JACC: CASE REPORTS VOL. 1, NO. 4, 2019
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CASE REPORT

INTERMEDIATE

HEART CARE TEAM/MULTIDISCIPLINARY TEAM LIVE

Iatrogenic Left Internal Mammary Artery Perforation Treated With a Covered Stent Via Transradial Approach

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CME/MOC/ECME Objective for This Article: Upon completion of this activity, the learner should be able to: 1) rapidly recognize unusual complications from PM or ICD implantation; 2) identify LIMA injury or perforation during PM or ICD implantation; and 3) manage safely and quickly an unstable clinical condition caused by inadvertent LIMA perforation through a percutaneous radial approach with covered stents.

Author Disclosures: The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

Medium of Participation: Online (article and quiz).

CME/MOC/ECME Term of Approval

Issue Date: December 2019
Expiration Date: November 30, 2020

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Informed consent was obtained for this case.

Manuscript received September 18, 2019; accepted September 26, 2019.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2019.09.024

JACC: CASE REPORTS, VOL. 1, NO. 4, 2019
DECEMBER 2019:463–7

Iatrogenic Left Internal Mammary Artery Perforation Treated With a Covered Stent Via Transradial Approach

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ABSTRACT

Inadvertent perforation of the left internal mammary artery during a blind approach to the subclavian vein for pacemaker or central venous catheter insertion is an emergency that requires immediate treatment. Covered stent deployment is a quick and effective treatment, especially in patients with hemodynamic instability. The procedure may be safely performed by using the radial approach. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2019;1:463–7)
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A 71-year-old man with ischemic cardiomyopathy and severe left ventricular impairment was admitted at our institute for elective implantable cardioverter-defibrillator (ICD) insertion. The ICD implantation was planned through the standard left subclavian venous approach by using an 18-G needle with the Seldinger technique. After several unsuccessful attempts of venous puncture likely due to a deep location of the vessel, left arm venous angiography was performed to look for a venous obstruction and/or anomaly. The patient was asymptomatic, and the chest fluoroscopy did not show mediastinal hematoma or pleural effusion. Contrast medium slowing at the level of the axillary vein was detected (**Figure 1A**, Video 1). Immediately afterwards, severe hypotension occurred requiring infusion of plasma expanders with temporary stabilization of the blood pressure values.

The patient's medical history included ischemic cardiomyopathy determining severe left ventricular dysfunction treated with previous percutaneous revascularizations, persistent atrial fibrillation, nonsustained ventricular tachycardia episodes, and stage III renal impairment.

LEARNING OBJECTIVES

- The physician's goal should be to quickly suspect and recognize a LIMA injury or perforation.
- The treatment goal should be to treat safely and quickly, by using a percutaneous radial approach with covered stents, an unstable, deteriorating clinical condition caused by inadvertent LIMA perforation.

QUESTION 1: WHAT IS THE DIFFERENTIAL DIAGNOSIS AND WHAT KIND OF DIAGNOSTIC EVALUATION WOULD YOU SUGGEST AS FIRST LINE?

Answer 1: The differential diagnoses were pneumothorax and active arterial or venous bleeding.

Blind puncture of the subclavian vein for central venous catheter or pacemaker lead insertion is a common procedure associated with potentially serious complications ranging between 1% and 3% (1). These complications may include pneumothorax, arteriovenous fistula, subclavian artery and vein, or left internal mammary artery (LIMA) injury or perforation.

Our first thought therefore was to assess the exact site of bleeding by performing urgent computed tomography angiography (CTA). The examination revealed an active contrast medium extravasation from the proximal segment of the LIMA leading to hematoma of the antero-superior mediastinum compressing the left subclavian vein (**Figures 1B to 1D**).

QUESTION 2: WHAT IS THE RISK OF SUCH A COMPLICATION?

Answer 2: If unrecognized, vascular damages may lead to mediastinal and thoracic hematoma causing a rapidly worsening hemodynamic condition, thus requiring hemodynamic support (2). Perforation/damage of the LIMA occurs very rarely. The mortality of this complication varies depending on factors

related to the patient and the procedure performed, reaching 44% in patients with Ellis type III perforation. The prompt identification of the bleeding site (usually by CTA) is therefore mandatory to locate the site of bleeding and to determine the most appropriate treatment strategy.

QUESTION 3: WHAT TYPE OF CLINICAL MANIFESTATIONS ARE TO BE EXPECTED?

Answer 3: Regardless of the mechanisms of bleeding, hemodynamic impairment usually occurs rapidly, requiring pharmacological support and urgent diagnostic testing for the identification of the source of bleeding. In our patient, the difficulty in catheterizing the subclavian vein solicited the left arm venography to look for anomalous vein course, vascular malformation, or unknown thrombotic process. The detection of contrast medium slow flow at the level of the axillary vein suggested an ab-extrinseco compression of the vessel as a potential cause. At that time, the patient's condition rapidly worsened, and he developed symptomatic hypotension. The following CTA confirmed the proximal LIMA perforation with the hematoma compressing the subclavian vein.

QUESTION 4: WHAT IS THE MOST EFFECTIVE PROCEDURE TO SOLVE THIS TYPE OF VASCULAR COMPLICATION?

Answer 4: Treatment of this type of complication includes either a surgical or an endovascular approach. As for any vascular complication occurring during percutaneous maneuvers or interventions, endovascular repair should always be the first option, especially in critical patients, provided a suitable anatomy, a right device "on the shelf" (i.e., coils or covered stent), and extensive operator experience in peripheral interventions are available.

The rationale for coil embolization lies in the well collateralization of the LIMA that allows its sacrifice without increasing the risk of ischemia (3). Conversely, if damage occurs in a patient with a LIMA graft to the left anterior descending artery or in a patient who is a potential candidate for cardiac surgery because of extensive coronary artery disease, an alternative treatment strategy is preferred.

In the present case, the clinical, anatomic, and procedural conditions indicated an endovascular repair using a balloon-expandable covered stent via the left radial approach. To the best of our knowledge, this case is the first in which LIMA treatment was performed via the left radial approach. This strategy is preferred over the standard femoral route for the more favorable arterial pathway to LIMA ostium that speeds up target vessel engagement (with the aid of a dedicated diagnostic catheter) and offers better catheter support and stability. Balloon-expandable covered stents are commonly used in the coronary circulation to treat vessel perforation. Due to the double-stent layer design, trackability and deliverability of these devices may be suboptimal, especially in small, distal vessels.

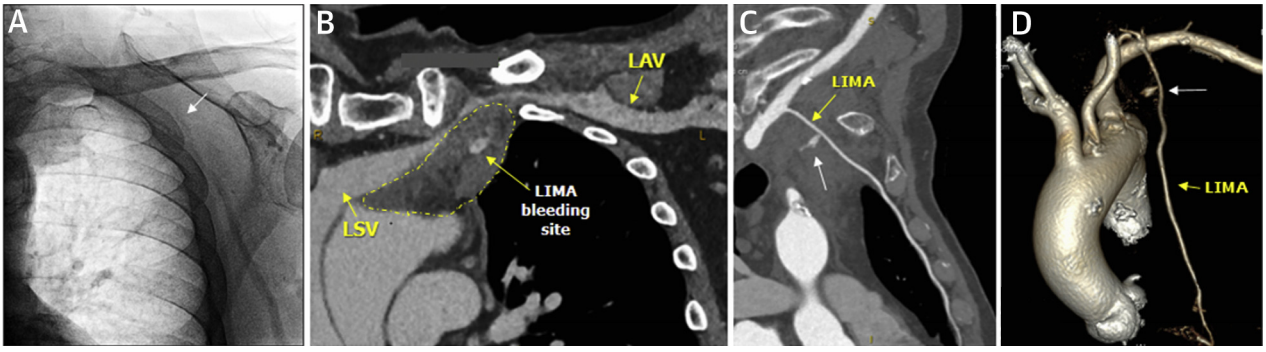
ABBREVIATIONS AND ACRONYMS

CTA = computed tomography angiography

ICD = implantable cardioverter-defibrillator

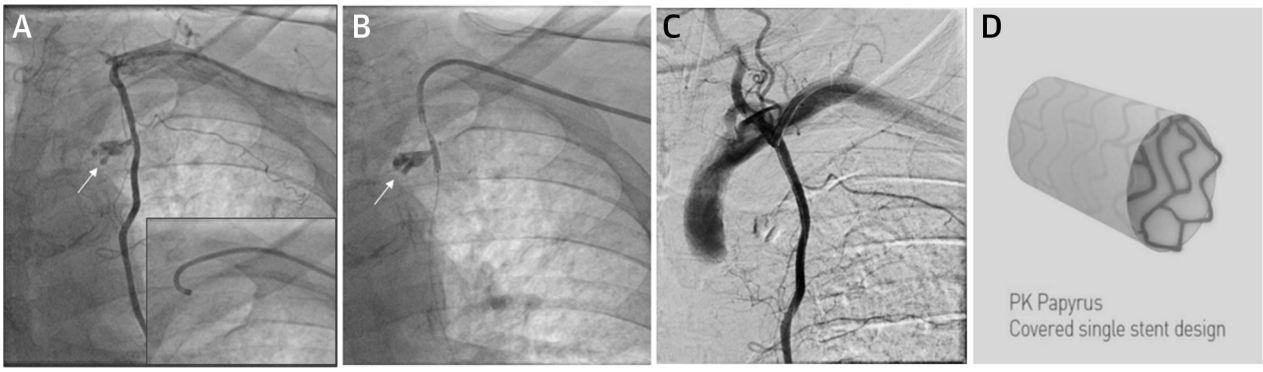
LIMA = left internal mammary artery

FIGURE 1 Venography and CTA Scan Images



(A) Left arm venography and **(B to D)** thorax computed tomography angiography (CTA) in the study patient. **(A)** A contrast medium slow flow at the level of the axillary vein **(arrow)** is shown. See Video 1. **(B)** Venous phase showing the wide hematoma **(yellow dotted area)** compressing the left subclavian vein (LSV). Contrast medium extravasation **(white arrow)** is detectable within the hematoma. **(C)** Arterial phase showing the bleeding site located in the proximal tract of the left internal mammary artery (LIMA) **(arrow)**. **(D)** Aortic arch and LIMA reconstruction (volume rendering). The **arrow** indicates bleeding site. LAV = left axillary vein.

FIGURE 2 Percutaneous Endovascular Treatment of LIMA Perforation



Selective engagement of the left internal mammary artery (LIMA) ostium with a 5-F dedicated diagnostic catheter with a reshaped distal tip (frame). Injection of the contrast medium highlights the bleeding site located in the proximal LIMA tract **(A)**. Covered stent implantation **(B)** and final angiographic view (digital subtraction angiography) showing complete sealing of the bleeding site **(C)**. **(D)** The PK Papyrus single stent design stent.

An alternative treatment should therefore be considered in these patients depending on the hemodynamic status of the patient and the severity of the perforation. These alternatives include medical management and close observation, urgent cardiac surgery, and microcoil/gel foam embolization (4).

In the current case, the interventional planning included a LIMA angiography via left radial artery approach (6-F sheath). Selective cannulation of LIMA was obtained with a 5-F IM dedicated diagnostic catheter (5), and the site of bleeding was confirmed (**Figure 2A**). A 0.014-inch coronary guidewire was positioned in the distal LIMA, and the diagnostic catheter was exchanged for a 6-F hockey-stick guide that was deeply intubated into the target artery. A 2.5-mm semi-compliant balloon was inflated at the bleeding site, and occlusion was checked by using contrast injection (**Figure 2B**). A covered coronary stent (PK Papyrus, 2.5 × 15 mm, Biotronik, Berlin, Germany) was then deployed and post-dilated with a noncompliant balloon leading to complete sealing of the arterial hole (**Figures 2C and 2D**).

QUESTION 5: WHAT ARE THE TECHNICAL CHARACTERISTICS OF THIS COVERED STENT?

Answer 5: The PK Papyrus stent is a cobalt-chromium single-stent design with proBIO amorphous silicon carbide coating, achieving 58% greater bending flexibility and a smaller crossing profile (1.25 mm vs. 1.63 mm) compared with the traditional sandwich design stent. The stent is 5-F guide-compatible.

QUESTION 6: WHICH ANTIPLATELET THERAPY SHOULD BE PREFERRED AFTER A COVERED STENT IMPLANTATION?

Answer 6: One major issue related to the use of covered stents is their inherent risk of stent thrombosis, thus requiring prolonged dual-antiplatelet therapy (at least 6 months) and their higher risk of in-stent restenosis. After adequate sealing of the perforation, dual-antiplatelet therapy with aspirin and clopidogrel should be restarted as soon as possible and extended for at least 6 months to decrease the risk of thrombotic occlusion.

The patient's recovery was uneventful. No significant decrease in hemoglobin levels requiring blood transfusion occurred. Single-chamber ICD was successfully implanted via the right subclavian approach with no further complications.

The patient was ultimately discharged on a chronic direct oral anticoagulant (apixaban 2.5 mg twice daily) plus clopidogrel 75 mg once daily.

CONCLUSIONS

Inadvertent LIMA perforation during percutaneous interventions may be associated with high-risk complications requiring prompt diagnosis and treatment. The ipsilateral radial artery approach with a dedicated diagnostic catheter makes LIMA cannulation and covered stent deployment an easy and effective treatment strategy to save a patient's life.

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KEY WORDS cardiac pacemaker, complication, hemorrhage, thoracic

APPENDIX For a supplemental video, please see the online version of this paper.

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