral embolic events occur, catheter extraction should be reconsidered [3] [6] [8]. Decision of extraction or conservative maintain of lead in LV depends according many studies on different parameters [3]. It seems that the patients who underwent lead extraction are younger (less than 70 years) ($p = 0.014$), implanted in more recent years ($p = 0.002$) and diagnosed earlier after implantation (less than 1 year) ($p < 0.0001$), when compared with those who are treated non-invasively [3].

Prevention of LMLV is essential. During lead implantation some simple maneuvers should be done routinely to avoid LMLV [3] [5] [13]. Cephalic vein cannulation virtually excludes the risk of arterial cannulation, compared to the risk carried by the subclavian or axillary approach [17]. The path of the guidewire to the right atrium must be checked before introduction of the dilator, to avoid the risk of arterial or aortic injury [5]. When the implantation is from the left side, the guidewire usually crosses the spine from the left to the right. Independently from the implantation side, the guidewire should always be advanced below the diaphragm into the inferior vena cava [5]. To position the atrial Lead, according to authors, the preformed guidewire can be rotated clockwise to orientate the lead towards the RA [5]. Finally, for the Ventricular Lead, it is recommended to cross the pulmonary valve whose projection is easily identifiable. Use of a 40˚ LAO or RAO fluoroscopic view at the time of implantation is also recommended [5] [17]. After implantation, a careful evaluation of the 12-lead ECG is very useful to confirm correct lead placement [1] [4] [5]. If there is a RBBB pattern, recording of leads V1 and V2 one intercostal space below the usual (Klein's maneuver) is recommended [15].

This case study highlights the importance of TTE in the diagnostic of ILMLV. ECG and lateral view Chest x-ray may also display this complication of electronic cardiac devices which is probably underreported.

## 4. Conclusion

ILMLV is uncommon, but it should not be misdiagnosed to avoid complications. This lead malposition may be discovered by a routine Transthoracic echocardiography. Post-operative ECG or Chest-Ray can diagnose the malposition. Decision of Lead extraction or conservative approach with lifelong anticoagulation depends on the age of the patient, the delay between the implantation and the diagnosis. This decision must be taken collegially by a multidisciplinary team, in order to choose the most appropriate and secure treatment for the patient.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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