Case Report/Series

Double set up technique as a bailout of diagonal branch coronary perforation: a case report

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ABSTRACT
Coronary artery perforation is a rare but potentially life-threatening complication of percutaneous coronary intervention (PCI). A 55-year-old male with a history of implanted stent on the left main ostium to the proximal left circumflex artery (LCX) and distal right coronary artery, and chronic total occlusion (CTO) on ostium left anterior descending (LAD). PCI was performed using a stiff wire to cross the CTO body in LAD. We performed an injection and confirmed the presence of extravasation. We successfully managed to stop the bleeding by placing the tips of floppy wire that were cut into pieces. A drainage pathway was made through thoracotomy for pericardial effusion. Angiography showed persisting extravasation at the wire insertion site. We then made our own covered stent. We implanted on the osteal LAD until proximal LCX. Repeated angiography showed no contrast extravasated from the perforation site, and the patient was stabilized and discharged.

KEYWORDS complication, coronary artery, stent

Coronary artery perforation (CAP) is an infrequent yet potentially life-threatening complication of percutaneous coronary intervention (PCI). Its incidence ranges from 0.1 to 3%, with the greatest risk observed during PCI procedures for chronic total occlusion (CTO).[1,2] CAP occurrence is classified based on location (in large, distal, and collateral vessels) and severity (using the Ellis classification). Novel devices such as the rotablator, and procedures such as directional coronary atherectomy, transluminal extraction catheter atherectomy, and laser angioplasty carry a heightened risk of causing perforations compared to balloon angioplasty.[3] CAP is associated with cardiac tamponade in 17% and mortality in 9% of patients.[4] In the case where a suitable-sized covered stent (CS) is unavailable for the blood vessel diameter and no matching coil for the perforation location, a cutting wire and a homemade stent sandwich may help in avoiding mortality.

A specialized device is typically used for embolization and sealing of perforations in patients with CAP. This device consists of a coil for embolization and a stent constructed with a metallic stent framework covered with a synthetic material that can be expanded. Modifying the existing equipment aims to create coil embolization (CE) and cover the stent to seal the perforation in situations where a specific specialized device is unavailable. This modification is crucial to potentially save a patient's life during CAP. We report a case of coronary perforation in the diagonal branch (Ellis type III cavity spilling into the pericardial space), which was successfully first treated in our center using a fragmented coronary wire, as an improved embolization technique and assembled cover stent sandwich to seal the left anterior descending (LAD).

CASE REPORT

A 55-year-old man, who was a smoker with a history of hypertension and normal physical findings, was admitted to our hospital for chronic typical chest pain, which started 3 days before admission. He had a history of acute coronary syndrome 1 year prior and had an implanted stent in the distal right coronary artery (RCA). Electrocardiography revealed ST-segment elevation in leads aVR and V1, with ST-segment depression in II, III, aVF, and V4–V6. Angiography showed the left CTO of the osteal LAD with the RCA as a collateral supply to the distal LAD (Figure 1). He refused coronary artery bypass grafting (CABG). We previously crossed the CTO, but the thrombus shifted from the LAD artery to the left circumflex artery (LCX). We aspired the thrombus and deployed a 3.5 × 36 mm biomatrix stent (Biosensors Europe SA, Switzerland) from the left main ostium to the proximal LCX. We reattempted to perform PCI in the ostial LAD (CTO lesion with Japan-CTO) score of 3.

Double puncture was performed at the right femoral region to access the left coronary artery (antegrade) and at the left femoral region to access the RCA (guiding the distal lesion from the collateral posterior descending artery) (Figure 1, a and b). Owing to the clear proximal cap, good major side branch and distal target, and lesion length of <20 mm, antegrade wire escalation was performed. Initially, a floppy wire was used, followed by a stiff wire (Conquest Pro 8-20 [Asahi, Japan]) to cross the CTO body. The balloon was inflated on the proximal cap of the CTO and continued with tracing the LAD path. Unfortunately, the wire entered the first diagonal branch (D1). Therefore, a parallel-wire technique was used to remove the stiff wire using a Runthrough hypercoat (Ashitaka, Japan) on D1.

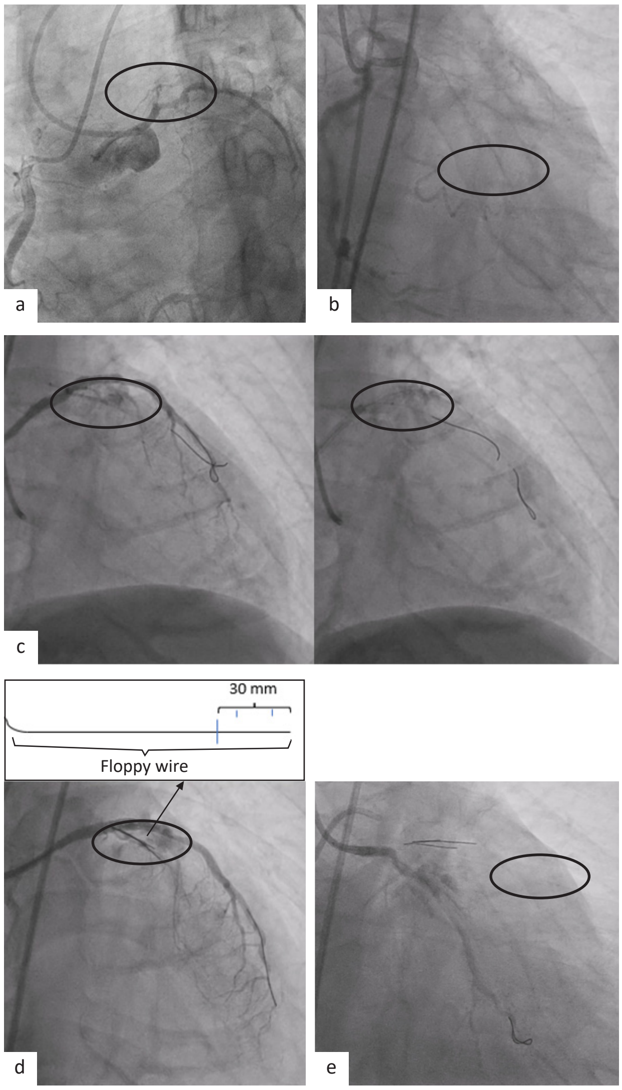

Figure 1. Coronary angiography of coronary artery. Chronic total occlusion (CTO) of the osteal left anterior descending (LAD) (black circle) (a) and collaterals from right coronary artery (RCA) (black circle) (b); coronary artery perforation (CAP) (Ellis III with cavity spilling) (black circle) on first diagonal branch (c); tip of floppy wire divided into 3 parts, then cut 10 mm at proximal tip and fragmented wire delivered to D1 (black circle) and repeated 3 times (d); coronary angiography after delivered the assembled stent sandwich. The extravasation of contrast was disappeared (black circle) (e)

We tried to cross the CTO body in the LAD using Fielder XT (Asahi) but could not advance the wire any further. The microcatheter was moved to a parallel wire (Fielder XT) and contrast was injected to evaluate the tip of the parallel wire. Contrast injection confirmed the presence of extravasation (Ellis type III cavity spilling) on D1 (Figure 1c). We then administered a vasopressor and left the microcatheter on perforation site. Considering that the perforation site was on the LAD branch, we assumed that the perforation was distal.

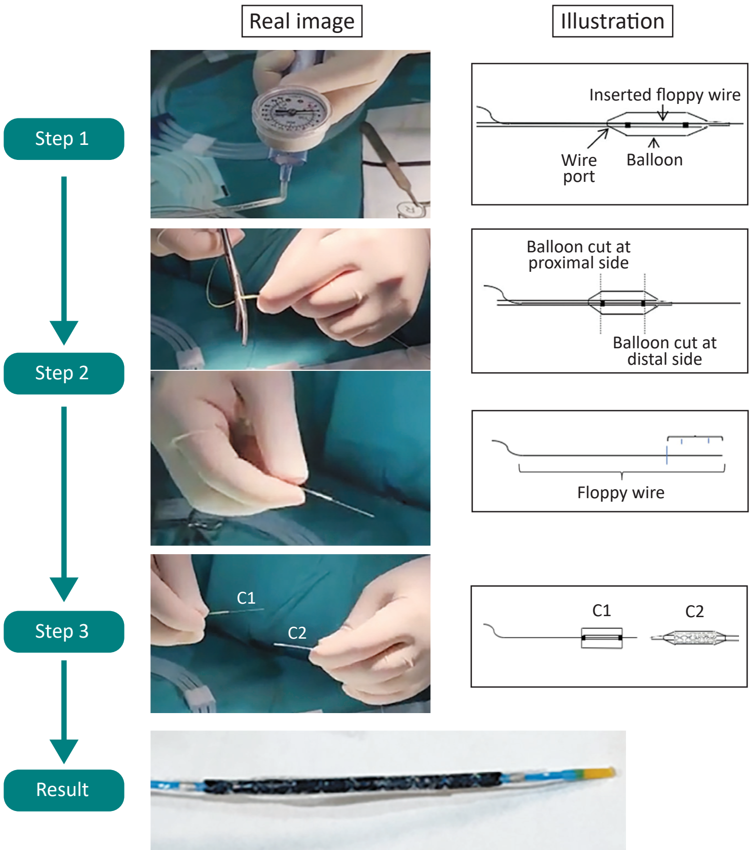

Figure 2. Method of making handmade rail and stent sandwich. Intact cylindrical balloon was made (step 1); balloon was cut at the proximal and distal part and it left only the wire (step 2); wire in tunnel cylindrical balloon (C1) became a rail to mounting cylindrical balloon above 3.5 mm × 20 mm CID CRE8 stent (C2) (step 3); assembled stent sandwich without outside layer (result)

As we lacked a coil device to embolize the CAP, we attempted to stop the bleeding by placing the tips of the floppy wires. We opted for a floppy wire because of its radiopaque nature, which ensured visibility during fluoroscopy. The tips were cut into pieces and delivered to D1 as an improvised embolization technique. The tip of the floppy wire was divided into three parts: proximal, mid, and distal. By inserting the floppy wire in the opposite direction and cutting the proximal part (10 mm) (Figure 1d), the cut wire was pushed toward the perforation area using a Fielder XT wire. This technique aimed to cover the perforation and promote thrombus formation, potentially causing embolization in the affected region.

Echocardiography revealed pericardial effusion that led to pericardiocentesis. However, the pericardial space could not be accessed due to the patient's chest musculature. We consulted a cardiothoracic surgeon and decided to create a drainage pathway via a thoracotomy. The blood from the drain flowed actively and rapidly, exceeding the expected drainage capacity. Consequently, a repeat angiography was performed, and the extravasation persisted at the wire insertion site.

We did not have a large stent cover available for deployment in the left main artery. We then created a CS to seal the LAD artery flow and prevent blood flow from the left main to the LAD. The approach involved creating a CS by placing a balloon-compliant material between two stents, forming a 'sandwich' configuration. The equipment consisted of an angioplasty balloon compliance stent and a previously deployed stent on the ostial left main until the proximal LCX as the outside layer of the assembled CS.

In the cardiac catheterization laboratory, we assembled a "stent sandwich" to seal the flow through the LAD. We inserted a floppy wire into the wire port of a 2.5 mm × 15 mm Boston Emerge (Boston Scientific, USA) balloon, and the wire was passed through the catheter balloon's tunnel. A low-pressure angioplasty balloon was inflated. The balloon was cut from the distal side. Subsequently, we reinserted the outside wire (which had passed through the proximal side) and cut the proximal side of the balloon, creating an intact cylindrical balloon (Figure 2a).

The wire in the tunnel cylindrical balloon was used to mount the cylindrical balloon above the 3.5 mm × 20 mm CID CRE8 stent. We firmly crimped the balloon above the stent without an outside layer of the stent sandwich (Figure 2, b and c). We delivered a stent sandwich without an outer layer to the ostial left main until the proximal LCX (Figure 2d). In this case, the previous stent in the ostial left main until the proximal LCX was outside the layer of the assembled stent sandwich. The device was deployed under 12 atmospheres.

Coronary angiography was performed after delivery of the assembled stent sandwich. The LAD was sealed successfully (Figure 1). Echocardiography revealed minimal pericardial effusion. Therefore, the surgeon planned to perform CABG, but the patient refused to undergo surgery. A follow-up angiography 2 days later confirmed no CAP, and he was stabilized in the cardiovascular care unit before discharge. He was discharged with double-antiplatelet therapy (aspirin and clopidogrel). At the 6th month of follow-up, his condition was better at the outpatient clinic visit, with no symptoms, hemoglobin reduction, or hospitalization.

DISCUSSION

CAP is an uncommon complication that can occur during PCI, affecting approximately 0.17–0.43% of the patients. However, the risk significantly rises to 4.1–4.8% in complex lesions. The primary cause is the inadvertent puncture of the coronary artery wall using an intracoronary guidewire. In this case, the perforation was first closed with a cutting wire; however, numerous cutting wires could not cover the entire segment of the perforation and embolization, causing persistent perforation. Interestingly, the use of atheroablation devices amplifies the susceptibility to this complication, resulting in a higher incidence (1% compared to 0.2% when these devices are omitted, with a statistically significant *p*-value of <0.001).[2,5] Planting a stent graft or stent sandwich into the main vessel due to distal side-branch perforation should be avoided.[6] Further, the homemade coil should be created appropriately and the requirement of winding or a spring coil must be checked.[7]

Ellis et al[3] categorized the outcomes of coronary perforations into three classes based on the angiographic characteristics of the perforation: class I represented an extraluminal crater without contrast extravasation; class II included instances of pericardial or myocardial blushing; and class III included perforations with a diameter of 1 mm or more accompanied by contrast streaming and cavity spilling. Dippel et al,[8] in a study spanning 1995–1999 involving 6,214 procedures, found that mortality was confined to the class III subgroup. None of the patients with class II perforations required emergency surgery or died. Mortality in the class III subgroup was noted as 11.1%, with a 22.2% need for emergency CABG and an incidence of 22.2% for cardiac tamponade.[8] Patel et al,[9] in a comprehensive analysis of 65 studies involving 18,061 patients undergoing CTO PCI, reported 419 perforation cases.

In many cases, CAP is managed through percutaneous procedures, including balloon sealing,[10] suction with a microcatheter, embolization using blood clots, fat tissue, and gel foam,[11] CE,[12] and CS implantation. Selecting the most appropriate approach to manage CAP depends on factors such as the perforation type and location, the size of the blood vessel, and the underlying cause of the perforation. CSs are effective as a viable treatment, particularly in scenarios involving larger vessels or type III blow-out perforations, often obviating surgical intervention and potentially preserving lives.[13] Nevertheless, in cases where perforations occur in smaller vessels, involve significant side-branch vessels, or manifest distally, CSs have not shown any functionality. In such instances, CE has proven to be feasible and efficacious.[12]

A recent study showed CE for CAP could effectively stop bleeding in 98.2% of cases, demonstrating its efficacy.[14] In the present case, we had no coil device; therefore, we fragmented a wire and delivered it to the perforation site as a coil function. Given the persistent extravasation, we created a version of CS to seal the LAD flow.

Advanced techniques involving CS implantation are typically reserved for life-threatening CAP in large vessels with hemodynamic instability and resistance to standard treatment.[12] The CS usage provides a satisfactory safety profile and effective management of CAP during PCI.[15] CS consists of a metallic stent framework enclosed by a synthetic material such as expanded polytetrafluoroethylene or electrospun polyurethane and, at times, a biological membrane like pericardium. This external covering aims to prevent potential blood leakage. The specific material composition and design of the stent cover, whether it adopts a sandwich structure or an outer/inner layer configuration, can influence the endothelialization process. This subsequently affects the stent's thrombogenicity, similar to various other implantable medical devices.[16] The biocompatibility of these stents leads to a noticeably higher risk of adverse events than drug-eluting stents, albeit not as prominent as that seen with bare metal stents.[17,18]

We successfully sealed the flow from the left main to the LAD using the CS. We created a stent sandwich using the balloon compliance between the two stents, which became a cylindrical balloon. The cylindrical balloon was placed above the 3.5 mm × 20 mm CID CRE8 stent and we crimped it firmly without the outer layer of the stent sandwich. Then, the stent sandwich (without the outer layer) was delivered to the ostial left main until the proximal LCX. In this case, the previous stent in the ostial left main until the proximal LCX served as the outer layer of the assembled stent sandwich. Pienvichit and Waters,[18] successfully made their own CS by sandwiching a D1 balloon material between two S660 stents. The device was deployed, and it yielded satisfactory results. It can be assembled within a reasonable time (less than 5 min) without any difficulty or specialized tools. The authors suspected that other combinations of balloon-expandable stents and balloon materials could achieve similar results. The recuperation duration following the procedure was not extended, and the patient was discharged without any complications on the 2nd day after the surgery.[19] Song et al[19] compared the clinical outcomes of self-made polyurethane-covered stent (PU-CS) implantation to treat CAP and found that the self-assembled PU-CS exhibited impressive efficacy in achieving successful delivery and sealing of critical CAP during PCI.

This report was limited in scope because it is a single case study. A comparative analysis of cases using a coronary wire as a coil and a handmade cover stent sandwich in coronary perforation is needed to evaluate the success of utilizing those techniques.

In conclusion, we reported a case of a 55-year-old man with iatrogenic CAP in the D1 branch. Using pieces of coronary wire as an embolization device and creating a self-made CS by sandwiching a balloon between the two stents successfully sealed the flow into the LAD. This was a bridging therapy to surgical CABG and could be used in cases of iatrogenic distal coronary perforation requiring a fast solution due to rapid deterioration and refusal to undergo CABG.

Conflict of Interest

The authors affirm no conflict of interest in this study.

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REFERENCES

1. Doll JA, Nikolsky E, Stone GW, Mehran R, Lincoff AM, Caixeta A, et al. Outcomes of patients with coronary artery perforation complicating percutaneous coronary intervention and correlations with the type of adjunctive antithrombotic therapy: pooled analysis from REPLACE-2, ACUITY, and HORIZONS-AMI trials. J Interv Cardiol. 2009;22(5):453–9.
2. Shimony A, Joseph L, Mottillo S, Eisenberg MJ. Coronary artery perforation during percutaneous coronary intervention: a systematic review and meta-analysis. Can J Cardiol. 2011;27(6):843–50.
3. 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.
4. Ajluni SC, Glazier S, Blankenship L, O'Neill WW, Safian RD. Perforations after percutaneous coronary interventions: clinical, angiographic, and therapeutic observations. Cathet Cardiovasc Diagn. 1994;32(3):206–12.
5. Januszek R, Bryniarski L, Siudak Z, Malinowski KP, Bryniarski KL, Surdacki A, et al. Five-year report from the Polish national registry on percutaneous coronary interventions with a focus on coronary artery perforations within chronic total occlusions. Postepy Kardiol Interwencyjnej. 2020;16(4):399–409.
6. 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.
7. Hartono B, Widito S, Munawar M. Sealing of a dual feeding coronary artery perforation with homemade spring guidewire. Cardiovasc Interv Ther. 2015;30(4):347–50.
8. 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. Catheterization Cardiovasc Interv. 2001;52(3):279–86.
9. Patel VG, Brayton KM, Tamayo A, Mogabgab O, Michael TT, Lo N, et al. Angiographic success and procedural complications in patients undergoing percutaneous coronary chronic total occlusion interventions: a weighted meta-analysis of 18,061 patients from 65 studies. JACC Cardiovasc Interv. 2013;6(2):128–36.
10. Dixon SR, Webster MW, Ormiston JA, Wattie WJ, Hammett CJ. Gelfoam embolization of a distal coronary artery guidewire perforation. Catheter Cardiovasc Interv. 2000;49(2):214–7.
11. Qin Q, Chang S, Xu R, Fu M, Chen L, Ge L, et al. Short and long-term outcomes of coronary perforation managed by coil embolization: a single-center experience. Int J Cardiol. 2020;298:18–21.
12. Lemmert ME, van Bommel RJ, Diletti R, Wilschut JM, de Jaegere PP, Zijlstra F, et al. Clinical characteristics and management of coronary artery perforations: a single-center 11-year experience and practical overview. J Am Heart Assoc. 2017;6(9):e007049.
13. Hachinohe D, Kashima Y, Okada Y, Kanno D, Kobayashi K, Kaneko U, et al. Coil embolization for coronary artery

perforation: a retrospective analysis of 110 patients. J Interv Cardiol. 2021;2021:9022326.
14. Irie T. New embolization microcoil consisting of firm and flexible segments: preliminary clinical experience. Cardiovasc Intervent Radiol. 2006;29(6):986–90.
15. Kilic ID, Fabris E, Serdoz R, Caiazzo G, Foin N, Abou-Sherif S, et al. Coronary covered stents. EuroIntervention. 2016;12(10):1288–95.
16. Harnek J, James SK, Lagerqvist B. Very long-term outcome of coronary covered stents: a report from the SCAAR registry. EuroIntervention. 2019;14(16):1660–7.
17. Schächinger V, Hamm CW, Münzel T, Haude M, Baldus S, Grube E, et al. A randomized trial of polytetrafluoroethylene-membrane-covered stents compared with conventional stents in aortocoronary saphenous vein grafts. J Am Coll Cardiol. 2003;42(8):1360–9.
18. Pienvichit P, Waters J. Successful closure of coronary artery perforation using makeshift stent sandwich. Catheter Cardiovasc Interv. 2001;54(2):209–13.
19. Song X, Qin Q, Chang S, Xu R, Fu M, Lu H, et al. Clinical outcomes of self-made polyurethane-covered stent implantation for the treatment of coronary artery perforations. J Interv Cardiol. 2021;2021:6661763.