Damage to the left internal mammary artery during anterior epicardial access for ventricular tachycardia ablation

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Introduction

Epicardial ventricular tachycardia (VT) ablation is increasingly performed in patients with recurrent VT in whom epicardial arrhythmogenic substrate is suspected. It is a preferred approach if the substrate for VT is located epicardially, such as in patients with arrhythmogenic right ventricular cardiomyopathy and nonischemic dilated cardiomyopathy. Moreover, endo-epicardial substrate homogenization may also be useful as a first-line therapy in patients with VTs after myocardial infarction,[1,2] especially in the presence of a transmural scar.[3] Complications in epicardial VT ablation can occur during pericardial puncture or can be caused by the ablation catheter. The most common cardiac complications are right ventricular perforation leading to pericardial bleed (4.5%),[4] and coronary vessel damage. Furthermore, because of the proximity of surrounding extracardiac structures and anatomic variance, one should be cautious for intra-abdominal, pleural, and vessel complications. We report 2 cases involving patients who had pericardial access for epicardial VT ablation that resulted in damage to the left internal mammary artery (LIMA).

KEY TEACHING POINTS

- One of the complications of a pericardial puncture is laceration of the left internal mammary artery (LIMA).
- An anterior approach is preferred to avoid right ventricular puncture.
- An anterior approach may be related to a higher incidence of LIMA damage.
- When approaching the pericardium, caution is needed during needle advancement to avoid a higher-than-usual puncture or needle take-off.
- A very anterior puncture can be avoided when the puncture needle is aimed at a minimum angle of 20° toward the anterior right ventricle silhouette. A preprocedural computed tomography scan can aid in avoiding LIMA puncture in cases of difficult anatomy.
- A pericardial drain with proximal side holes outside the pericardium is recommended to detect extrapericardial bleed that otherwise is left unnoticed.

Case reports

Case 1

We present a case of a 48-year-old man who was seen for a second opinion after multiple appropriate internal cardioverter-defibrillator (ICD) shocks for VT, which mostly occurred during exercise. Four years before, he had received an ICD for secondary prophylaxis. His ejection fraction was moderately reduced. Coronary angiogram revealed no epicardial stenosis, and cardiac magnetic resonance imaging showed a scar with the characteristics of a previous myocardial infarct in the inferoposterior region. He consented for a VT ablation and was planned for endo-epicardial scar homogenization in the context of the Epilogue trial.[5] After endocardial access, pericardial access via an anterior xiphoid puncture[6] was obtained without difficulty. Both the endocardial and epicardial voltage maps did not show areas of low voltage. VT induction led to hemodynamic instability, for which rescue electrical

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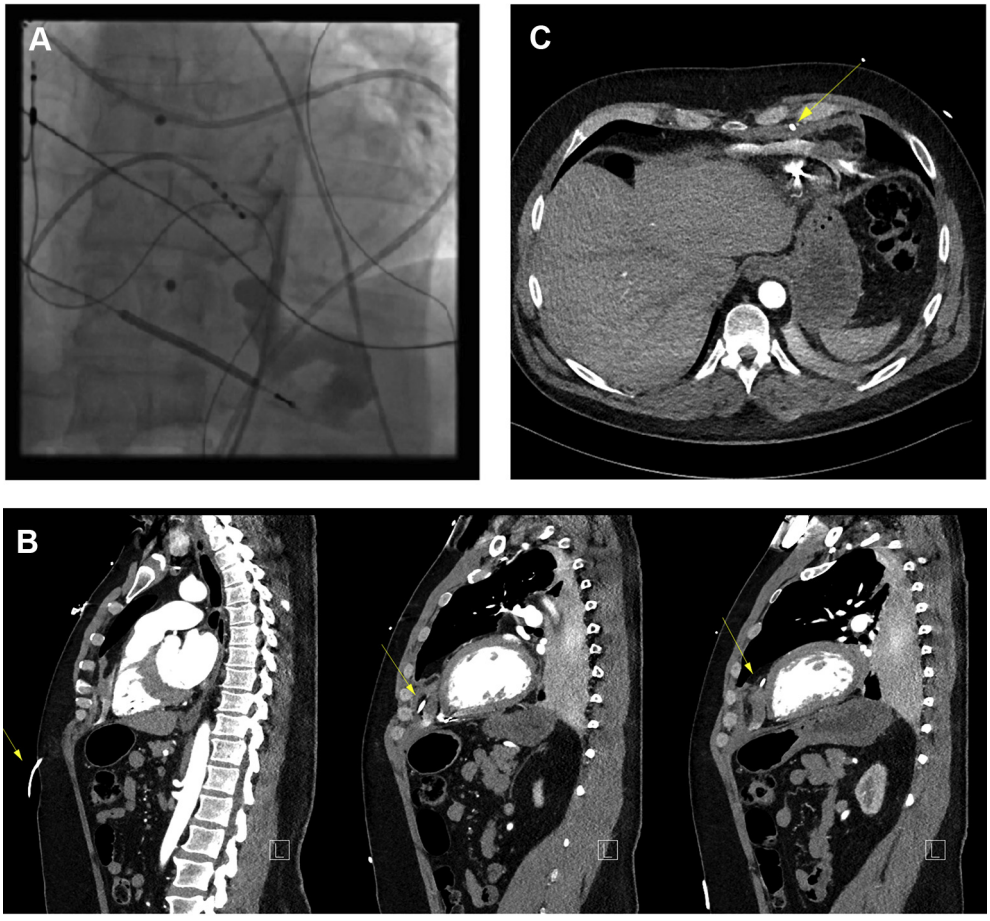

Figure 1 Damage to the left internal mammary artery (LIMA), patient 1. **A:** Fluoroscopy reveals contrast extravasation extrapericardially. **B:** Computed tomography (CT; sagittal view) demonstrates the anterior course of the pericardial drain. **C:** CT (axial view) shows that the pericardial drain is directly adjacent to the LIMA and courses through its side branch (*arrow*).

cardioversions were needed. The best depicted location by pace map was the inferior epicardium; however, during activation mapping this area was late. Therefore we did not proceed with radiofrequency ablation.

After we replaced the arrow sheath with a pericardial drain (Perivac, Boston Scientific, Marlborough, MA), blood was noticed. Contrast injection through a drain with proximal side holes demonstrated extravasation in the thorax and not the pericardium (Figure 1A). The patient remained clinically stable. A computed tomography (CT) scan confirmed a pericardial drain, positioned at an anterior position of the heart, that brushed a side branch of the LIMA (Figure 1B and C). Within a few hours after the procedure, the drain production stopped and the drain was removed without complications. With amiodarone therapy, the patient remained free of VT. In the absence of scar on 3-dimensional voltage mapping, a new diagnostic effort was made and a genetic form (*RMB20* mutation) of dilated cardiomyopathy was recognized.

Case 2

The second case involves a 62-year-old man with a known myocardial infarction and a moderately impaired left ventricle who had recurrent VTs, for which he received an ICD. He was scheduled for an endo-epicardial VT ablation[5] because of recurrent sustained VT. Angiography did not reveal novel coronary artery stenosis. Amiodarone and oral anticoagulation were withheld. VT ablation was performed under general anesthesia. To accomplish pericardial access, a subxiphoid anterior puncture was undertaken using a Tuohy needle. During the first puncture the guidewire aligned with the cardiac silhouette; however, it took off higher than the normal pericardial folds (Figure 2A). Advancing the guidewire further confirmed a localization in the pleural space (Figure 2B). In a second attempt, the needle unintendedly moved up over the epicardium, resulting in a pleural puncture. A third attempt resulted in successful pericardial access. Heparin was given and activated clotting time $>$ 250 seconds was targeted. Sequential endocardial and epicardial electroanatomic maps (CARTO 3 RMT, Biosense Webster, New Brunswick, NJ) revealed a large area of low-voltage signals and identified various late potentials (Figure 3A and B). During mapping, increasing inotropic support was necessary to treat hypotension. At a critical isthmus a few radiofrequency applications were given. The procedure was impeded because of

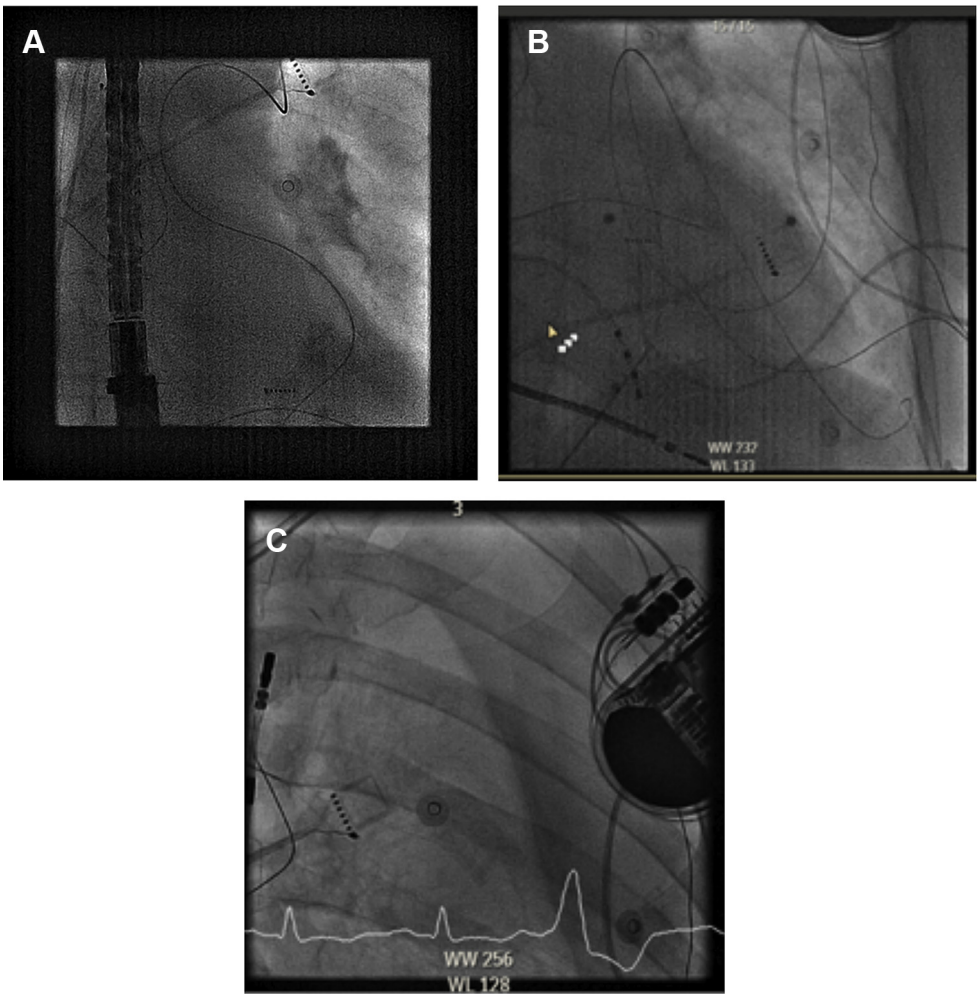

Figure 2 Fluoroscopy during and after pericardial puncture, patient 2. **A:** During the first puncture, the guidewire aligned with the cardiac silhouette. However, it took off higher than the normal pericardial folds. **B:** Advancing the guidewire further confirmed its localization in the pleural space. **C:** On fluoroscopy, extensive pleural fluid on the left thorax is seen.

therapy-resistant hypotension. Repeated fluoroscopy revealed extensive pleural fluid on the left thorax (Figure 2C). Immediate drainage of the pleural space resulted in 2 liters of blood. In the operating room emergency lateral thoracotomy was performed. A laceration of the LIMA near the 6th intercostal space was identified and repaired with a single suture. At follow-up the patient developed recurrent exudative pleural fluid.

Discussion

A LIMA laceration, a complication of a pericardial puncture, can remain temporarily concealed and may lead to a potential life-threatening condition.

We would like to emphasize the importance of understanding the anatomy and recognizing the person-to-person variability when performing epicardial VT ablation. The angle of a successful pericardial puncture is dependent on the rotation of the heart and the type and quantity of tissue that is crossed. High body mass index, pulmonary disease, and a history of abdominal operations are risk-elevating factors.

As an alternative, an anterior approach that directly accesses the fibrous pericardium without going through the diaphragm can be used. A conventional inferior pericardial puncture has been safely used, but still contains a limited risk of right ventricle and liver trauma.[7,8] Few complications so far have been described.[6] Since the runoff of the LIMA is more anterior, an anterior puncture in general may contain a higher risk of LIMA perforation.

CT is very helpful in delineating the structural relationship of the pericardium with other chest and abdominal organs. CT preceding epicardial VT ablation may prevent injury to unexpected structures during pericardial puncture.

Conclusion

Pericardial puncture may be complicated by a laceration of the LIMA. An anterior approach, preferred to avoid right ventricular puncture, can potentially increase the incidence of LIMA damage. Caution is needed during needle

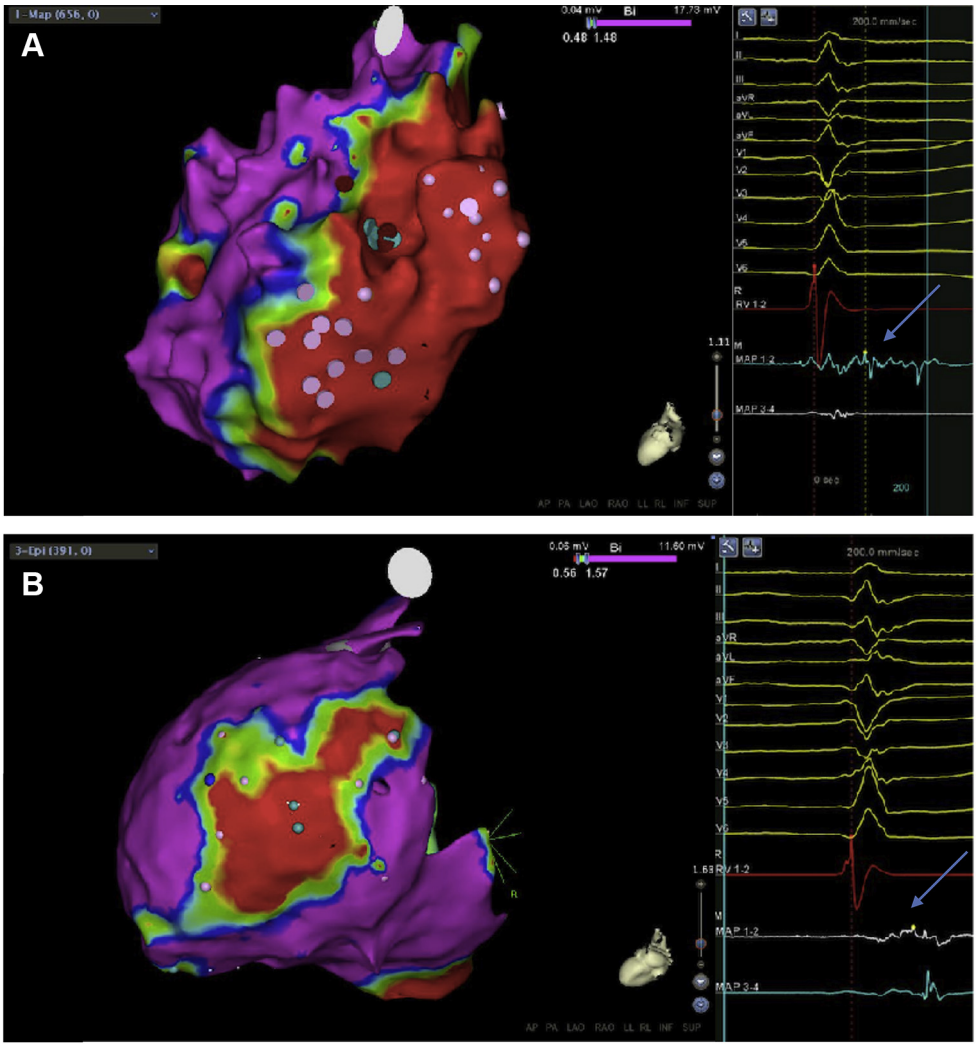

Figure 3 Endocardial and epicardial voltage map, patient 2. **A:** Endocardial map showing an area of low voltage, posterior view, and on the right an intracardiac electrogram revealing an abnormal potential. **B:** Epicardial map showing an area of low voltage, posterior view, and on the right an intracardiac electrogram revealing an abnormal potential.

advancement when approaching the pericardium to avoid a higher-than-usual puncture or needle take-off.

References

1. Di Biase L, Santangeli P, Burkhardt DJ, et al. Endo-epicardial homogenization of the scar versus limited substrate ablation for the treatment of electrical storms in patients with ischemic cardiomyopathy. J Am Coll Cardiol 2012;60:132–141.
2. Izquierdo M, Sánchez-Gómez M, Ferrero de Loma-Osorio A, Martínez A, Bellver A, Peláez A, Núñez J, Núñez C, Chorro J, Ruiz-Granell R. Endo-epicardial versus only-endocardial ablation as a first line strategy for the treatment of ventricular tachycardia in patients with ischemic heart disease. Circ Arrhythm Electrophysiol 2015;8:882–889.
3. Acosta J, Fernández-Armenta J, Penela D, et al. Infarct transmurality as a criterion for first-line endo-epicardial substrate–guided ventricular tachycardia ablation in ischemic cardiomyopathy. Heart Rhythm 2016;13:85–95.
4. Sacher F, Roberts-Thomson K, Maury P, et al. Epicardial ventricular tachycardia ablation a multicenter safety study. J Am Coll Cardiol 2010; 55:2366–2372.
5. Hendriks AA, Khan M, Geller L, Kardos A, de Vries LJ, Yap SC, Wijchers SA, Theuns DA, Szili-Torok T. Ventricular tachycardia in ischemic cardiomyopathy; a combined endo-epicardial ablation as the first procedure versus a stepwise approach (EPILOGUE) - study protocol for a randomized controlled trial. Trials 2015;16:487.
6. Lakkireddy D, Afzal MR, Lee RJ, et al. Short and long-term outcomes of percutaneous left atrial appendage suture ligation: results from a multicenter evaluation. Heart Rhythm 2016;13:1030–1036.
7. Ludwig DR, Menon PG, Fill B, Gartner M, Schwartzman D. A novel toolkit to improve percutaneous subxiphoid needle access to the healthy pericardial sac. J Cardiovasc Electrophysiol 2015;26:576–580.
8. Keramati AR, DeMazumder D, Misra S, Chrispin J, Assis FR, Raghuram C, Dey S, Calkins H, Tandri H. Anterior pericardial access to facilitate electrophysiology study and catheter ablation of ventricular arrhythmias: a single tertiary center experience. J Cardiovasc Electrophysiol 2017;28:1189–1195.