European Heart Journal - Case Reports (2022) **6**, 1–5
https://doi.org/10.1093/ehjcr/ytac234

CASE REPORT
Arrhythmias/electrophysiology

Percutaneous extraction of a malpositioned subclavian arterial pacing lead using the retained wire technique and a vascular closure device: a case report

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Received 21 January 2022; first decision 11 March 2022; accepted 6 June 2022; online publish-ahead-of-print 10 June 2022

Background Inadvertent lead malposition (ILM) in the left ventricle (LV) via the subclavian artery is a rare complication during the insertion of cardiac implantable electronic devices (CIED). If not identified, there is a risk of systemic thromboembolism. Transarterial pacing lead extraction often requires surgical removal and carries high risks of bleeding and thromboembolism, but percutaneous extraction has also been previously described.

Case summary A 71-year-old female presented with left homonymous hemianopia on Day 1 post-insertion of a dual-chamber permanent pacemaker (PPM). A computed tomography (CT) angiogram of the brain and aortic arch revealed an acute occlusion of a branch of the right posterior circulating artery (PCA) and a malpositioned pacing lead in the left subclavian artery. Urgent percutaneous removal of the transarterial lead using the retained wire technique was successfully performed.

Discussion Inadvertent lead malposition in the arterial system is rare and often requires lead extraction due to systemic thromboembolic complications. The retained wire technique has been previously described for percutaneous transvenous lead extraction and exchange, but to our knowledge, we are the first to report utilizing this technique for transarterial lead extraction. Using a case report, we highlight the utility, safety, and effectiveness of the retained wire technique in extracting a malposition lead in the subclavian artery and LV.

Keywords Cardiac pacemaker • Lead malposition • Lead extraction • Vascular closure device • Stroke • Case report

ESC Curriculum 5.9 Pacemakers • 5.10 Implantable cardioverter defibrillators • 5.11 Cardiac resynchronization therapy devices

Learning points

- Percutaneous extraction of malpositioned subclavian arterial pacing leads can be safely performed using the retained wire technique and a vascular closure device.
- Early identification and treatment of inadvertent lead malposition are important to prevent complications of systemic thromboembolism.
- Various strategies and techniques should be utilized during pacemaker implantation to ensure the accurate placement of the pacing lead in the right ventricle.

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Handling Editor: Goksel Cinier
Peer-reviewers: Michael Spartalis and Chikezie Alvarez
Compliance Editor: Daniel Tardo
Supplementary Material Editor: Anthony Paulo Sunjaya

Introduction

Inadvertent lead malposition (ILM) into the left side of the heart, most commonly into the left ventricle (LV), is a rare complication of cardiac implantable electronic device (CIED) insertion. Ohlow *et al.*[1] reported an incidence of 0.34% in a single-centre retrospective study of 1764 patients undergoing CIED insertion. However, ILM through the subclavian artery, across the aortic valve, and into the LV is an extremely rare complication. The frequency of this complication is unknown, but is thought to be largely unreported.[2] We describe a case of a patient who had ILM in the LV via the subclavian artery, who subsequently suffered a stroke within 24 h of permanent pacemaker (PPM) insertion. We highlight the novel use of the retained wire technique and a collagen-based vascular closure device (VCD) for extraction of the transarterial pacing lead and closure of the subclavian arteriotomy site.

Timeline

Day 0	*Insertion of permanent pacemaker* - Cardiac pacemaker inserted for symptomatic Mobitz II second-degree atrioventricular (AV) block.
Day 1	*Stroke onset* - Patient found to have homonymous hemianopia. Computed tomography (CT) angiogram of brain and aortic arch vessels revealed acute occlusion of a branch of the right posterior circulating artery and a malpositioned lead in the left subclavian artery. - Anticoagulation with unfractionated heparin initiated.
Day 2	*Pacemaker lead extraction* - Insertion of new pacemaker lead into right ventricle. - Extraction of malpositioned lead using retained wire technique. Subclavian arteriotomy closed with collagen-based VCD.
Day 5	*Discharge from hospital with rehabilitation in the home* - Patient remained well, remaining independent with her activities of daily living at 3-months post-discharge.

Case presentation

A 71-year-old female with shortness of breath was found to be in intermittent Mobitz II second-degree AV block on 24 h Holter monitor. Her echocardiogram showed normal LV and right ventricular (RV) size and function. She was subsequently referred for an insertion of a PPM. Other relevant past medical history included type 2 diabetes mellitus, hypertension, and dyslipidaemia.

A dual-chamber PPM was inserted in the left infraclavicular position on Day 0 of hospital admission. Venous access was particularly difficult as the patient had morbid obesity. Eventually, a six-French bipolar active fixation lead was passed into the heart. Lead positioning was again difficult, but the lead was eventually fixed to a location with stable electrical parameters. Of note, there was increased intraprocedural bleeding, but haemostasis was achieved with manual pressure. Subsequently, a second subclavian venous puncture was used to introduce a bipolar active fixation lead into the right atrial appendage. Post-procedurally, a chest X-ray was performed (Supplementary material online, *Image 1*), and the electrical parameters remained satisfactory (pacing threshold of 0.5 V @ 0.4 ms, impedance of 440 Ω). Subsequently, the patient was admitted for overnight observation.

Figure 1 Pre-lead extraction CT aortogram. The malpositioned pacing lead (brown arrow) is seen in the ascending aorta, traversing across the aortic valve, and into the LV.

On Day 1, the patient complained of impaired peripheral vision on her left side, and was found to have left-sided homonymous hemianopia. Cardiovascular examination was unremarkable, with no murmurs detected. The rapid-response stroke team was activated. The patient underwent an emergent CT-angiogram of her head and neck, which revealed an acute occlusion of a branch of the posterior circulating artery (PCA). Incidentally, a malpositioned pacemaker lead was seen within the subclavian artery. A 12-lead electrocardiogram (ECG) showed a paced rhythm with a right bundle branch block (RBBB) morphology (Supplementary material online, *Image 2*), and a CT-aortogram confirmed the malpositioned lead in the LV (*Figure 1*). Mechanical thrombectomy and thrombolysis were not recommended as the occluded branch was small and there was increased bleeding risk given the recent procedure. Unfractionated heparin was initiated to prevent further thrombus propagation. After a multidisciplinary discussion between the cardiac surgeons, vascular surgeon, and cardiologists, we decided to attempt percutaneous extraction of the transarterial lead using the retained wire technique and closure using a VCD.

A six-French sheath was inserted into the left radial artery to provide an alternate access to the subclavian artery. An angiogram performed using a five-French Judkins right catheter showed the malpositioned LV lead in the subclavian artery with no evidence of active bleeding, pseudoaneurysm, or arteriovenous fistula (*Figure 2*).

A new transvenous six-French bipolar active fixation lead was inserted into the RV. Next, choosing a site just a few centimetres behind where the malpositioned lead entered the subclavian artery, a micropuncture needle was used to break and lift the insulation of the malpositioned lead (*Figure 3A*). A 0.014 inch coronary guidewire was inserted into the space between the insulation and outer conductor via the needle, which allowed for the guidewire and leads to be advanced together into the vascular space (*Figure 3B*). Once the tip of the guidewire was visualized in the ascending aorta, the guidewire was fixed and the pacing wire was advanced, freeing the guidewire into the intravascular space (*Figure 4*). The malpositioned lead was then extracted from the artery, and a six-French dilator was introduced over the coronary guidewire into the subclavian artery. The guidewire was then removed, and a 0.035 inch J-tip guidewire was inserted into the dilator. The dilator was exchanged for a six-French collagen-based VCD (Angio-Seal®), which was deployed to achieve immediate haemostasis. Subsequent angiograms showed a patent vessel with no active bleeding (*Figure 5*). Post-procedurally, the patient remained haemodynamically stable with no new neurological signs or symptoms.

The patient remained in hospital after the lead extraction, receiving post-stroke rehabilitation and was discharged back to her own home 5 days after the index procedure. During follow-up at 3 months, the patient was living independently at home and required minimal assistance with her activities of daily living.

Figure 2 Intraprocedural subclavian angiogram. Subclavian arterial angiogram using a Judkins right catheter (white arrow) showing the malpositioned lead in the subclavian artery (red circle). The right atrial lead is also seen in the subclavian vein (yellow arrow).

Discussion

We report a case of ILM into the LV via the subclavian artery which was successfully extracted using the retained wire technique and a collagen-based VCD. To our knowledge, this is the first reported case of transarterial lead extraction using this technique. The retained wire technique is well-described for use in the venous system, and is particularly useful in balloon venoplasty of severe subclavian stenosis during the extraction and replacement of transvenous pacing leads.[4] The advantage of this technique in transarterial lead extraction is that it maintains wire access through the same arteriotomy site of the extracted lead, which can be used to deploy a VCD to achieve rapid haemostasis.

Management of ILM in the left heart is not well defined due to limited data. If ILM is diagnosed early post-implantation of CIED (i.e. <12 months), removal via simple traction is usually possible.[5] In cases of chronic lead malposition (>1 year), a multidisciplinary team approach is key in choosing the most appropriate treatment.

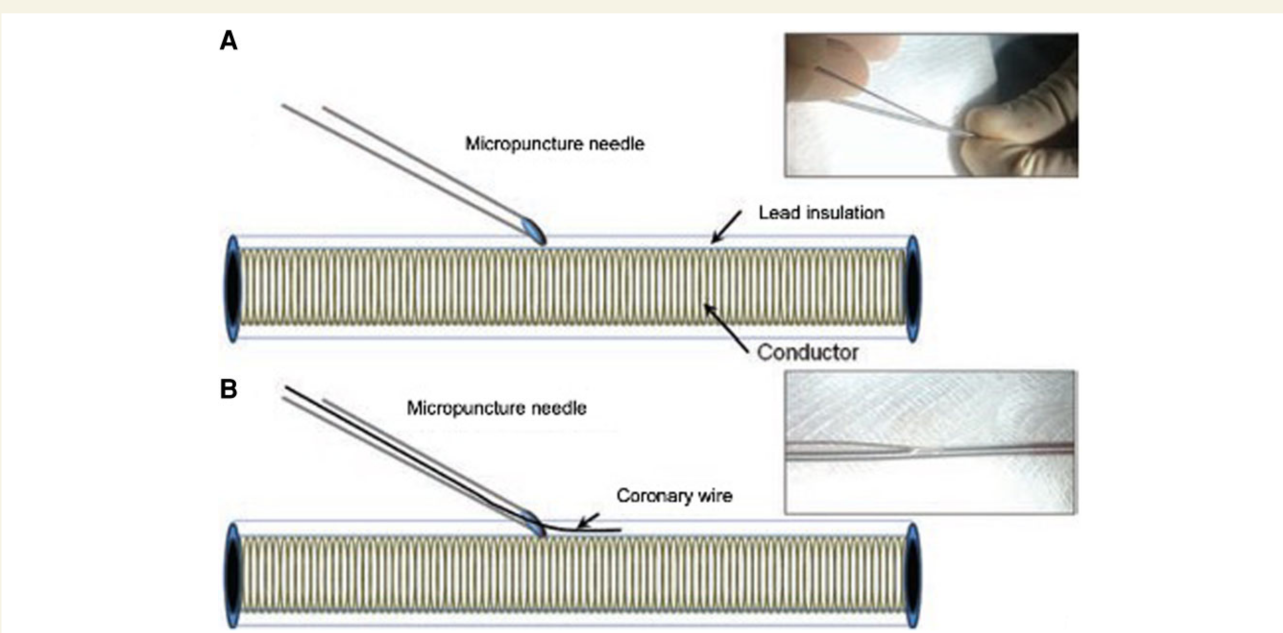

Figure 3 Diagram showing the coronary guidewire insertion technique using a micropuncture needle.[3] The micropuncture needle is inserted in between the lead insulation and conductor (*A*). The coronary guidewire is then advanced through the needle into the space between the insulation and conductor (*B*).

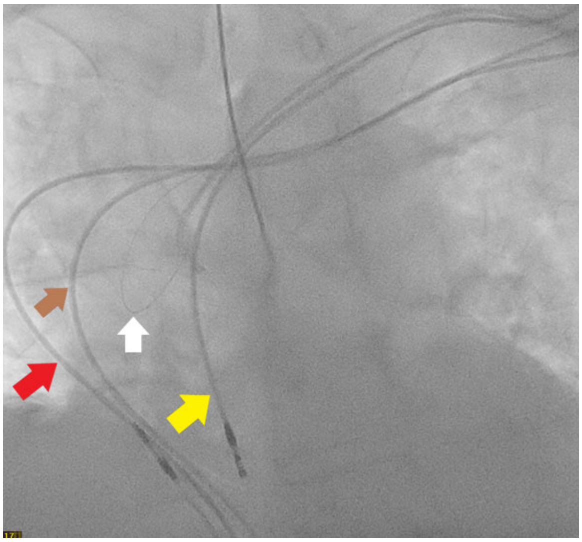

Figure 4 Intraprocedural fluoroscopy. Fluoroscopy showing the retained coronary guidewire (white arrow) and malpositioned RV lead (yellow arrow) in the ascending aorta. The newly implanted RV lead (red arrow) and RA lead (brown arrow) are also seen.

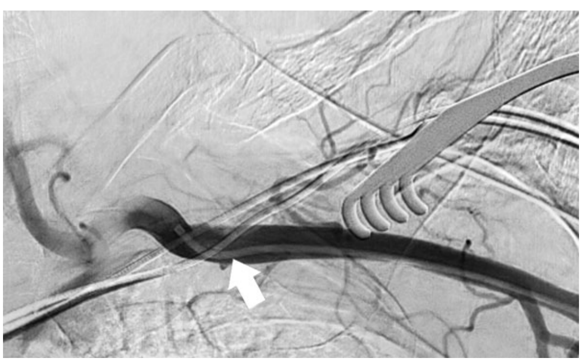

Figure 5 Post-lead extraction angiogram. Subclavian angiogram performed using a Judkins right catheter (white arrow) showed a patent vessel with no vascular complications.

Removal of transarterial leads which have fibrosed to neighbouring structures not only carries an increased risk of systemic thromboembolism, but also damage to the artery and cardiac valves. Such cases often require surgical removal and open repair of the artery which carries significant risks. Therefore, removal of chronic arterial leads is usually not recommended unless there is a compelling reason to do so (e.g. lead endocarditis with persistent bacteraemia).[6] If a conservative approach is adopted, long-term anticoagulation with warfarin can be considered, aiming for an international normalized ratio of 2.5–3.5.[1]

Percutaneous removal of leads from a non-compressive site such as the subclavian artery carries increased risks of complications, which include fatal haemorrhage, pseudoaneurysm formation, arterial dissection, and distal embolism. Percutaneous extraction has been utilized successfully, with balloon tamponade and covered stents being described previously.[7–9] Collagen-based VCDs are widely used to close femoral arteriotomies, but in order for these devices to be used, wire access into the vessel needs to be maintained once the lead is removed. The retained wire technique helps achieve this and represents a safe method to aid the deployment of a VCD.

There are several strategies that operators can adopt to help minimize the risk of ILM in the left heart. Firstly, the cephalic venous approach not only reduces the risk of accidental puncture of the subclavian artery, but also avoids complications associated with the subclavian or axillary venous approach. Secondly, a sheath in the arterial system is usually characterized by arterial pulsation, although this is harder to confirm in hypotensive and haemodynamically unstable patients. Thirdly, if venous access is obtained, the guidewire or pacing wire should be on the right side of the spine when advanced on anteroposterior (AP) fluoroscopy, and can also often be passed down the inferior vena cava. Conversely, a pacing wire in the arterial system is usually seen on the left side of the spine and will often prolapse against the aortic valve. However, a lead passing through a septal defect or patent foramen ovale into the LV can be difficult to recognize on AP fluoroscopy. In such cases, the left anterior oblique view can be useful in helping identify the malposition, with the lead crossing or pointing towards the spine in this projection.[10] Fourthly, unusual electrical parameters, which include poor sensing or pacing thresholds, or an abnormal electrogram appearance may suggest ILM. Finally, the presence of a RBBB pattern on the post-procedural 12-lead ECG should also raise suspicions of ILM. However, there are exceptions to this. Tzeis *et al.*[11] found that a RBBB configuration was seen in 16% of patients with a RV apical lead, likely due to placement of the pacing lead in the most posterior portion of the RV, which is relatively distant from the chest wall and early precordial chest leads.

This case report illustrates the feasibility of using the retained wire technique for transarterial pacing wire extraction and haemostasis. It also highlights the importance of considering ILM in patients presenting with embolic stroke early post-pacemaker implantation. Importantly, operators should be wary of accidental subclavian artery puncture, and adopt various strategies to ensure that the pacing lead is truly in the venous system. Early identification and intervention can help prevent embolic strokes, with lead extraction being the preferred treatment if the pacemaker was implanted within 12 months.

Patient consent statement

The authors confirm that written consent for submission and publication of this case report, including images and associated text, have been obtained from the patient in line with COPE guidance.

The patient gives her consent for the material presented about herself to appear in EHJ Case Reports and in related publications. It has been explained to her that the material has educational or scientific value and that publication may help to improve the care that others will receive in the future; however, the patient will not receive any financial benefit.

The patient had the opportunity to see and read the material (including the text and any other media – pictures, videos, etc.) to be submitted for publication and understand that the final publication may differ in style, grammar, consistency, and length.

The patient also understands:

(1) Although the publication is primarily aimed at medical professionals and academic researchers, it will potentially be freely available to the general public anywhere in the world without time limit and may be used for commercial purposes.
(2) Although the patient's name will not be attached and efforts will be made to protect anonymity, complete anonymity cannot be guaranteed, and it is possible somebody may recognize her from the information included in the article.
(3) The patient's consent and the material itself cannot be withdrawn after the material is approved for publication.
(4) The material may be used in full or in part, in any format or may be translated or used in other publications or products derived from this publication by its original publisher and other publishers.

Lead author biography

Primero Ng is a Cardiology Trainee working in Perth (Western Australia). Graduated from the University of Western Australia in 2014, he is currently in his final year of Cardiology training. His interests are in the many different aspects of interventional cardiology, and is planning to pursue a fellowship and career in structural and complex coronary intervention.

Supplementary material

Supplementary material is available at *European Heart Journal—Case Reports* online.

Slide sets: A fully edited slide set detailing these cases and suitable for local presentation is available online as Supplementary data.

Consent: Written informed consent was obtained from the patient for anonymized information to be published in this article.

Conflicts of interest: None declared.

Funding: None declared.

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