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CASE REPORT

Managing Coronary Artery Perforation in a Calcified, Tortuous, and Angulated LAD

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Abstract

Background: Coronary artery disease remains a leading cause of morbidity and mortality worldwide. Non-ST elevation myocardial infarction (NSTEMI) often presents with complex anatomical challenges, particularly in patients with significant coronary artery disease. Understanding the risks associated with various intervention techniques is essential for improving patient outcomes.

Case Presentation: A 78-year-old male, ex-smoker, with no known comorbidities presented with shortness of breath on exertion and chest pain classified as Canadian Cardiovascular Society (CCS) Class III. Initial evaluation on May 6, 2024, included echocardiography, which revealed an ejection fraction of 40-45% with severe hypokinesis of the apex and anterior wall. The ECG demonstrated sinus rhythm with deep T wave inversions in leads V2-V5. Coronary angiography indicated a short left main artery, a single-vessel disease with a tortuous and critically diseased proximal left anterior descending (LAD) artery, and mild disease in the right coronary artery (RCA) and dominant left circumflex artery (LCX). The patient was planned for percutaneous coronary intervention (PCI) to the LAD.

Results: During the PCI, a hydrophilic wire induced a perforation in the LAD. The lesion was subsequently crossed with a workhorse wire, and pre-dilation was performed using a semi-compliant balloon. Two drug-eluting stents (DES) were successfully placed. A relook angiogram conducted 48 hours later showed no signs of perforation and achieved TIMI 3 flow following post-dilation.

Conclusion: Coronary perforation is a recognized complication of PCI, particularly in patients with tortuous and angulated coronary vessels. While hydrophilic wires are beneficial for navigating complex anatomy, they carry a risk of dissection and perforation due to their poor tactile feedback. Careful management and monitoring during procedures involving challenging coronary anatomies are crucial for optimizing patient outcomes.

Keywords

Chronic Total Occlusion, Coronary Angiography, Percutaneous Coronary Intervention, Coronary Artery Perforation, Tortuosity, Wire Techniques.

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Introduction

Coronary artery disease (CAD) is a leading cause of morbidity and mortality globally, characterized by the narrowing or blockage of coronary arteries due to atherosclerotic plaque buildup[1]. This condition compromises blood flow to the heart muscle, increasing the risk of life-threatening events such as heart attacks and other cardiovascular complications. Acute coronary syndrome (ACS) is a critical manifestation of CAD and can present in various forms, most commonly unstable angina and non-ST elevation myocardial infarction (NSTEMI). These conditions are medical emergencies that require immediate diagnosis and intervention to reduce mortality and prevent further damage to the heart muscle[2].

The management of ACS is particularly complex in patients with intricate coronary anatomies, such as tortuous or highly calcified arteries, as these factors can complicate standard treatment procedures[3]. A key therapeutic approach for ACS is percutaneous coronary intervention (PCI), a minimally invasive procedure used to open blocked or narrowed coronary arteries. PCI, which typically involves the insertion of a stent to restore normal blood flow, has become a cornerstone in the treatment of obstructive coronary lesions and has significantly improved outcomes for many patients[4]. However, despite its effectiveness, PCI is not without risks. The procedure can be particularly challenging in patients with anatomically difficult coronary arteries, where the risks of complications, such as coronary artery perforation, increase substantially. These complications may arise when navigating calcified, tortuous, or angulated arteries, which require a high level of expertise and precision to manage effectively.

Coronary artery perforation, though relatively rare, is one of the most serious complications of PCI. It occurs when the coronary artery wall is breached during the procedure, leading to potential life-threatening consequences such as cardiac tamponade or hemorrhage[5]. Perforation is more likely in cases where the coronary anatomy presents unique challenges, making it crucial for interventional cardiologists to anticipate and manage these risks proactively.

In this case report, we discuss a 78-year-old male patient who presented with NSTEMI, characterized by chest pain and shortness of breath. Upon admission, echocardiography revealed an ejection fraction (EF) of 40-45%, indicating compromised cardiac function. Coronary angiography, performed via the right radial approach, unveiled a challenging coronary anatomy featuring a short left main artery, a tortuous and angulated left anterior descending (LAD) artery with significant disease in the proximal segment, and a mildly diseased right coronary artery (RCA). The left circumflex artery (LCX) was identified as dominant. After obtaining informed consent, the patient was planned for PCI to the LAD; however, the procedure was complicated by a hydrophilic wire-induced perforation, necessitating careful management and intervention.

Case Presentation

A 78-year-old male, an ex-smoker with no prior known comorbidities, was admitted through the emergency room due to shortness of breath on exertion for one week and chest pain classified as CCS Class III for three days. Initial evaluation on May 6, 2024, included echocardiography, which revealed an ejection fraction of 40-45%, severe hypokinesis of the apex and anterior wall, and mild mitral regurgitation. The right ventricle was functioning normally. The ECG demonstrated sinus rhythm with deep T wave inversions in leads V2-V5. The patient was hemodynamically stable, managed as NSTEMI with a TIMI score of 4, and was planned for left heart catheterization (LHC)

Diagnostic Assessment

Angiography was performed via the right radial approach using a Tiger catheter. Due to the short left main artery, engagement was challenging. The tortuous LAD exhibited sharp curves and critical diffuse disease in the proximal segment, accompanied by calcification (Figure 1). The LCX was dominant, and the RCA was non-dominant with mild disease. The patient was diagnosed with single-vessel disease (SVD), and PCI with drug-

eluting stent (DES) placement in the LAD was planned after obtaining informed consent.

Therapeutic Intervention

For the PCI, an EBU catheter was utilized to engage the left system. A hydrophilic wire was employed to cross the lesion but encountered significant resistance due to severe calcification and angulation. During the procedure, the patient experienced chest pain, and wire-induced perforation of the LAD was noted, leading to complete occlusion (Figure II B). A workhorse wire successfully crossed the lesion, and the artery was pre-dilated with a 2.0 x 15 mm semi-compliant balloon. A short DES (2.75 x 19 mm) was deployed in the perforated segment, resulting in no dye extravasation and achieving TIMI 3 flow distally. A second DES (3.0 x 38 mm) was placed from the ostium to the mid-LAD, overlapping the previously deployed stent. A follow-up angiogram demonstrated good TIMI flow, with no complications noted.

Post-stenting angiography was conducted after 48 hours, showing no signs of perforation or staining and patent stents. A non-compliant balloon (3.25 x 15 mm) was used for post-dilation. Final angiographic results confirmed good TIMI 3 flows.

Follow-Up and Outcomes

Post-procedure, the patient was admitted to the coronary care unit (CCU). Echocardiography revealed no signs of pericardial effusion, and other findings remained stable. Throughout the hospital course, the patient was clinically and hemodynamically stable, reporting no chest pain or shortness of breath. He was discharged on guideline-directed medical therapy (GDMT) with a plan for outpatient follow-up.

Discussion

Coronary artery perforation (CAP) is a recognized but potentially severe complication that can occur during percutaneous coronary interventions (PCI), with its incidence strongly linked to the complexity of coronary artery disease (CAD)[1]. The overall incidence of CAP in PCI procedures is about 0.43%, but this rate can rise significantly in high-risk situations, such as chronic total occlusions (CTOs), where the rate of perforation increases to approximately 2.9%. Cases involving CTOs are particularly challenging, as they require advanced techniques, including complex wire navigation, which increases the risk of vessel injury[3].

In the case at hand, which presented unique challenges. Hydrophilic wires, although helpful in traversing tortuous vessels due to their smooth coating, carry a significant risk of perforation due to poor tactile feedback. This complication is a well-documented risk in patients with angulated, calcified, or tortuous coronary vessels. In this case, the perforation was caused as the hydrophilic wire attempted to cross the lesion but encountered resistance due to the vessel's difficult anatomy. However, after the perforation, the lesion was successfully crossed using a workhorse wire, which typically provides better control and feedback than hydrophilic wires[6]. The procedure continued with pre-dilation using a semi-compliant balloon, which was followed by the placement of two drug-eluting stents (DES). DESs are known for their effectiveness in preventing restenosis and were crucial in managing the perforated vessel[7]. The choice of DES over bare-metal stents (BMS) also reflected an effort to reduce the risk of in-stent restenosis, which is particularly important in vessels with complex anatomy like the LAD in this case.

A relook angiogram, conducted 48 hours after the procedure, revealed no signs of perforation and confirmed the restoration of blood flow with TIMI 3 flow, indicating normal perfusion. This positive outcome following the perforation reflects effective management, with careful attention to post-procedural care and vigilant monitoring. The placement of the stents, followed by post-dilation, ensured that the artery remained patent, with no evidence of further complications such as tamponade or re-occlusion. The potential severity of CAP is further underscored by the possibility of developing cardiac tamponade, where blood leaks into the pericardial space, compressing the heart and impairing its function[8]. Even when timely pericardiocentesis is performed to relieve the

pressure, in-hospital mortality rates can exceed 5%, highlighting the life-threatening nature of this complication. Fortunately, in this patient, no tamponade or significant complications occurred, as confirmed by follow-up echocardiograms showing no pericardial effusion[9].

Several procedural factors are associated with an increased risk of CAP. In this case, the tortuous and calcified LAD represented a major risk factor. Heavily calcified vessels, angulated arteries, and narrow coronary arteries are prone to perforation during PCI because of the added difficulty in crossing and dilating the lesion. Additionally, the use of oversized balloons or stents, atheroablative devices, and excessive post-dilation can further exacerbate the risk of perforation. However, in this case, the semi-compliant balloon and subsequent non-compliant balloon used during post-dilation minimized the risk of further injury to the artery. Hydrophilic wires, such as the one initially used in this case, are often chosen to navigate tortuous vessels because of their flexibility and ease of movement through complex anatomies. However, their poor tactile feedback increases the risk of unintentional perforation[10]. Operators must carefully weigh the benefits of using such wires against the risks in cases involving complex coronary lesions. In contrast, the use of a workhorse wire after the perforation provided better control, allowing successful completion of the procedure without further complications.

The absence of intravascular imaging, such as intravascular ultrasound (IVUS) or optical coherence tomography (OCT), may have contributed to the perforation risk[11]. These imaging techniques enable real-time visualization of the vessel's structure, plaque characteristics, and stent placement, offering crucial information for precise wire manipulation and device selection. Without these tools, operators must rely on their judgment, increasing the risk of complications like perforation.

Conclusion

Coronary artery perforation remains a serious complication during PCI, particularly in patients with complex coronary lesions like the tortuous LAD in this case. The careful management of the perforation through the successful placement of drug-eluting stents and vigilant monitoring post-procedure were crucial in achieving a positive outcome. Awareness of the anatomical and procedural risks—such as the use of hydrophilic wires in challenging anatomies—can help mitigate the risk of CAP and improve patient outcomes. The successful use of workhorse wires and timely post-procedural angiographic evaluations were key to the favorable recovery of this patient.

Learning points

- Awareness of these anatomical variations is critical for avoiding complications, such as coronary artery perforation (CAP). Pre-procedural planning and careful selection of guidewires and stents can help reduce risks.
- Care should be taken when using such wires, especially in angulated or calcified vessels.
- Immediate recognition and management of CAP are crucial for patient outcomes. Regular follow-up with echocardiograms and angiography is necessary to monitor for potential late complications such as tamponade.
- The importance of GDMT in post-PCI patients cannot be overstated. Patients should be closely monitored post-procedure for recurrent symptoms, and appropriate therapies, including antiplatelet medications, should be initiated to improve long-term outcomes.
- Vigilant post-procedural care is essential, particularly in cases of coronary perforation. Serial echocardiography and repeat angiograms help ensure that the perforation has been adequately managed and that there is no development of pericardial effusion or other complications.

References

1) Shao C, Wang J, Tian J, Tang YD. Coronary artery disease: from mechanism to clinical practice. Coronary Artery Disease: Therapeutics and Drug Discovery. 2020:1-36.

2) Mir MA, Dar MA, Qadir A. Exploring the Landscape of Coronary Artery Disease: A Comprehensive Review. Am J Biomed Pharma. 2024;1(1):9-22.
3) Lugo-Gavidia LM, Alcocer-Gamba MA, Martinez-Cervantes A. Challenges and Advances in Interventional Cardiology for Coronary Artery Disease Management. Medicina. 2024;60(8):1323.
4) Lionakis N, Briasoulis A, Zouganeli V, Dimopoulos S, Kalpakos D, Kourek C. Spontaneous coronary artery dissection: A review of diagnostic methods and management strategies. World J Cardiol. 2022;14(10):522.
5) Yanagawa Y, Jitsuiki K, Ota S, Muramatsu KI, Kushida Y, Nagasawa H, Takeuchi I, Ohsaka H, Omori K, Ishikawa K. Significance of medical intervention for non-traumatic hemorrhagic cardiac tamponade. Am J Emerg Med. 2021;50:636-639.
6) Olorunfemi O, Alfonso CE. Revascularization of complex coronary lesions: the importance of vessel and plaque preparation strategies. InDebulking in Cardiovascular Interventions and Revascularization Strategies 2022 (pp. 181-220). Academic Press.
7) Mattesini A, Demola P, Parikh SA, Secco GG, Pighi M, Di Mario C. Material Selection. Interventional Cardiology: Principles and Practice. 2022:54-68.
8) Wilderman M, Tateishi K, O'Connor D, Simonian S, Ratnathicam A, Cook K, De Gregorio L, Hmoud H, De Gregorio J. Safety and efficacy of covered stent grafts in the treatment of emergent access related complications. Cardiovascular Revascularization Medicine. 2024.
9) Yamani N, Abbasi A, Almas T, Mookadam F, Unzek S. Diagnosis, treatment, and management of pericardial effusion-review. Ann med surg. 2022;80:104142.
10) Golub IS, Misic A, Schroeder LP, Aldana-Bitar J, Krishnan S, Kianoush S, Benzing T, Ichikawa K, Budoff MJ. Calcific coronary lesions: management, challenges, and a comprehensive review. AIMS Med Sci. 2024;11(3):292-317.
11) Hennessey B, Vera-Urquiza R, Mejia-Renteria H, Gonzalo N, Escaned J. Contemporary use of coronary computed tomography angiography in the planning of percutaneous coronary intervention. Int J Card Imaging. 2020;36:2441-2459

Figure/Video

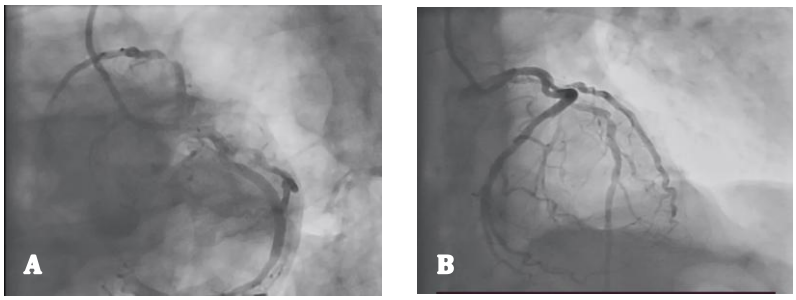

Figure 1A: Caudal angulation demonstrating the short left main artery and the tortuous proximal segment of the left anterior descending (LAD) artery.
Figure 1B: Cranial view highlighting the complexity of the coronary anatomy and the angulated trajectory of the LAD.

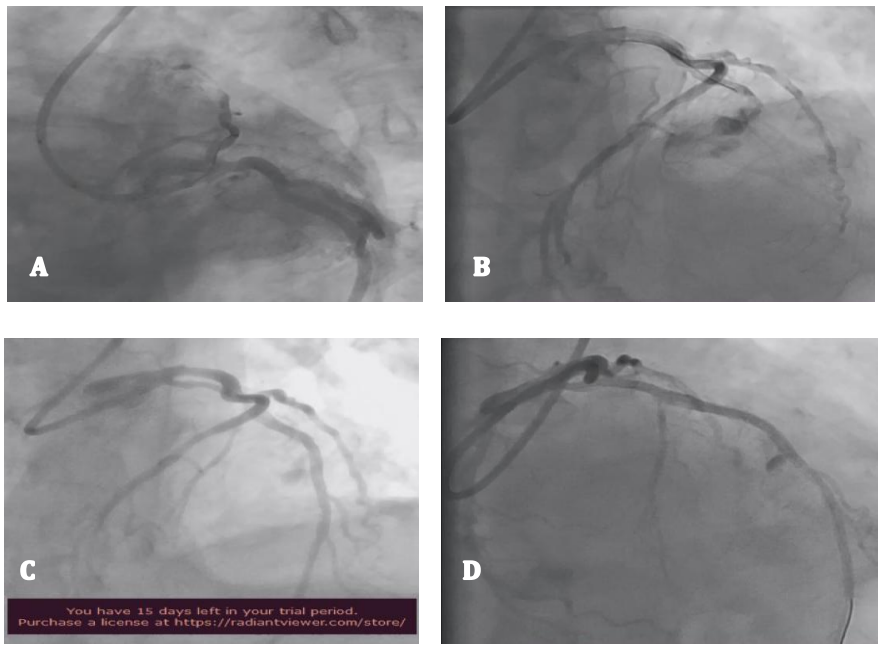

Figure 2A: Hydrophilic wire was used and try to cross the lesion
Figure 2B: Wire induced perforation was noted in LAD
Figure 2C: Angiographic results after 1st stent
Figure 2D: Results after DES 3.0x 38mm taken from Ostium to mid LAD, overlapping the previously deployed stent.

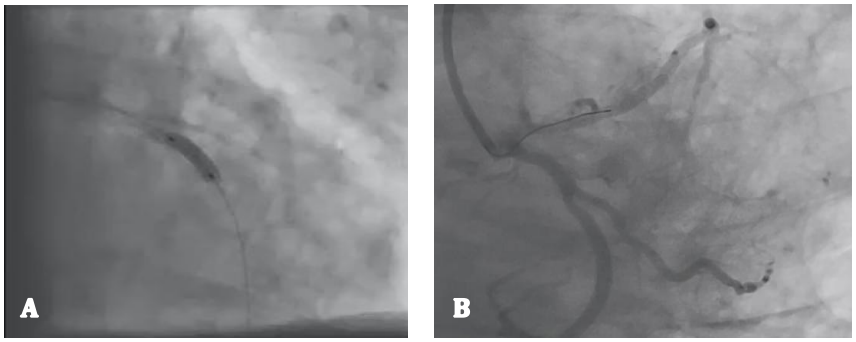

Figure 3A: Post dilation with NC balloon 3.25x 15mm B) Final angiography results shows good TIMI 3 flow.