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Complications in Cath Lab – how to bail out

Complicações em Serviços de Hemodinâmica – como agir

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ABSTRACT - Various factors, including improved therapeutic interventions and advanced technologies, have led to better clinical outcomes for complex percutaneous coronary interventions. However, complications can still occur and have a negative impact on patient survival and healthcare costs. The risk of these complications can be reduced through experienced operators and preventative procedures. This article discusses a case series of five patients with specific periprocedural issues, such as coronary perforation, dissections, abrupt closure of the coronaries, and no-reflow phenomenon.

Keywords: Percutaneous coronary intervention/adverse effects; No-reflow phenomenon; Cardiology service, hospital

RESUMO - Vários fatores, incluindo intervenções terapêuticas aprimoradas e tecnologias avançadas, levaram a melhores desfechos clínicos nas intervenções coronárias percutâneas complexas. No entanto, ainda podem ocorrer complicações capazes de impactar negativamente na sobrevida do paciente e nos custos de saúde. O risco dessas complicações pode ser reduzido, por meio de operadores experientes e procedimentos preventivos. Este artigo discute uma série de casos de cinco pacientes com problemas específicos relacionados aos procedimentos, como perfuração coronária, dissecções, fechamento abrupto das coronárias e fenômeno de *no-reflow*.

Descritores: Intervenção coronária percutânea/efeitos adversos; Fenômeno de não refluxo; Serviço hospitalar de cardiologia

INTRODUCTION

Major complications of percutaneous coronary intervention (PCI) are rare, but improper management can result in severe consequences. In the past, complications were more frequent with balloon angioplasty, but now they occur less frequently, possibly once a year or even once in a career. In the United States,[1] over 600 thousand PCI procedures are performed annually, and in high-complexity procedures and risk patients,[2] it is essential to effectively avoid, recognize and manage complications associated with PCI. This can significantly impact patient outcomes and healthcare costs. Operators should be prepared to manage complications, especially when performing complex and high-risk procedures.[3] Unfortunately, there are limited opportunities for operator training in the management of complications.

Events such as coronary perforation, major dissection, no-reflow, and equipment entrapment are rare but can occur during routine PCI procedures. It is important to develop competencies to manage these complications. Nonetheless, many operators are unaware of how to recognize evolving complications and the interventions that can be used to reduce the risk associated with such events.[4] Additionally, many operators lack confidence in managing these rare events, which can result in under-treatment of coronary artery disease with appropriate clinical indications.

In this case series, we sought to include cases with the most common complications in day-to-day practice. To summarize, the following cases describe five different patients who underwent PCI procedures and experienced complications, such as dissections, perforations, and abrupt closures. In Case 1, a dissection occurred during wire navigation and was treated with patience entry into true lumen navigation of guidewire, and completed with balloon dilatation and stent implantation. In Case 2, there was a calcified lesion in the left anterior descending artery (LAD), where the Guidezilla™ support was used to cross the stent. In Case 3, abrupt closure occurred

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due to clot formation which was bailed out with direct stenting. In Case 4, type 3 perforation occurred during chronic total occlusion (CTO) PCI which was bailed out with fat embolization. In Case 5, type 3 perforation occurred and it was managed with GraftMaster® deployment with the ping-pong technique.

CASE REPORTS

Case 1

A 56-year-old male patient with diabetes and hypertension presented at the emergency room with symptoms of an acute posterolateral ST-elevation myocardial infarction. The patient's echocardiogram (ECHO) showed abnormalities in the posterolateral region of the heart, with an ejection fraction (EF) of 38%. The patient was given antiplatelet, antianginal, anti-hypertensive, and oral hypoglycemic agents. The patient's troponin test was positive and his risk of bleeding was high according to the HAS-BLED score.

The patient underwent coronary angiography (CAG), which revealed triple vessel disease. The left circumflex artery (LCX) was found to be the most affected, with a 100% occlusion caused by a grade six thrombus (culprit vessel) (Figure 1A). It was decided to perform culprit angioplasty on the affected vessel. The left main coronary artery (LMCA) was hooked using a 7F Extra-Back Up (EBU) 3.75 guide (Medtronic, Minneapolis, Minnesota, United States). An attempt was made to cross the lesion with a floppy wire (Figure 1B), but it was difficult due to knuckle and dissection (Figure 1C). With effort, the wire was able to cross the dissection and navigate into the true lumen. The important point this navigation is to patiently find the way to true lumen by poking in different views. The lesion was then dilated using a 1.5-mm non-compliant balloon (Terumo Interventional Systems, New Jersey, United States), followed by a thrombus aspiration by catheter (Eliminate™ Aspiration Catheter, Terumo Interventional Systems). The lesion was pre-dilated using a 2.5x15mm non-compliant balloon (AccuForce™, Terumo Interventional Systems), which cleared the thrombus and revealed underlying dissection. A drug-eluting stent (DES; cobalt-chromium everolimus-eluting stent, Xience™ Xpedition; Abbott Vascular, Santa Clara, California) was then deployed, measuring 3.5x28mm, at 12 atmosphere (ATM) (Figure 1D). The final result was good, with a Thrombolysis in Myocardial Infarction (TIMI) 3 flow achieved and no complications (Figure 1E).

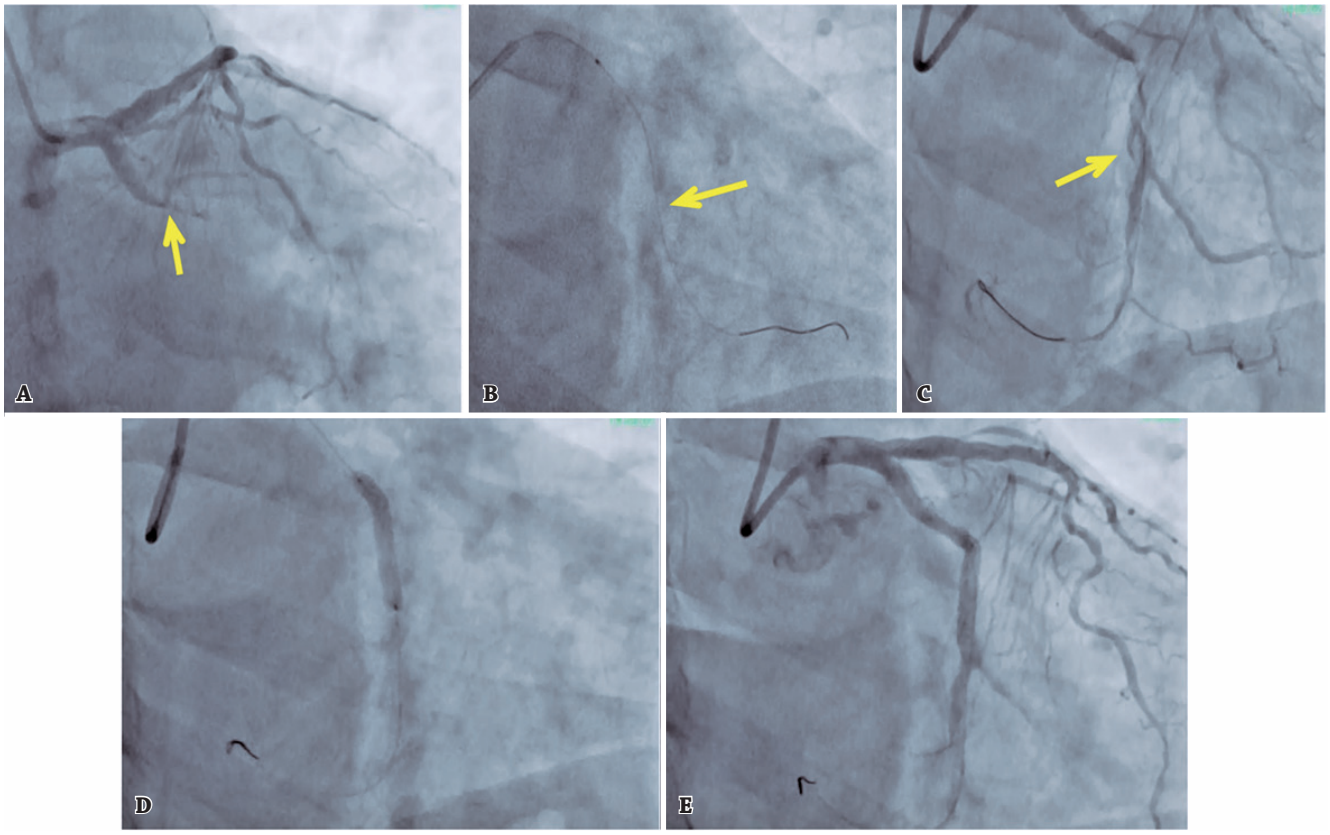

Figure 1. Inferolateral myocardial infarction percutaneous coronary intervention done after dissection caused by workhorse wire. (A) Coronary angiography showing occluded left circumflex artery with grade 6 clot (arrow). (B) Coronary angiography showing BMW wire not crossing (arrow). (C) Coronary angiography showing dissection by antegrade wire (arrow). (D) Drug-eluting stent deployed 3.5x28mm at 10 ATM after crossing the dissection. (E) Good result.

Case 2

A 77-year-old male patient with hypertension, diabetes and dyslipidemia presented to the hospital with symptoms of angina on exertion. The patient's ECHO showed an EF of 30% and reduced motion of the heart wall. The patient was known diabetic, hypertensive and dyslipidemic. Antiplatelet, antianginal, anti-hypertensive, and oral hypoglycemic agents were administered. Coronary angiography was performed and revealed small vessel with calcification in the LAD (Figure 2A). Using a 7F EBU guide (Medtronic), the left main coronary artery was engaged. Initially, a balloon dilatation was attempted using a 2.5mm diameter balloon (AccuForce™, Terumo Interventional Systems), but it resulted in severe dissection in the LAD. Subsequently, a cobalt-chromium everolimus-eluting stent (Xience™ Xpedition) of 2.5x30mm and 2.5x18mm dimensions was attempted to cross serially, but it was unable to cross the calcified lesion (Figure 2B). The buddy wire technique with the use of two wires was attempted but was also unsuccessful. Finally, Guidezilla™ Guide Extension Catheter (Boston Scientific) support from the LAD was used to cross the lesion distally with the use of a 2.5x18mm stent (Figure 2C). The stent was deployed at 14 ATM and post-dilated with a 3.0x12mm balloon (AccuForce™, Terumo Interventional Systems) with good results (Figure 2D).

Case 3

A 54-year-old female patient with diabetes, hypertension, and dyslipidemia presented at the Outpatient Department with angina on exertion class 2. An ECHO revealed dysfunction in the left ventricle (LV) and an EF of 40. The patient was started on antiplatelet, antianginal, antihypertensive and oral hypoglycemic drugs. During a CAG, it was determined the patient had a borderline lesion in their right coronary artery (RCA) (Figure 3A) in addition to her left ventricular dysfunction. A 7F EBU guide (Medtronic) was used to access the RCA, which had a plaque burden of approximately 65% and intravascular ultrasound (IVUS) run was done to see the significance of lesion (Figure 3B). However, the patient then reported pain due to an occlusion in the mid-RCA caused by a clot (Figure 3C). There was development of clot in the RCA vessel and the patient experienced ischemic chest pain on the table. Urgently activated clotting time was done and maintained at 300 milliseconds. Direct stenting was done to compress the clot. A cobalt-chromium everolimus eluting stent (Xience™ Xpedition) was placed across the clot and the lesion, and deployed at 12 ATM, resulting in good outcome and TIMI-3 flow (Figure 3D).

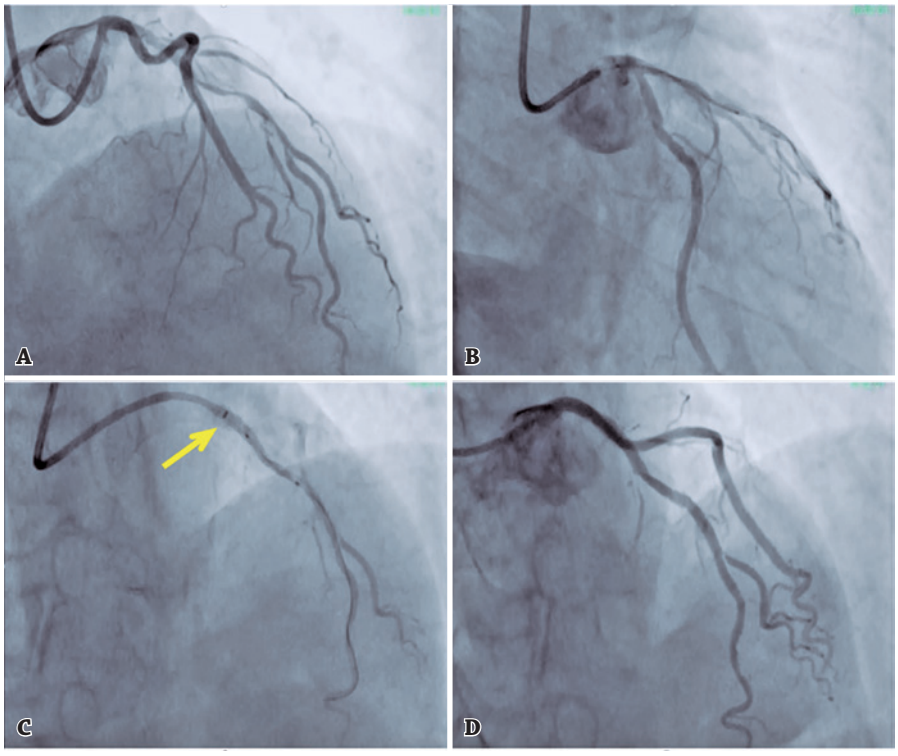

Figure 2. Uncrossable calcified lesion in left anterior descending artery crossed with Guidezilla™ support. (A) Coronary angiography shows small and heavily calcified left anterior descending artery. (B) 2.5mm balloon dilation expanded but severe dissection in left anterior descending artery. (C) Stent crossed with Guidezilla™ support (arrow). (D) Good result.

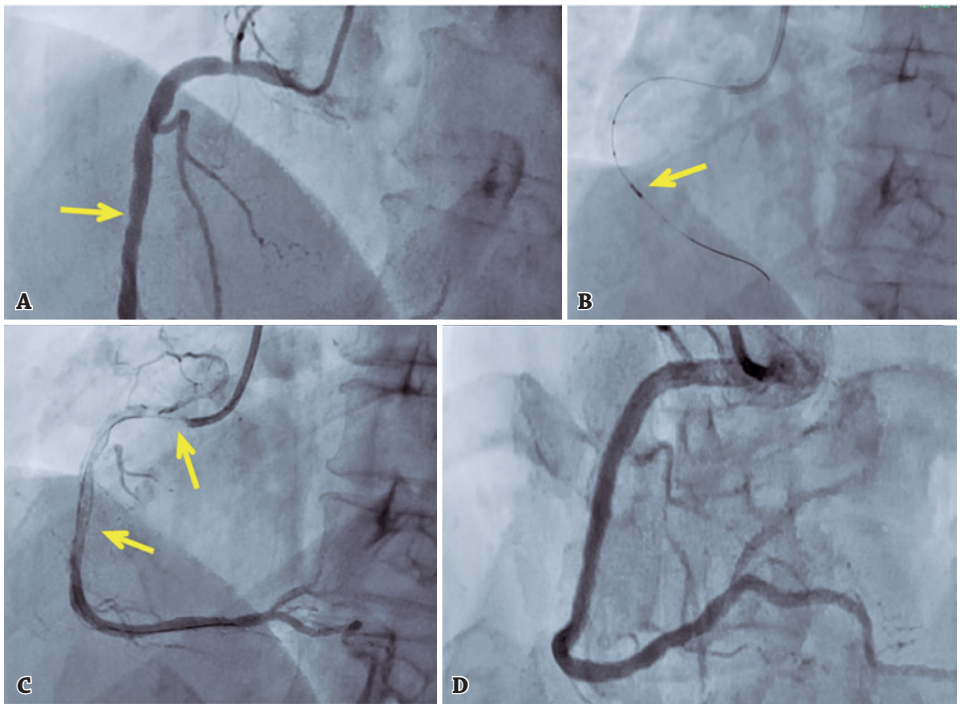

Figure 3. Direct stenting to bail-out thrombus formation in right coronary artery. (A) Coronary angiography shows right coronary artery with borderline lesion (arrow). (B) Coronary angiography showing intravascular ultrasound (arrow). (C) Coronary angiography showing clot in right coronary artery (arrow). (D) Coronary angiography showing bail-out with direct stenting and good result.

Case 4

A 46-year-old male patient, diabetic and normotensive, presented at the emergency room with symptoms of acute breathlessness and dyslipidemia. An ECHO revealed severe dysfunction in the LV and an EF of 20%. The patient was also diagnosed with acute coronary syndrome and had high troponin levels. Treatment included administering antiplatelet drugs, other antianginal drugs, and oral hypoglycemic drugs.

Upon performing angiography, it was discovered the patient had a 100% blockage in the LAD (Figure 4A). Initially, the balance middle weight (BMW) wire was attempted, but it was unable to cross due to CTO. The LAD was not visible at all. The Fielder FC coated wire was eventually crossed with great difficulty and manipulations, and the area was then predilated with a 1.25mm diameter balloon. However, after this procedure, a type-3 perforation was reported at the distal LAD (Figure 4B).

Immediately, a dilated balloon was used in the proximal area of the perforation for temporary sealing. Another microcatheter 7F was carefully crossed in the proximal area of the LAD. Subcutaneous fat was obtained from the patient's abdomen and was used to embolize the vessel (Figure 4C), and this maneuver stopped bleeding. The patient was found to be clinically stable. Due to the non-viable myocardium and a scarred LAD, the PCI was not performed further (Figure 4D).

Case 5

A 43-year-old female came with history of chest pain at rest, class-4 symptoms. Electrocardiogram (ECG) done showed ST-coving and T inversion in V1 to V4. ECHO done showed apical hypokinesia with EF of 48%. Troponin I was raised and patient was diagnosed as non ST-elevation myocardial infarction. Patient was known diabetic since 15 years, normotensive, dyslipidemic with a body mass index of 26. Coronary angiography was done in the patient, wich revealed 95% blockage in LAD (Figure 4E). The left main coronary artery was hooked with a 7F EBU 3.75 guide (Medtronic). The lesion was crossed with workhorse BMW wire, and plain old balloon angioplasty was done with a 2.5x15mm balloon (AccuForce™, Terumo Interventional Systems). The balloon expanded and a DES 3.0x34mm was deployed (Xience™ Xpedition) at 18 ATM. There was a type-3 perforation (Figure 4F). Patient collapsed and developed pericardial tamponade immediately, as indicated by severe hypotension and sinus tachycardia. Left anterior descending artery was blocked with inflated balloon. Immediate pericardiocentesis done with pigtail positioned into pericardium (Figure 4H). Another guiding 7F JL catheter was engaged and with a ping-pong technique (Figure 4G) a stent-graft 3.5x20mm GraftMaster® was deployed through 7F guiding. Patient's vital signs improved as the perforation sealed and a good final result and TIMI-3 flow (Figure 4I). After stenting, the patient was observed at the intensive care unit and pigtail was removed after 24 hours, when the pericardial drainage was less than 10mL in 24 hours.

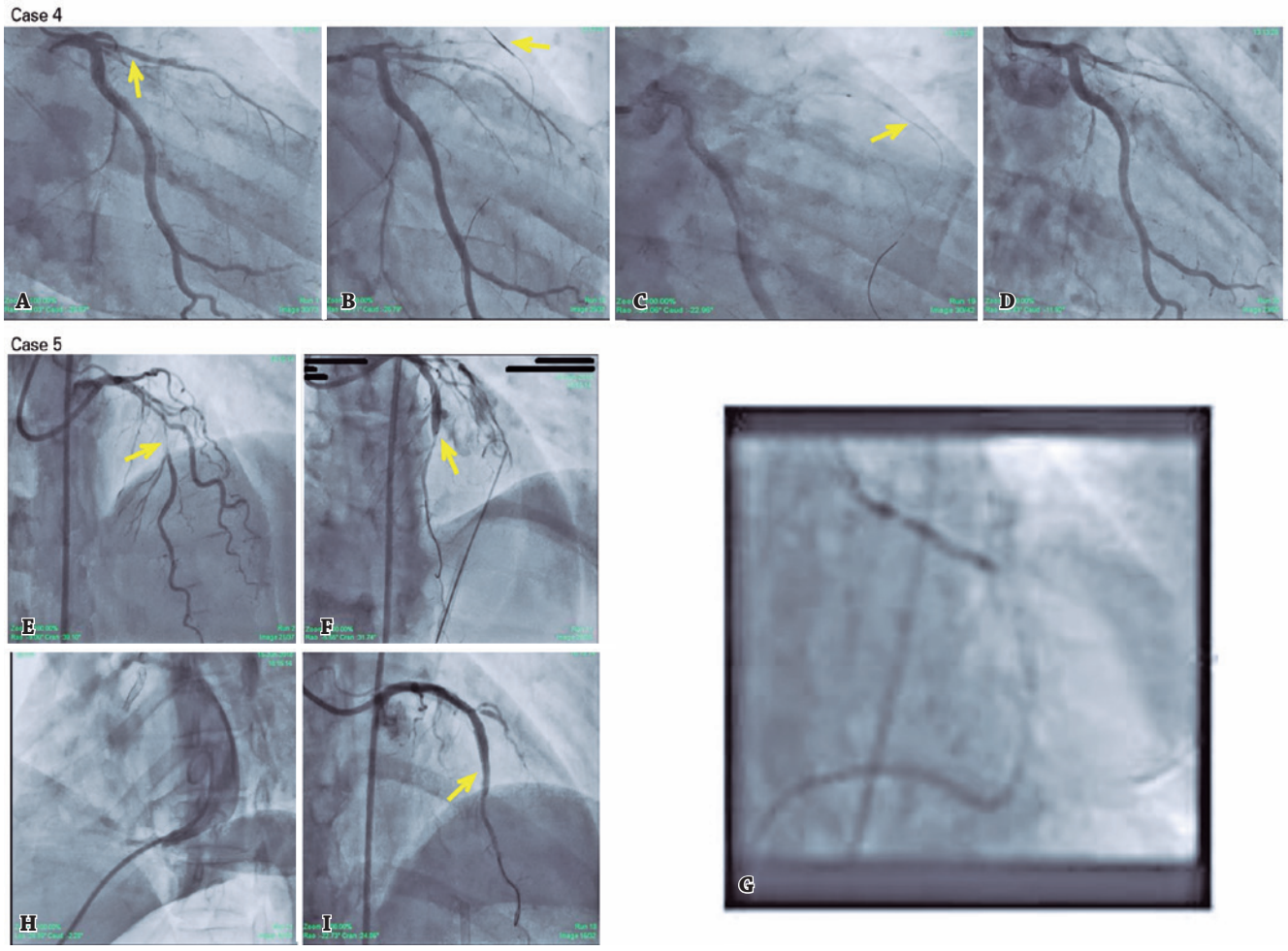

Figure 4. Cases showing type-3 perforations. (A) Case 4: chronic total occlusion percutaneous coronary intervention of left anterior descending artery showing perforation after plain old balloon angioplasty and bailed-out by fat embolization. Coronary angiography showing left anterior descending artery chronic total occlusion (arrow). (B) Coronary angiography showing distal left anterior descending artery with perforation after plain old balloon angioplasty (arrow). (C) Coronary angiography showing fat embolization done through micro-catheter (arrow). (D) Coronary angiography showing sealed perforation. (E) Case 5: perforation in proximal left anterior descending artery and bail-out by using ping-pong technique to deliver covered stent. Coronary angiography showing 95% proximal lesion (arrow). (F) Coronary angiography showing perforation after plain old balloon angioplasty (arrow). (G) Coronary angiography showing ping-pong guide technique. (H) Pericardial dye injection to show pericardiocentesis by pigtail catheter (arrow). (I) Coronary angiography showing good final result after graft master deployment.

DISCUSSION

A high success rate is achieved with various novel therapeutic techniques, such as hemodynamic support device-assisted PCI and revascularization of coronary CTO for complex PCI, but these techniques also result in high risk of complications. Therefore, operators who commonly choose complex PCI procedures and perform CTO interventions are more frequently exposed to these complications.

The article presents five cases of complications that can occur during PCI procedures. As described, Case 1 of our series showed dissection during wire navigation. Coronary artery dissection is a condition that occurs when blood flow is interrupted due to a tear in the arterial wall. These complications were extremely common in the days of balloon angioplasty, but the incidence of clinically significant dissection was greatly reduced with the advent of stents.[5] However, this complication must be recognized as quickly as possible, since early treatment improves vascular patency and patient outcomes. Major dissections may lead to coronary flow obstruction, vessel occlusion, hemodynamic collapse, and even death. According to the National Heart, Lung, and Blood Institute (NHLBI) system, dissection refers to an intraluminal filling defect or flap with hazy, ground glass appearance. Luminal injury severity can be classified using the traditional Type A-F system.[6] Operators specializing in CTO PCI are more often faced with dissections, and may sometimes create dissections to use the subintimal space for dissection re-entry techniques.[7] Novel techniques and devices developed by

CTO specialists to manage dissections may be used to treat iatrogenic dissections.[8] The primary goal of the operator should be to establish and maintain an open artery. In cases of flow-restricting dissections, balloon dilatation should be followed by stent implantation. Anterograde contrast injection must be avoided to prevent propagation of the dissection. In case of uncertain guidewire position (true lumen or subintimal space), intravascular imaging test can be used to examine the dissection. In large intramural hematomas, a cutting balloon may be introduced to release the hematoma prior to stenting. In longer dissections, initial stenting of the distal margin is warranted to prevent downstream propagation.[9] Maintenance of the guidewire in the true lumen is critical. If guidewire position is lost and the true lumen cannot be regained by advancing a spring-coil wire (favored over polymer-jacketed guidewires), antegrade dissection-re-entry may be considered.[9] Retrograde wiring may facilitate anterograde stenting.[8] Emergency coronary artery bypass graft surgery is required when these methods fail. Catheter-induced, spiral, and stent-edge dissection are the most prevalent causes of iatrogenic coronary dissection.

The fourth and fifth case are coronary perforations type-3 and type-4 and were managed with GraftMaster® stent and fat embolization, respectively. Coronary perforations were reported with a prevalence of 0.5%, which causes a 13-fold rise in the in-hospital adverse clinical outcomes in the patients.[10] Mismatch balloon or stent specifically when the ratio of balloon-artery is >1.2:1 is majorly responsible for the perforation in the coronary vessel. However, there are some other uncommon reasons, such as calcification in the arteries and lack of integrity in the vessel wall, which are also responsible for coronary artery perforation.[11] Furthermore, various risk factors, such as advanced age, female sex, and previous history of coronary artery bypass graft and usage of various devices, such as excimer laser or rotational atherectomy, can potentiate the susceptibility of patients to coronary artery perforation. Based on severity, coronary artery perforation has been classified into five types: type 1 to 5.[12] Certain severe effects, such as myocardial infarction, death, and collapse of the haemodynamic system can be caused by type-3 perforations.

In our fourth case, the sudden closure of the vessel was likely due to clot formation, caused by low activated clotting time and a prolonged procedure. The activated clotting time should ideally be managed between 250 and 300 milliseconds during the procedure. Abrupt vessel closure is a known complication of PCI, but with the use of more potent antiplatelet agents and advanced stent modifications, the incidence has decreased from 3 to 0.3%. Symptoms of abrupt vessel closure include chest pain, cardiac arrhythmia, and a drop in blood pressure. Potential causes of abrupt vessel closure include formation of intracoronary thrombus, dissections, and air injection.[13] Immediate steps to manage abrupt vessel closure include positioning the coronary guidewire at the intraluminal position, using IVUS to confirm the position of the guidewire, and performing balloon inflations to confirm the presence of dissection or thrombus. Additional treatment options include therapeutic administration of glycoprotein IIb/IIIa antagonists, aspiration if air injection is the cause, and administering inotropic agents, atropine, and vasopressors in case of hemodynamic instability.[14] The coronary no-reflow phenomenon is also a potential cause of abrupt vessel closure and can be treated with distal embolic protection devices, and distal intravenous medications, such as nitroprusside, epinephrine, and verapamil.[15]

CONCLUSION

In crossing total occlusion of acute myocardial infarction, sometimes dissection can be encountered due to bending, and patience is required to negotiate guidewire across dissection. Repeated efforts can do the trick.

In calcified lesions, balloon crossing sometime can occur, but the stent might fail to cross. Nonetheless, the lesion may be modified by means of rotational atherectomy or intravascular lithotripsy, if crossable. In our case, we did not use rotational atherectomy before ballooning and later there was a lot of dissection. In such cases, support by guide catheter extension system can help in delivering the stent distally.

Sometimes we come across cases where the clot suddenly appears on the working coronary, especially when we are using imaging devices. Hence, in cases where imaging exams are performed, activated clotting time should be kept approximately at 280 to 300 milliseconds. In such situations, direct stenting compressing the clot can be a useful technique to bail-out.

Type-3 perforation is a dreaded complication of percutaneous coronary intervention. Urgent pericardiocentesis and sealing are important. Calcific nodules pose a significant risk. modification pre-stenting is essential. Covered stents are life-saving. Ping-pong technique can be employed.

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None.

CONFLICTS OF INTEREST

The authors declare there are no conflicts of interest.

CONTRIBUTION OF AUTHORS

Conception and design of the study: RM, DD, BM, AA, LR and ISM; data collection: RM, DD, BM, AA, LR and ISM; data interpretation: RM, DD, BM, AA, LR and ISM; text writing: RM, DD, BM, AA, LR and ISM; approval of the final version to be published: RM, DD, BM, AA, LR and ISM.

REFERENCES

1. Fanaroff AC, Zakroysky P, Dai D, Wojdyla D, Sherwood MW, Roe MT, et al. Outcomes of PCI in relation to procedural characteristics and operator volumes in the United States. J Am Coll Cardiol. 2017;69(24):2913-24. https://doi.org/10.1016/j.jacc.2017.04.032
2. Waldo SW, Gokhale M, O'Donnell CI, Plomondon ME, Valle JA, Armstrong EJ, et al. Temporal trends in coronary angiography and percutaneous coronary intervention: insights from the VA clinical assessment, reporting, and tracking program. JACC Cardiovasc Interv. 2018;11(9):879-88. https://doi.org/10.1016/j.jcin.2018.02.035
3. Iverson A, Stanberry LI, Tajti P, Garberich R, Antos A, Burke MN, et al. Prevalence, trends, and outcomes of higher-risk percutaneous coronary interventions among patients without acute coronary syndromes. Cardiovasc Revasc Med. 2019;20(4):289-92. https://doi.org/10.1016/j.carrev.2018.07.017
4. Bell SK, White AA, Yi JC, Yi-Frazier JP, Gallagher TH. Transparency when things go wrong: physician attitudes about reporting medical errors to patients, peers, and institutions. J Patient Saf. 2017;13(4):243-8. https://doi.org/10.1097/PTS.0000000000000153
5. Roy P, de Labriolle A, Hanna N, Bonello L, Okabe T, Pinto Slottow TL, et al. Requirement for emergent coronary artery bypass surgery following percutaneous coronary intervention in the stent era. Am J Cardiol. 2009;103(7):950-3. https://doi.org/10.1016/j.amjcard.2008.12.025
6. Huber MS, Mooney JF, Madison J, Mooney MR. Use of a morphologic classification to predict clinical outcome after dissection from coronary angioplasty. Am J Cardiol. 1991;68(5):467-71. https://doi.org/10.1016/0002-9149(91)90780-o
7. Brilakis ES, Mashayekhi K, Tsuchikane E, Abi Rafeh N, Alaswad K, Araya M, et al. Guiding principles for chronic total occlusion percutaneous coronary intervention. Circulation. 2019;140(5):420-33. https://doi.org/10.1161/CIRCULATIONAHA.119.039797
8. Costello-Boerrigter LC, Salomon C, Bufe A, Lapp H. The novel use of retrograde CTO PCI techniques as a rescue strategy for an acute right coronary artery occlusion due to iatrogenic dissection. J Cardiol Cases. 2017;17(3):89-91. https://doi.org/10.1016/j.jccase.2017.10.007
9. Doll JA, Hira RS, Kearney KE, Kandzari DE, Riley RF, Marso SP, et al. Management of percutaneous coronary intervention complications: algorithms from the 2018 and 2019 Seattle Percutaneous Coronary Intervention Complications Conference. Circ Cardiovasc Interv. 2020;13(6):e008962. https://doi.org/10.1161/CIRCINTERVENTIONS.120.008962
10. Kinnaird T, Kwok CS, Kontopantelis E, Ossei-Gerning N, Ludman P, deBelder M, et al.; British Cardiovascular Intervention Society and the National Institute for Cardiovascular Outcomes Research. Incidence, determinants, and outcomes of coronary perforation during percutaneous coronary intervention in the United Kingdom between 2006 and 2013: an analysis of 527 121 cases from the British Cardiovascular Intervention Society Database. Circ Cardiovasc Interv. 2016;9(8):e003449. https://doi.org/10.1161/CIRCINTERVENTIONS.115.003449
11. Dippel EJ, Kereiakes DJ, Tramuta DA, Broderick TM, Shimshak TM, Roth EM, et al. Coronary perforation during percutaneous coronary intervention in the era of abciximab platelet glycoprotein IIb/IIIa blockade: an algorithm for percutaneous management. Catheter Cardiovasc Interv. 2001;52(3):279-86. https://doi.org/10.1002/ccd.1065
12. Ellis SG, Ajluni S, Arnold AZ, Popma JJ, Bittl JA, Eigler NL, et al. Increased coronary perforation in the new device era. Incidence, classification, management, and outcome. Circulation. 1994;90(6):2725-30. https://doi.org/10.1161/01.CIR.90.6.2725
13. Klein LW. Coronary complications of percutaneous coronary intervention: a practical approach to the management of abrupt closure. Catheter Cardiovasc Interv. 2005;64(3):395-401. https://doi.org/10.1002/ccd.20218
14. Al-Mukhaini M, Panduranga P, Sulaiman K, Riyami AA, Deeb M, Riyami MB. Coronary perforation and covered stents: an update and review. Heart Views. 2011;12(2):63-70. https://doi.org/10.4103/1995-705X.86017
15. Dash D, Mody R, Ahmed N, Thejus J, Malan SR, Mody B. Management of complications during percutaneous coronary intervention: a current appraisal. J Transcat Intervent. 2022;30:eA202202. https://doi.org/10.31160/JOTCI202230A202202