CASE REPORT

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Insights into Coronary Artery Perforations: A Cath Lab Nightmare

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Abstract

Coronary artery perforation (CAP) is an uncommon yet clinically significant complication that may occur during percutaneous coronary intervention. Ongoing advances in interventional devices and techniques have enabled treatment of increasingly complex lesions, including heavily calcified or tortuous vessels and chronic total occlusions, thereby contributing to a higher incidence of CAP. Early recognition and implementation of appropriate treatment strategies are crucial for reducing mortality and complications associated with CAP. In this case series, we report nine cases of CAP that were successfully managed with timely recognition and appropriate intervention, achieving favorable in-hospital outcomes without in-hospital mortality or need for urgent surgical intervention.

Keywords: Coronary artery perforations, covered stents, percutaneous coronary intervention

INTRODUCTION

Coronary artery perforation (CAP) is an uncommon yet potentially life-threatening complication of percutaneous coronary intervention (PCI) which leads to serious complications such as myocardial infarction, pericardial effusion, cardiogenic shock, tamponade, and even death.[1] Ellis classified coronary perforations based on their angiographic appearances as follows: grade I (extraluminal crater), grade II (myocardial or pericardial blushing), grade III (prominent contrast streaming from a ≥1 mm tear), and grade IV (cavity spilling).[2,3] The risk of CAP increases in complex coronary anatomy and during the use of oversized balloons, high-pressure post-dilatation, atheroablative devices, hydrophilic guidewires, and in calcified or tortuous vessels.[2] Management strategies vary according to the severity of perforation and may include prolonged balloon inflation, covered stent implantation, pericardiocentesis, or surgical intervention.[4]

Despite its low incidence, CAP requires immediate recognition and timely intervention to prevent adverse outcomes. In this retrospective descriptive case series, we report nine angiographically confirmed cases of CAP encountered during PCI at a single tertiary care center over a one-year period. The present case series outlines the angiographic severity, procedural context, and management strategies employed in each case, providing a consolidated account of our institutional experience in the recognition and intraprocedural management of CAP.

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CASE REPORTS

Case 1

A 55-year-old female presented with symptoms of unstable angina and had a history of uncontrolled diabetes mellitus, and hypertension. Angiogram revealed 80% long segment stenosis (calcified lesion) in the proximal and mid left anterior descending artery (LAD) and 60-70% stenosis in the proximal obtuse marginal artery (OM1). Treatment included rotablation of the LAD using a 1.5 mm burr, followed by the deployment of a 2.75×48 mm drug-eluting stent (DES). Post-procedure, two perforations (Ellis grade III) were noted at the distal edge of the stent. Two attempts of intermittent sustained balloon tamponade were unsuccessful. Consequently, the patient was managed with a 2.8×16 mm GraftMaster™ RX coronary stent graft system (Abbott Vascular, Santa Clara, CA) (covered stent), yielding satisfactory results. The patient remained hospitalized for three days, during which a repeat echocardiogram showed minimal effusion.

Case 2

A 46-year-old female with a history of diabetes mellitus and hypertension was admitted to our tertiary care center with unstable angina. Electrocardiogram (ECG) showed T-wave inversions in lateral leads while the echocardiogram was unremarkable, demonstrating concentric left ventricular hypertrophy. Angiogram revealed 80% stenosis in mid LAD and thus the patient was treated with direct stenting to the diseased segment. Post-stenting, a perforation (Ellis Grade III) was noted at the distal edge of the stent, which was immediately addressed with intermittent prolonged balloon tamponade. However, this intervention failed after two attempts. For rescue, a 3.5×16 mm GraftMaster™ (covered stent) was deployed, which sealed the perforation after complete inflation. Post-procedure, the patient was hospitalized for four days. During this time, the patient experienced minimal pericardial effusion; however, this was successfully managed without any drainage.

Case 3

A 60-year-old male presented with chief complaints of breathlessness on exertion (New York Heart Association Class II) and exertional chest discomfort for the past eight to nine months. The patient's medical history included uncontrolled diabetes and coronary artery bypass grafting (five years ago), involving two grafts [reversed saphenous vein graft (rSVG) to OM1 and rSVG to posterior descending artery]. ECG and echocardiogram were normal. The coronary angiogram showed 85% occlusion in proximal rSVG-OM1 graft and 80% occlusion in the mid graft segment, 70% stenosis in proximal LAD, diffuse disease in the non-dominant left circumflex artery (LCX), and a totally occluded native right coronary artery (RCA) in the mid-segment with distal RCA filling retrogradely through collaterals. A 4.5×20 mm Supralimus Grace DES (Sahajanand Medical Technologies Limited, Surat, Gujarat, India) was deployed in the rSVG-OM1 graft. During this procedure, an Ellis grade I perforation was noted, which was attributed to overzealous inflation in a venous graft. However, the perforation was sealed spontaneously and was managed conservatively. Subsequent echocardiograms did not show any significant pericardial effusion.

Case 4

A 65-year-old male presented with anterior wall myocardial infarction. He was a chronic smoker, diabetic, and had a family history of coronary artery disease. Coronary angiogram revealed 95% stenosis in proximal to mid-LAD and 99% stenosis in proximal diagonal 1 (D1) branch. After successful thrombolysis with streptokinase, the patient underwent elective PCI to the LAD. The D1 and LAD both were wired because of the steep angle. Post-stenting, while performing non-compliant (NC) balloon inflation, an Ellis grade III perforation was observed at mid-LAD. Balloon tamponade was unsuccessful in halting the extravasation. Thus, a 3.5×19 mm GraftMaster™ stent (covered stent) was successfully deployed, sealing the perforation with no residual extravasation. Subsequently, the D1 and the proximal LAD lesions were successfully stented. Echocardiographic assessment following PCI demonstrated no pericardial effusion. The patient remained hemodynamically stable without the need for surgical intervention and was discharged after 48 hours of monitoring.

Case 5

A 70-year-old hypertensive male was admitted with acute onset retrosternal chest discomfort. The ECG showed inferior wall myocardial infarction for which the patient was treated with thrombolysis using streptokinase. An echocardiogram revealed hypokinesia in the territory of the RCA. Coronary angiogram revealed double vessel disease with 95% occlusion and diffuse disease in ostial to mid-RCA, as well as 99% stenosis in the distal segment of the non-dominant LCX. Consequently, an elective PCI was performed in ostial to mid-RCA. Post-stenting, a large Ellis grade III perforation was observed in the mid portion of the RCA, which was immediately managed using a 3.5×26 mm GraftMaster™ stent (covered stent) in the mid-RCA and a 3.5×19 mm GraftMaster™ stent (covered stent) in the proximal to mid-RCA. Post-procedure, the patient did not develop significant pericardial effusion. On the fourth day, the patient was discharged in stable condition.

Case 6

A 62-year-old male with a medical history of diabetes mellitus and hypertension was admitted for unstable angina. The ECG and echocardiogram were unremarkable. Coronary angiography revealed 90% occlusion of proximal LAD (at level of D1) and 90% stenosis in mid-RCA. After successfully stenting the RCA lesion, the LAD lesion was crossed using a wire and predilated with a 3×15 mm Sapphire II pro balloon (Orbus Neich). A check angiogram showed Ellis grade II perforation, attributed to the use of an oversized balloon in a smaller artery. This was managed successfully with a 3×29 mm DES. Post-procedure, the patient did not develop any significant pericardial effusion. Clinical stability was maintained, allowing discharge on the second day after the intervention.

Case 7

A 70-year-old hypertensive female was admitted for non-ST-segment elevation myocardial infarction. The ECG was suggestive of ST coving and T-wave inversion in the inferior leads, while the echocardiogram indicated inferior wall hypokinesia. Coronary angiogram revealed diffuse disease, with 85% stenosis in the mid and distal RCA and 80% stenosis in the ostial to mid-LAD with calcification. After successfully stenting RCA lesion, rotablation of the calcified LAD lesion was performed using a 1.5 mm rotablation burr. Following adequate lesion preparation, a 3×24 mm Biomime Aura DES (Meril Life Sciences Pvt. Ltd., India) was deployed in the mid-LAD. An Ellis grade III perforation was observed after NC balloon expansion. Balloon tamponade was immediately performed, followed by the implantation of a 3 ×19 mm covered stent. The ostial and proximal lesion were also covered with a stent after the perforation was sealed off. An echocardiogram showed significant pericardial effusion, which was drained using a pigtail catheter. Post-procedure, the patient remained stable and was discharged after seven days.

Case 8

A 62-year-old female with a history of diabetes mellitus and hypertension presented with chief complaints of exertional chest discomfort radiating towards the back and left shoulder for the past seven to eight days. The ECG was suggestive of biphasic T-waves in V2-V5, while the echocardiogram showed hypokinesia of anterior wall. Coronary angiogram revealed 70% stenosis in proximal RCA, 95% stenosis in mid-RCA and 80-85% stenosis in proximal LAD. After stenting the RCA lesions, the LAD lesion was crossed with a wire and after adequate lesion preparation, a 3×60 mm BioMime Aura DES was deployed in proximal to mid-LAD. Subsequently, a 3×12 mm NC Quantum Apex™ balloon at 12-18 atm (Boston Scientific, Natick, MA, USA) was used for inflation in the mid segment of the stent. After the procedure, an Ellis grade III perforation was observed. Therefore, balloon tamponade was performed immediately, followed by the deployment of a 3.5×26 mm GraftMaster™ (covered stent). The echocardiogram did not show any significant pericardial effusion. Post-procedure, the patient was stable and was discharged after three days.

Case 9

A 53-year-old diabetic male presented with chief complaints of exertional chest discomfort radiating to the back and left shoulder for the past seven-eight days. The patient had a medical history of acute coronary syndrome eight years ago, for which stenting was performed in the proximal to mid-LAD. ECG was suggestive of T-wave inversion in inferior leads, and the echocardiogram showed inferior and posterior wall akinesia. Coronary angiogram revealed 80% long-segment stenosis in the proximal to mid-RCA with a patent stent in proximal to mid-LAD. Elective PCI was performed in the proximal to mid-RCA using a 3×44 mm Supraflex Cruz DES (Sahajanand Medical Technologies Limited, Surat, Gujarat, India). Post-stenting, NC balloon was used for adequate stent deployment, after which a large Ellis grade II perforation was observed, which was managed conservatively with intermittent sustained balloon tamponade till the defect sealed off. Post procedure, no pericardial effusion was observed in echocardiography. Clinical stability was maintained, allowing discharge on the third day after the intervention.

Figure 1 demonstrates angiogram showing coronary perforation in each case. Summary of each case is represented in Table 1. As this was a retrospective descriptive case series involving standard clinical care, formal ethics committee approval was waived in accordance with institutional policy. Written informed consent for publication of clinical data and angiographic images was obtained from all patients.

DISCUSSION

In the present series of nine cases, CAP was categorized according to the Ellis classification, and management decisions were tailored based on angiographic severity and hemodynamic status. The perforations occurred during routine PCI procedures and were immediately recognized angiographically. These cases illustrate the intraprocedural decision-making process adopted in our catheterization laboratory.

Table 1. Summary of each case

Case no	Age (years)	Gender	Cause of perforation	Ellis grade	Treatment	In-hospital clinical outcome
1	55	Female	Distal stent edge perforation post-rotablation and DES	III	Covered stent	Minimal effusion; no drainage; discharged stable
2	46	Female	Distal stent edge perforation post-direct stenting	III	Covered stent	Minimal effusion; no drainage; discharged stable
3	60	Male	Overzealous balloon inflation in venous graft	I	Conservative	No significant effusion; discharged stable
4	65	Male	NC balloon overexpansion post-stenting	III	Covered stent	No effusion; discharged stable
5	70	Male	Post-stent deployment perforation in RCA	III	Covered stent	No significant effusion; discharged stable
6	62	Male	Oversized pre-dilatation balloon	II	Drug-eluting stent	No effusion; discharged stable
7	70	Female	NC balloon overexpansion post-DES	III	Covered stent	Significant effusion; pericardiocentesis done; discharged stable
8	62	Female	NC balloon overinflation	III	Covered stent	No significant effusion; discharged stable
9	53	Male	NC balloon overinflation	II	Balloon	No effusion; discharged stable

LAD: Left anterior descending artery, NC: Non-compliant, RCA: Right coronary artery, DES: Drug-eluting stent

Appropriate sizing of the guidewire and balloon is important in reducing the risk of CAP.[5] Initial management of CAP includes proximal balloon inflation to temporarily occlude antegrade flow and limit contrast extravasation, alongside prompt discontinuation of intravenous anticoagulation and correction of coagulopathy. This conservative strategy is often adequate for Ellis grade I and II perforations as well as distal vessel injuries to achieve haemostasis. In many cases, however, balloon tamponade serves only as a bridging measure until definitive therapy can be instituted.[6] The Ellis grade III and IV CAPs can lead to severe complications and may necessitate more invasive treatments, such as surgery or emergency pericardiocentesis.[7]

Covered stents have transformed the management of CAP. Expanded polytetrafluoroethylene covered stents have enabled treatment of CAP in catheterization laboratory, eliminating the need for emergency surgery especially for perforations in proximal and middle segments of large epicardial arteries. Studies indicate a high success rate for covered stent implantation, with angiographic success rates ranging from 92% to 96%. Currently, the implantation of covered stents is the treatment of choice for Ellis grade III perforations in arteries >2 mm diameter.[7] The Ellis grade III CAPs are particularly life-threatening and can induce a cycle of ischemia and tamponade physiology due to coronary blood extravasation. In managing these scenarios, balloon tamponade at the perforation site, along with pericardiocentesis and auto-perfusion is recommended. Simultaneous volume resuscitation and inotropic support are essential, with procedural efficiency improved by having a balloon catheter prepared and ready for rapid insertion.

A recently described double guide catheter technique has been introduced to minimize time loss during balloon deflation. In this approach, the target coronary artery is sub-selectively engaged using a 7F guiding catheter via second femoral access. While maintaining balloon inflation, the initial guidewire is withdrawn, after which the balloon is gradually deflated as the second guiding catheter is positioned to allow rapid delivery of definitive therapy. The covered stent is placed over-the-wire at the coronary perforation. Following successful management, a few minutes may be required to stabilize hemodynamics before performing a final check angiogram. In cases of Ellis grade III CAP, prompt notification of the cardiothoracic surgical team is essential, as surgical repair may be necessary if percutaneous measures are unsuccessful, although this is uncommon.[5]

Furthermore, several embolic agents have been reported for therapeutic use, including microcoils, polyvinyl alcohol particles, gelatin sponge, thrombin, fibrin glue, cyanoacrylate adhesive, newer agents such as Onyx, as well as autologous blood clots and fat. Microcoils are among the most feasible and commonly used methods for therapeutic embolization. Appropriately sized microcoils, typically selected up to 1.5 times the diameter of the target vessel, are deployed through microcatheters and promote sealing of the perforation by inducing thrombosis.[4]

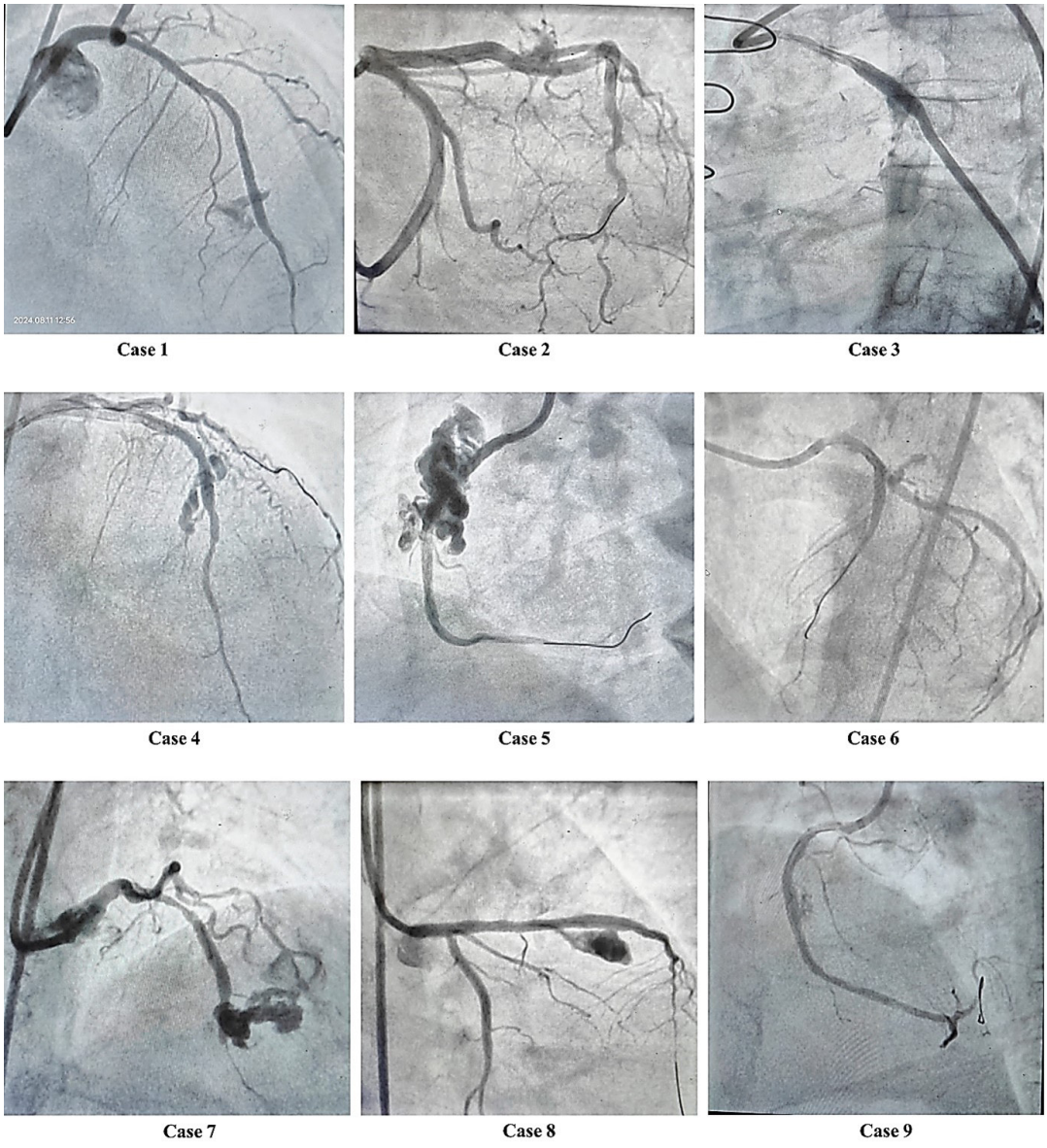

Figure 1. Angiogram showing coronary perforation in each case

Our experience from these nine cases emphasizes the importance of immediate angiographic recognition of CAP and prompt escalation of therapy according to perforation severity. By documenting cases encountered in routine clinical practice at a single tertiary care center, this series illustrates the spectrum of Ellis grades and the corresponding management strategies employed in real time. This report provides a consolidated institutional perspective on the recognition and intraprocedural management of CAP.

Study Limitations

This case series has several limitations. First, it is a retrospective descriptive case series without a predefined protocol. Second, outcomes are limited to in-hospital follow-up without systematic mid-term or long-term outcome assessment. Third, details regarding activated clotting time monitoring and protamine administration were not consistently documented in procedural records and therefore could not be systematically analyzed. Fourth, quantitative vessel-to-balloon ratios were not consistently documented in procedural records, limiting detailed analysis of device-to-artery sizing as a mechanism of perforation. Lastly, routine serial post-procedural cardiac biomarker measurements were not uniformly available for all patients, particularly those presenting with acute coronary syndromes and elevated baseline troponin levels. Therefore, biochemical myocardial injury specifically attributable to the perforation event could not be reliably assessed. Although no

patient developed hemodynamic instability, required urgent surgical intervention, or experienced in-hospital mortality, subclinical myocardial necrosis cannot be excluded.

CONCLUSION

In conclusion, this case series presents nine cases of CAP encountered during PCI, encompassing a spectrum of Ellis grades and varied procedural contexts. Management was guided by angiographic severity and hemodynamic status, with conservative measures proving adequate for lower-grade perforations and covered stent implantation required for higher-grade lesions. All cases were successfully managed during index hospitalization. This series highlights the importance of prompt angiographic recognition and timely escalation of therapy in the management of CAP and provides a descriptive account of real-world perforation management at a tertiary care center.

Ethics

Informed Consent: Written informed consent for publication of clinical data and angiographic images was obtained from all patients.

Footnotes

Authorship Contributions

Surgical and Medical Practices: S.P., P.M., Concept: S.P., P.M., Data Collection or Processing: S.P., P.M., Analysis of Interpretation: S.P., P.M., Literature Search: S.P., P.M., Writing: S.P., P.M.

Conflict of Interest: No conflict of interest was declared by the authors.

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