

Received: 2021.03.10

Accepted: 2021.08.31

Available online: 2021.09.20

Published: 2021.10.22

A 37-Year-Old Woman with Hypertrophic Cardiomyopathy with a Dual-Chamber Implantable Cardioverter-Defibrillator Requiring Percutaneous Transvenous Lead Extraction and Multidisciplinary Management

Authors' Contribution:

Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ADEF 1 **Rahul Dhawan***
ADEF 1 **Faris Khan***
EF 1 **Saurabhi Samant**
EF 1 **Majid Asawaer**
DEF 2 **HelenMari Merritt Genore** 
ADEF 1 **Christopher C. Erickson**

1 Department of Internal Medicine, Division of Cardiovascular Medicine, University of Nebraska Medical Center, Omaha, NE, USA

2 Department of Surgery, Division of Cardiothoracic Surgery, University of Nebraska Medical Center, Omaha, NE, USA

Corresponding Author:

* Rahul Dhawan and Faris Khan have equal contribution in writing this manuscript

Faris Khan, e-mail: fariskhan@gmail.com

Financial support:

None declared

Conflict of interest:

Dr. Christopher C. Erickson is a consultant for Medtronic, Inc.; Dr. HelenMari Merritt Genore proctors for AtriCure. All other authors have no conflict of interest to disclose

Patient: Female, 37-year-old
Final Diagnosis: Hypertrophic cardiomyopathy
Symptoms: None
Medication: —
Clinical Procedure: Percutaneous ICD lead extraction • Surgical ICD lead extraction
Specialty: Cardiac Electrophysiology • Cardiac Surgery • Cardiology

Objective: Diagnostic/therapeutic accidents

Background: Percutaneous transvenous lead extraction (TLE) of cardiac implantable electronic devices can be performed with a high success rate. However, TLE has its limitations and challenges. Recognizing the challenges at an early stage during the procedure is vital for appropriate patient management. We present a challenging case of implantable cardioverter-defibrillator (ICD) lead extraction in which we aborted TLE in favor of elective surgical extraction (SE). This potentially prevented a major catastrophic complication of vascular tear, which would have required an emergent thoracotomy.

Case Report: A 37-year-old woman with history of hypertrophic cardiomyopathy had a primary prevention dual-chamber ICD implant in 2001 and underwent right ventricular ICD lead revision in 2009 due to lead fracture. In 2019, she was again found to have right ventricular ICD lead malfunction. TLE was attempted, but no meaningful progression could be made despite using multiple extraction tools. Therefore, TLE was aborted in favor of SE. During elective SE, significant adhesions were noted, and the innominate vein was completely avulsed during removal of the leads, requiring venous reconstruction by the vascular surgery team. After SE and vascular reconstruction, an epicardial ICD system was placed, and the patient had an uneventful postoperative recovery.

Conclusions: This case report highlights the limitations of TLE and the importance of recognizing them in a timely manner. In all challenging cases, conversion to elective SE should be considered to avoid potential injuries warranting emergent surgical repair.

Keywords: Defibrillators, Implantable • ICD Lead Extraction • Transvenous Lead Extraction

Abbreviations: CT – computed tomography; ICD – implantable cardioverter-defibrillator; RA – right atrial; SE – surgical extraction; TLE – transvenous lead extraction

Full-text PDF: <https://www.amjcaserep.com/abstract/index/idArt/932073>



1295



3



12



Background

Despite the evolution of cardiac implantable electronic devices over the last few decades, lead malfunction can occur, requiring surgical or percutaneous transvenous lead extraction (TLE) [1]. TLE is not successful in all situations and may need to be aborted in favor of surgical extraction (SE). We present a case of a 37-year-old woman with history of dual-chamber implantable cardioverter-defibrillator (ICD), who required ICD lead extraction due to lead fracture [2]. This case report highlights the limitations of TLE, reasons for aborting TLE in certain intraoperative conditions, and the importance of multidisciplinary management in such cases to minimize the risk of major complications.

Case Report

A 37-year-old woman with history of G716R mutation in MYH7 gene for hypertrophic cardiomyopathy had a primary prevention dual-chamber ICD implant in 2001. She underwent TLE and re-implantation of a new ICD lead (6947 Sprint Quattro Secure, Medtronic, Inc, Minneapolis, MN, USA) in 2009 due to ICD lead fracture (Guidant model 0147, Boston Scientific, Marlborough, MA, USA) along with a pulse generator exchange. She was referred to our hospital in 2019 when she was again found to have an ICD lead malfunction with sudden increase in lead threshold. No high-risk features or patient activities were identified that could have led to ICD lead malfunction, except that it was a retro-pectoral implant. A chest X-ray at presentation is shown in **Figure 1A**. Differential diagnoses of lead failure included conductor fracture, coil fracture, or an insulation breach. This patient had a sudden increase in capture threshold of ICD lead with significant noise (short V-V intervals), indicating a pace-sense conductor fracture.

ICD therapies were turned off to avoid inappropriate shocks and a LifeVest® (Zoll Medical Corporation, Pittsburgh, PA, USA) was ordered. All available options were discussed with her, including capping the malfunctioning ICD lead with re-implantation of a new lead versus lead extraction (TLE and SE, if indicated), followed by re-implantation of a new ICD lead. Given her age and anticipated needs of future lead revisions, it was decided to extract the malfunctioning ICD lead percutaneously with re-implantation of a new ICD lead.

During the extraction procedure, a 16-Fr GlideLight™ laser sheath (Philips, Amsterdam, Netherlands) and a TightRail™ (Philips, Amsterdam, Netherlands) mechanical extraction tool were used, but the innominate vein/superior vena cava junction could not be crossed due to significant lead-on-lead and lead-on-wall binding sites. During the TLE attempt, unwinding of the ICD lead was observed. The RA pace-sense lead (5076

Capsure Fix Novus [Medtronic Inc, Minneapolis, MN, USA]) also started to disintegrate; therefore, it was decided to extract the RA lead as well. RA lead extraction was attempted using a 14-Fr GlideLight™ laser sheath (Philips, Amsterdam, Netherlands) followed by a 16-Fr GlideLight™ laser sheath (Philips, Amsterdam, Netherlands), but no progress was made beyond the point where the ICD lead had significant adhesions. Since the lead-on-lead and lead-on-wall binding sites prevented any meaningful progression of extraction tools, the TLE procedure was aborted. Cardiovascular surgery was consulted for staged elective SE. A chest X-ray after the aborted TLE procedure is shown in **Figure 1B**. Computed tomography (CT) of the chest with contrast before TLE showed no evidence of venous stenosis or occlusion in left-sided chest veins. Despite no evidence of large-vein obstruction, CT angiography before SE demonstrated significant left-sided venous collateral vessels.

Elective SE was done the following day via a standard median sternotomy approach. The left innominate vein was noted to have a contained tear with both leads densely adherent to the vein. The tear continued back to the confluence of the left subclavian and jugular veins and began to bleed during exposure. Signs of collateralization were noted, suggestive of prior occlusion or at least compromise of the left innominate vein. Due to the dense adhesions, the innominate vein was completely avulsed during removal of the leads (**Figure 2**). Vascular surgery was consulted to assist due to significant vascular disruption. Ligation of left internal jugular vein and left subclavian vein was done. The right internal jugular vein was reconnected to the heart via pericardial patch reconstruction, with the left side left in discontinuity due to the presence of collaterals. All of this was performed on cardiopulmonary bypass support. Surgical removal of the leads and vascular reconstruction was followed by implantation of an epicardial single-chamber ICD system. Two unipolar single-coil ICD leads (6937A and SQ 6996, Medtronic, Inc, Minneapolis, MN, USA) and a single bipolar pace-sense epicardial electrode (Capsure Epi 4968, Medtronic, Inc, Minneapolis, MN, USA) were connected to a pulse generator (Visia AF MRI, Medtronic, Inc, Minneapolis, MN, USA). The patient had an uneventful postoperative recovery. A chest X-ray after the surgical procedure is shown in **Figure 3**.

Discussion

This case highlights the importance of early recognition of TLE limitations as well as the need to abort TLE in certain intraoperative situations. As noticed during elective SE, any further TLE attempts in this case would have resulted in a major vascular tear requiring emergent surgery. Elective involvement of a surgical team for staged SE in these situations can prevent potential catastrophic complications.

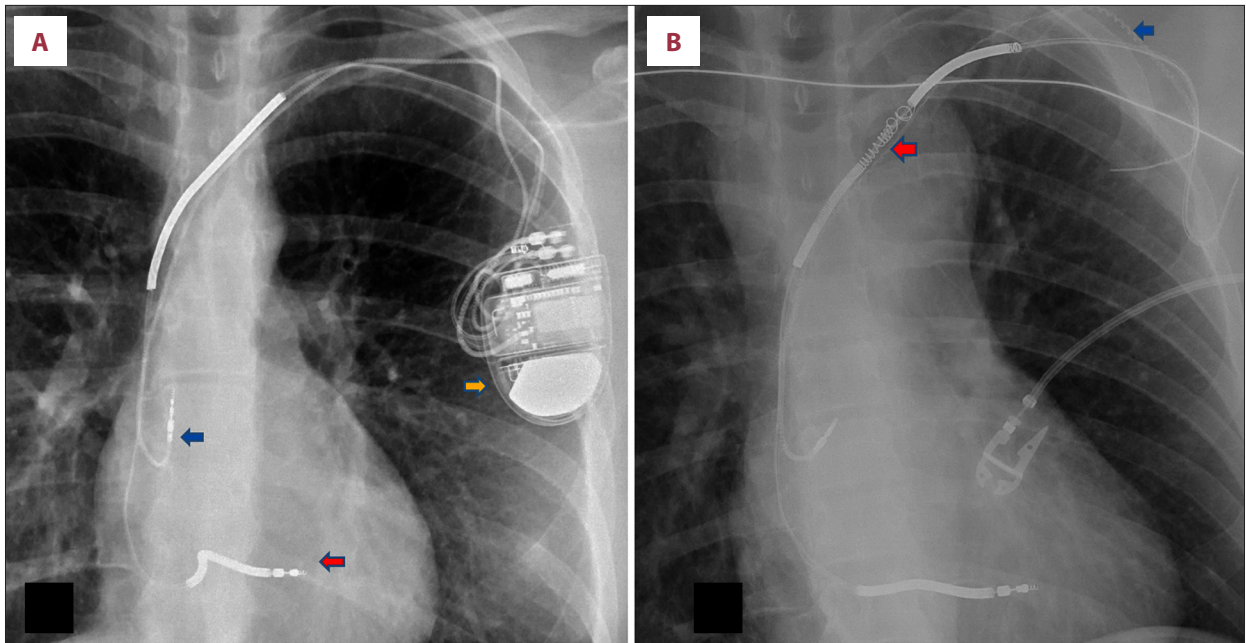


Figure 1. Chest X-ray before implantable cardioverter-defibrillator (ICD) extraction (A) showing pulse generator (Evera S DR, Medtronic, Inc, Minneapolis, MN, USA) (orange arrow) attached to right atrial pace-sense lead (5076 Capsure Fix Novus, Medtronic, Inc, Minneapolis, MN, USA) (blue arrow) and right ventricular defibrillator lead (6947 Sprint Quattro Secure, Medtronic Inc, Minneapolis, MN, USA) (red arrow). Chest X-ray after transvenous lead extraction attempt (B) showing removal of Medtronic device generator and unwinding of right atrial pace-sense lead (blue arrow) and right ventricular defibrillator lead (red arrow).

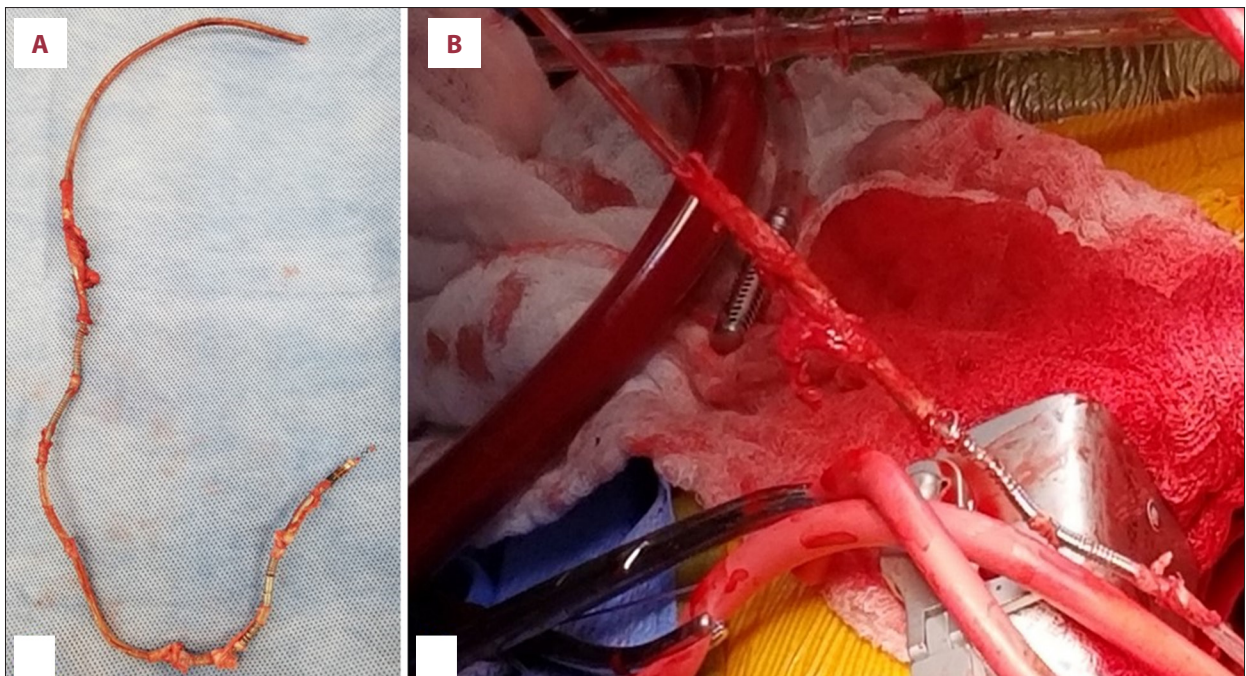


Figure 2. Extracted implantable cardioverter-defibrillator lead with adherent segments of innominate vein (A). Innominate vein avulsion over the lead during surgical extraction (B).

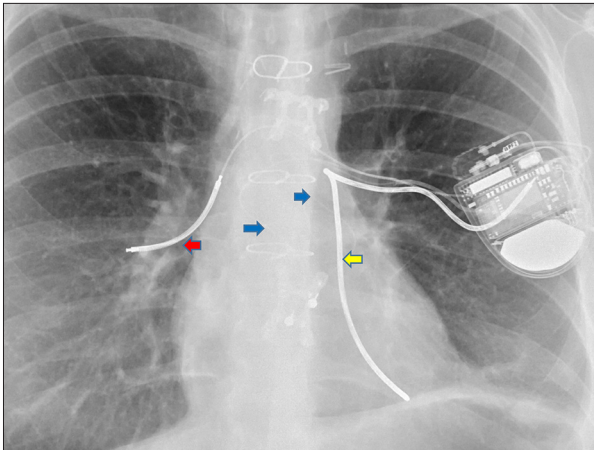


Figure 3. Chest X-ray after surgical extraction and implantation of an epicardial implantable cardioverter-defibrillator (ICD) pulse generator system (Visia AF MRI, Medtronic, Inc, Minneapolis, MN, USA) with 2 unipolar single-coil ICD leads (first lead is 6937A, Medtronic, Inc, Minneapolis, MN, USA) placed along the right thoracic surface in the intrathoracic fascia lateral to the mammary gland; red arrow, and second lead is SQ 6996 (Medtronic, Inc, Minneapolis, MN, USA) placed along the left pericardial surface deep to the phrenic nerve; yellow arrow, and a single bipolar pace-sense epicardial electrode (Capsure Epi 4968, Medtronic, Inc, Minneapolis, MN, USA) placed on the anterior surface of the heart (blue arrows).

Most cases of lead malfunction require implantation of a new lead(s) while capping or extracting the malfunctioning lead(s). SE is less often favored for lead extraction [3] due to higher morbidity, as well as availability of increasingly advanced TLE tools [4]. However, TLE is not without risks. The procedural complication rate of TLE varies from less than 1% to about 8% [1]. A study done on 3258 TLE procedures showed that around 0.8% patients had major complications requiring emergent surgery [5]. According to the National Cardiovascular Data ICD Registry™, 0.36% of patients undergoing TLE required emergent surgery due to complications, and one-third of those patients requiring surgery died [6]. The American Heart Association has highlighted the fact that these procedures require a team approach, including a primary operator, a cardiothoracic surgeon (who can be immediately available if need arises), anesthesiologist, echocardiographer, and assistants who could be nurses,

technicians or physicians [7]. There should be a low threshold to abort the TLE approach if no meaningful advancement is made using TLE tools. Important variables that are known to increase complication rate of TLE procedure are coagulopathy, female sex, low body mass index, cardiomyopathy, renal dysfunction, diabetes mellitus, thrombocytopenia, higher number of leads requiring extraction, presence of a dual-coil ICD lead, prior cardiac surgeries [1], and device infection [8].

A combination of TLE and minimal invasive surgery has been used as a hybrid approach in high-risk cases such as failed prior extractions, lead fractures, old age of lead, and more than 2 cm size vegetation or thrombus on leads [9-11]. The case presented above is different because a true hybrid approach was not planned. However, the Cardiac surgery team was available as a back-up for any unforeseen circumstances. The TLE approach was aborted due to the failure of meaningful progression during the procedure, and an elective sternotomy was planned the following day for SE. Benak et al reported a similar case in which TLE had to be aborted in favor of thoracotomy due to failure of progression [12].

Conclusions

Transvenous lead extraction (TLE) can be very challenging in certain cases. An experienced surgical back-up team is necessary for a safe and effective lead extraction program. Perioperative evaluation is critical to identify and make appropriate plans for high-risk cases. A multidisciplinary team approach must involve an electrophysiologist, cardiac surgeon, anesthesiologist, and cardiac radiologist. In addition, there should be a low threshold to abort the procedure if there is no meaningful progression during TLE. This is because continued attempts of TLE in some high-risk situations can potentially lead to catastrophic complications.

Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

References:

1. Kusumoto FM, Schoenfeld MH, Wilkoff BL, et al. 2017 HRS expert consensus statement on cardiovascular implantable electronic device lead management and extraction. *Heart Rhythm*. 2017;14(12):e503-51
2. Dhawan R, Asawaer M, Khan F, et al. Role of multidisciplinary approach for extractions of implantable cardioverter defibrillators. *J Am Coll Cardiol*. 2020;75(11 Suppl. 1):2634
3. Perez AA, Woo FW, Tsang DC, Carrillo RG. Transvenous lead extractions: Current approaches and future trends. *Arrhythm Electrophysiol Rev*. 2018;7(3):210-17
4. Bongiorno MG, Burri H, Deharo JC, et al. 2018 EHRA expert consensus statement on lead extraction: Recommendations on definitions, endpoints, research trial design, and data collection requirements for clinical scientific studies and registries: Endorsed by APhRS/HRS/LAHRs [published correction appears in *Europace*. 2018;20(7):1167]. *Europace*. 2018;20(7):1217
5. Brunner MP, Cronin EM, Wazni O, et al. Outcomes of patients requiring emergent surgical or endovascular intervention for catastrophic complications during transvenous lead extraction. *Heart Rhythm*. 2014;11(3):419-25

6. Sood N, Martin DT, Lampert R, et al. Incidence and predictors of perioperative complications with transvenous lead extractions: Real-world experience with national cardiovascular data registry. *Circ Arrhythm Electrophysiol.* 2018;11(2):e004768
7. Wilkoff BL, Love CJ, Byrd CL, et al. Transvenous lead extraction: Heart Rhythm Society expert consensus on facilities, training, indications, and patient management: This document was endorsed by the American Heart Association (AHA). *Heart Rhythm.* 2009;6(7):1085-104
8. Gomes S, Cranney G, Bennett M, et al. Twenty-year experience of transvenous lead extraction at a single centre. *Europace.* 2014;16(9):1350-55
9. Bontempi L, Vassanelli F, Cerini M, et al. Hybrid minimally invasive approach for transvenous lead extraction: A feasible technique in high-risk patients. *J Cardiovasc Electrophysiol.* 2017;28(4):466-73
10. Goyal SK, Ellis CR, Ball SK, et al. High-risk lead removal by planned sequential transvenous laser extraction and minimally invasive right thoracotomy. *J Cardiovasc Electrophysiol.* 2014;25(6):617-21
11. Migliore F, Cavalli G, Bottio T, et al. Hybrid minimally invasive technique with the bidirectional rotational Evolution® mechanical sheath for transvenous lead extraction: A collaboration between electrophysiologists and cardiac surgeons. *J Arrhythm.* 2018;34(3):329-32
12. Benak A, Kohari M, Besenyi Z, et al. Management of cardiac implantable electronic device infection using a complete interdisciplinary approach. *Herzschr Elektrophys.* 2021;32(1):124-27