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CASE REPORT
Coronary heart disease

Looped wire advancement—not always safe! Fat—not so useless! a case series

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Background Coronary artery perforation (CAP), although rare, can often be a life-threatening complication of percutaneous coronary intervention. Looped wire tip or buckling of wire is conventionally considered safer due to reduced risk of migration into smaller branches and false lumen. Occasionally, buckling can indicate the entry of tip into dissection plane, or the advancement of looped wire can cause small vessel injury leading to perforation. Distal coronary perforation can be life threatening and coil, foam, and thrombin injection are some of the material widely used for sealing it.

Case summary We hereby report three different cases illustrating the vessel injury that the looped wire can cause in the distal vasculature related to various mechanisms like high elastic recoil tension, dissection by the non-leading wire tip, or hard wire lacerating the fragile small branches. All these mechanisms lead to distal coronary perforation leading to cardiac tamponade. Each case also illustrate the novel technique of autologous fat globule embolization for the management of distal CAP.

Discussion Distal coronary perforation is often due to guidewire-related vessel injury and is more common with hydrophilic wires. Looped wire tip can sometime indicate vessel injury and its advancement further down the coronary artery may result in serious vessel injury and perforation. Management of distal coronary perforation is challenging, and here we demonstrate the steps of using the readily available autologous fat globules by selectively injecting them into the small coronary artery to control the leak.

Keywords Looped wire • Buckled wire • Coronary perforation • Coronary fat embolization • Autologous fat embolization • Case series

Learning points

- Distal vessel perforation due to inadvertent migration of coronary guidewire into small vessels is a potentially life-threatening complication of percutaneous coronary intervention.
- Abnormal configuration of looped or knuckled coronary wire tip may be an early indicator of vessel injury and should inform the operator to avoid further advancement.
- Autologous coronary fat embolization using microcatheter is a handy and effective technique of managing distal coronary artery perforation.

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Introduction

Percutaneous coronary intervention (PCI) is often the modality of choice for coronary revascularization. Although tremendous advancement has been made contributing to improved procedure safety, major periprocedural complications do occur in clinical practice. Coronary artery perforation, although rare, is a serious complication. With an incidence of 0.5%, it portends a 13-fold increase in in-hospital major adverse events and a 5-fold increase in 30-day mortality.[1,2] Guidewire-related coronary perforation make more than half of all the cases and use of hydrophilic wire is responsible for most.[3,4] Well-recognized mechanisms of perforation with wires include vessel piercing while crossing the lesion, distal migration, and wire fracture.[3] Looped wire tip is conventionally considered safer than straight tip as it reduces inadvertent migration into a distal segment or small branches. But our cases illustrate the potential vessel injury that the looped wire can cause in the distal vasculature related to various mechanisms like high elastic recoil tension, dissection by the non-leading wire tip, or hard wire lacerating the fragile small branches. There are only two cases reported of looped wire causing distal coronary perforation to the best of our knowledge.[5] They also educate on the readily available autologous fat embolization method to effectively manage distal coronary perforations.

Case presentation

Case 1

A 64-year-old female, known hypertensive, presented with inferior wall myocardial infarction. Coronary angiogram revealed significant stenosis in the dominant right coronary artery (RCA), left anterior descending artery (LAD), and major obtuse marginal. She underwent successful stenting of the culprit RCA. A week later, she was taken up for revascularization of obtuse marginal and LAD. Sion Blue (Asahi Intecc, Japan) hydrophilic coated wire was advanced through a 6 Fr EBU Launcher 4.0 catheter (Medtronic, Inc., MN, USA) into the obtuse marginal vessel. During the advancement, the wire tip appeared fixed, forming a loop which on further advancement assumed a peculiar large loop configuration (*Figure 1A* and *Video 1*). It was advanced into the vessel's distal segment, followed by which an Everolimus DES (drug eluting stent) (2.75 mm × 29 mm) was deployed in proximal diseased OM1 (obtuse marginal branch). Following stent deployment, it was noted that the distal tip of the looped wire had migrated down with linear tear of the distal segment of OM1, and there was contrast extravasation into pericardial space (*Figure 1B* and *Video 1*). Echocardiography confirmed pericardial effusion. Immediately the stent balloon was inflated at the site of the stent to stop the distal flow. Intermittently the balloon was inflated for 20 s at 8 atmospheres with an intervening 5 s deflation for a total of 20 min. Even after

Timeline

Sequence of events	Case 1	Case 2	Case 3
Presentation	64-year-old female, hypertensive Inferior wall myocardial infarction	64-year-old gentleman, hypertensive and diabetic Exertional angina refractory to medical therapy	54-year-old female Inferior wall myocardial infarction
Diagnostic angiogram	Significant stenosis of left anterior descending artery (LAD), LCX, and right coronary artery (RCA) Percutaneous coronary intervention to RCA done	Calcified vessels and significant stenosis of LAD, LCX, and RCA	Acute total occlusion of the dominant RCA
Index procedure	Sion Blue guidewire in OM Wire tip appeared fixed, forming a loop which on further advancement assumed a peculiar large loop configuration DES in proximal OM	Rotational atherectomy f.b exchange with Sion Blue guidewire Looped wire inadvertently got pushed into the distal vessel	Fielder FC guidewire introduced into the RCA Guidewire tip formed a loop, which was further advanced in the posterior descending branch (PDA) branch of RCA DES placed in RCA
Perforation	Branch of distal OM showed contrast extravasation Intermittent balloon dilatation failed	Posterior left ventricular artery perforation Intermittent balloon dilatation failed	Hypotension 2 h later due to large pericardial collection RCA angiogram showed perforation of a PDA branch
Management	Microcatheter placed proximal to perforation Pulverized fat globules injected to seal the flow	Microcatheter placed proximal to perforation Pulverized fat globules injected to seal the flow	Microcatheter placed proximal to perforation Pulverized fat globules injected to seal the flow
Fat embolization	Haemodynamically stabilized Normal flow on follow-up angiography	Haemodynamically stabilized	Haemodynamically stabilized

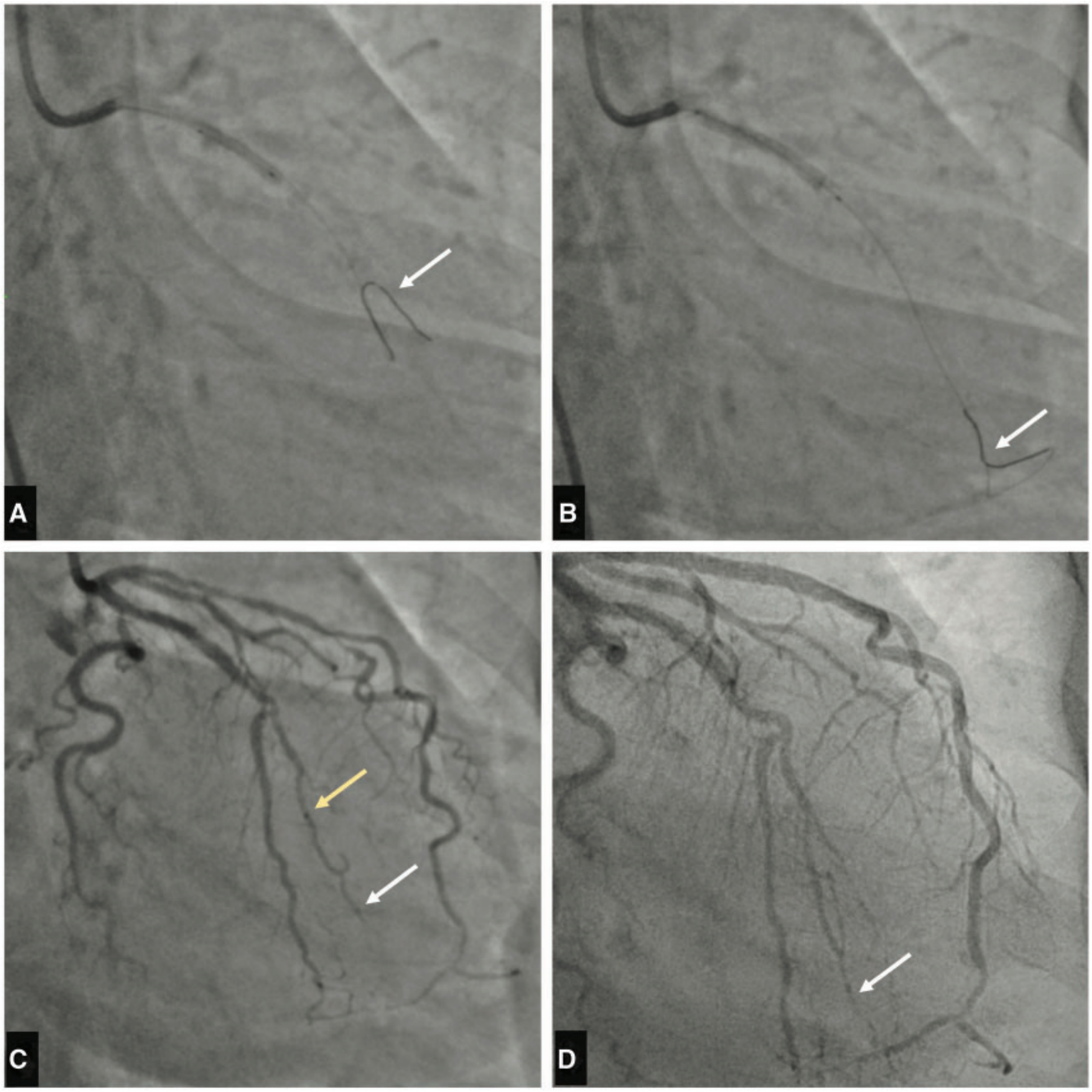


Figure 1 (*A*) Large loop of wire tip into a branch of OM (arrow). (*B*) Distal tip of the looped wire seen migrating down the small branch probably into the pericardial space (arrow). (*C*) Microcatheter (yellow arrow indicates tip of microcatheter tip) was used to inject fat globules into the branch proximal to the site of perforation. Immediate cessation of flow (white arrow) in the small branch after embolization. (*D*) Repeat angiogram after 6 months showed partial recanalization of the vessel distal to the embolization with no contrast extravasation.

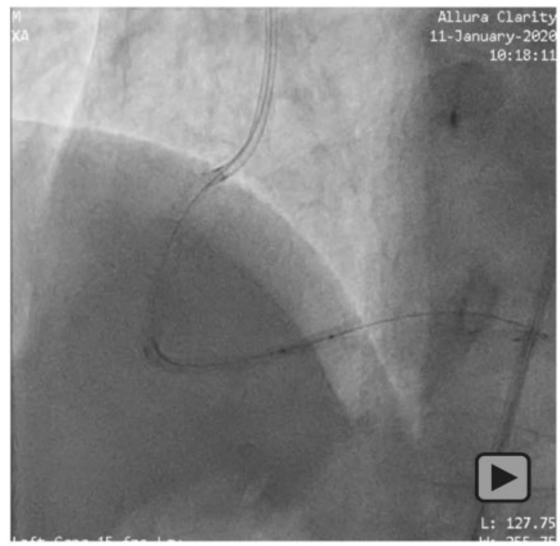
20 min, angiography demonstrated persistent contrast leak into the pericardial space. A Finecross microcatheter (Terumo Interventional Systems, Japan) was tracked down proximal to the perforation. A small incision (∼10 mm) was made close to the site of femoral access to extract subcutaneous fat tissue (*Figure 2A*). It was pulverized using a hypodermic needle to obtain fine fat globules, which was transferred to a 2 cc syringe along with iodine contrast (*Figure 2B*). Keeping the syringe vertical (so that the fat globules float above the contrast), the fat globule was injected via microcatheter into the distal part of the obtuse marginal branch just proximal to the perforation (*Figure 1C* and *Video 1*). A selective angiogram showed sluggish flow in the artery distal to embolization. A repeat angiogram after 2 min showed complete occlusion with a normal flow in the rest of vessel and its branches. Follow-up angiogram at 6 weeks showed recanalized distal OM1 with no contrast extravasation (*Figure 1D* and *Video 1*).

Case 2

A 64-year-old gentleman, known hypertensive and diabetic, presented to us with exertional angina refractory to medical therapy. Selective coronary angiography showed calcified vessels and significant stenosis of LAD, LCX (left circumflex artery), and dominant RCA (*Video 2*). Through femoral access, 6 Fr Judgkin's right 3.5 Launcher catheter (Medtronic, Inc.) was used to cannulate RCA. Due to inadequate support and tortuous coronary artery, a Guidezilla guide extension catheter was used. There was incomplete dilatation of the lesion with a semi-compliant balloon. The guidewire was exchanged with a 0.009 inch floppy RotaWire^{TM}

through a microcatheter. Rotational atherectomy was carried out using Rotablator™ rota ablation system (Boston Scientific Corporation) with a 1.25 mm burr. RotaWire™ was then exchanged with Sion Blue (Asahi Intecc) hydrophilic coated wire. While balloon dilating the lesion, the looped wire inadvertently got pushed into the distal vessel which the operator did not recognize (*Video 2*). Subsequently, coronary stents were deployed in proximal, mid, and distal RCA. The patient started to develop hypotension within few minutes, and the angiogram showed good stent expansion with no obvious complication. Upon changing the imaging angle to posteroanterior cranial view, contrast extravasation was noted in the distal tip of the posterior left ventricular (PLV) artery where the looped wire was previously parked (*Video 2*). Echocardiography confirmed a large pericardial collection. The pericardial blood was manually aspirated using a pigtail catheter. A femoral venous access was obtained using a 7 Fr vascular sheath

Video 1 Angiographic loops demonstrating the sequence of events in Case 1.



Video 2 Angiographic loops demonstrating the sequence of events in Case 2.

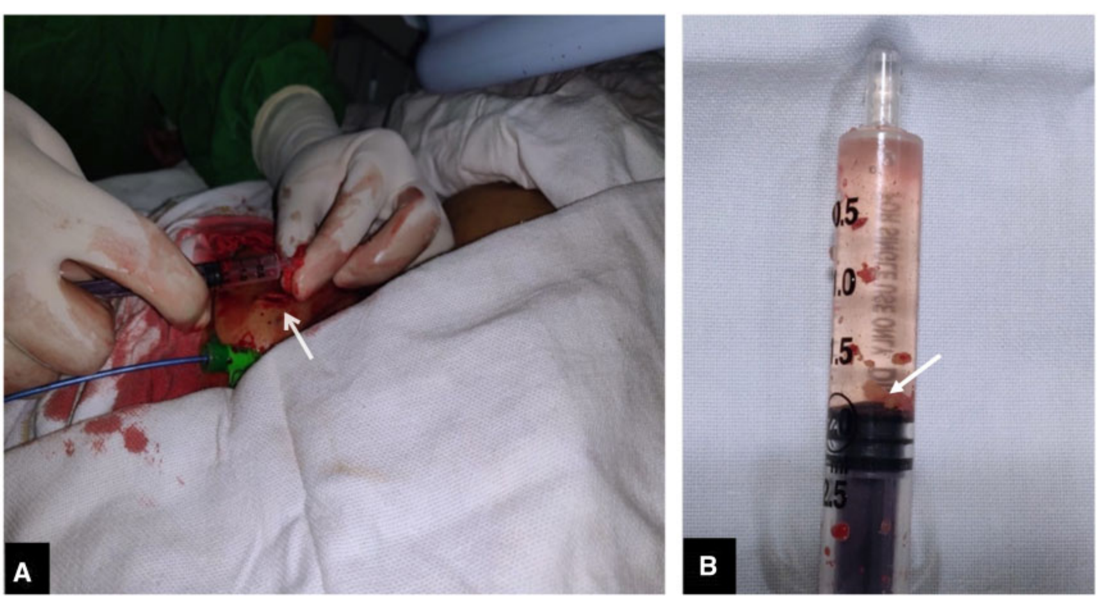


Figure 2 (*A*) Small incision over the groin to extract fat globules. (*B*) Pulverized fat globules (arrow) mixed with contrast agent in a small syringe ready to be injected through a microcatheter into the perforated vessel.

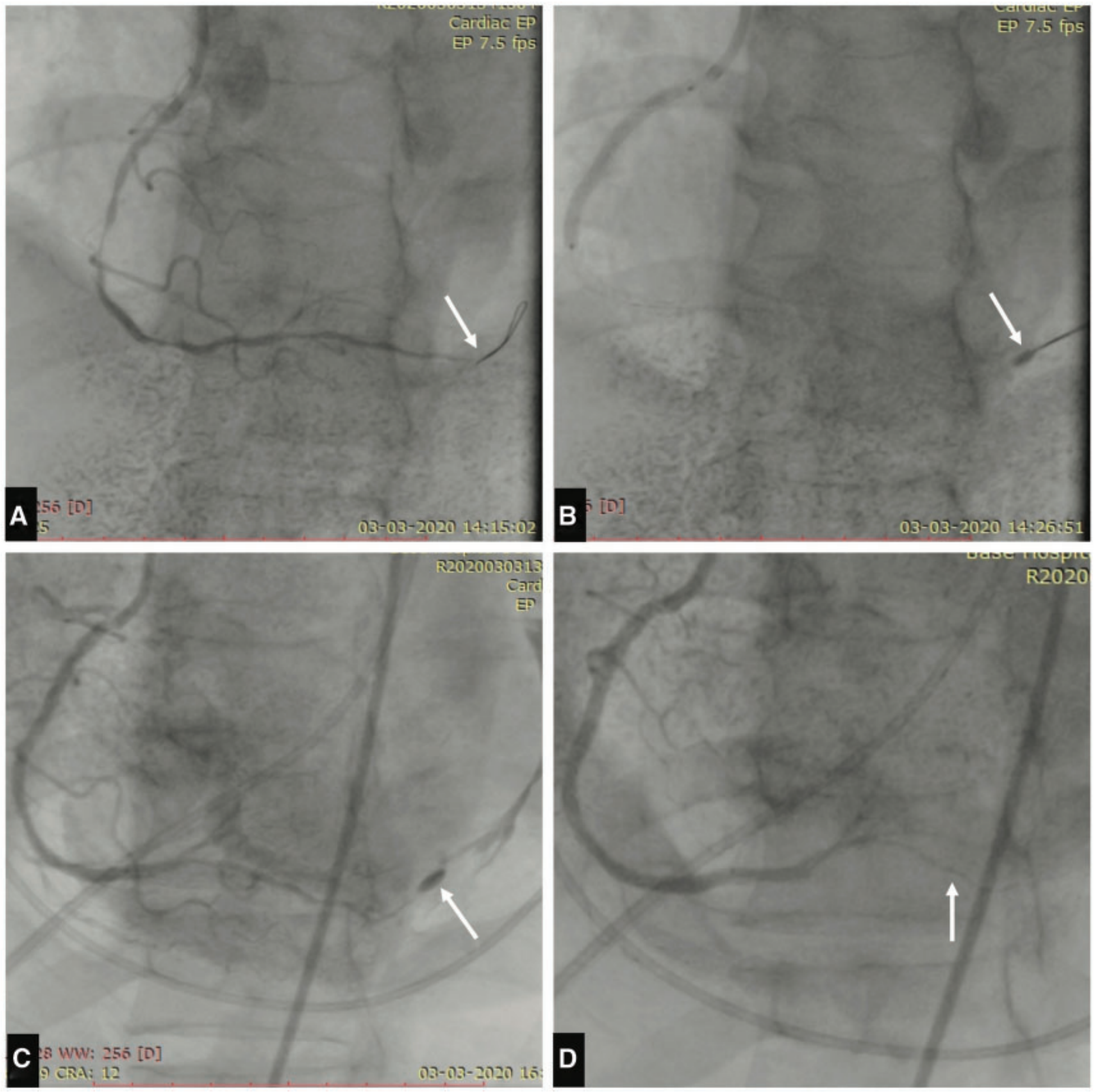


Figure 3 (*A*) The looped wire (arrow) was passed into the distal segment of posterior descending artery branch of right coronary artery. (*B*) Looped wire causing staining (arrow) of distal part of posterior descending branch due to vessel wall injury. (*C*) Check angiogram showing perforation in distal posterior descending branch. (*D*) Final angiogram showing cessation of flow in the distal posterior descending branch with sealing of perforation and normal flow in other branches.

and the aspirated blood was slowly hand injected (autotransfusion) through the sheath under sterile conditions. This cycle of aspiration and autotransfusion was continued till the perforation was sealed and the patient stabilized haemodynamically. The perforation did not seal despite intermittent balloon occlusion of the proximal arterial segment. Pulverized fat particles extracted from the subcutaneous fat of the thigh were mixed with iodine dye in a 2 mL syringe. The guidewire was exchanged with a Finecross microcatheter. The fat particle was injected into the distal part of PLV. Angiogram subsequently showed no contrast extravasation (*Video 2*). Reviewing all the angiogram confirmed that rota wire did not travel into the vessel of perforation. The patient improved haemodynamically, and there was no further accumulation of blood in the pericardial space.

Case 3

A 54-year-old female presented with inferior wall myocardial infarction. A selective coronary angiogram through right radial access done showed acute total occlusion of the dominant RCA in its middle segment and normal left-sided coronary circulation.

Using a 6 Fr JR 3.5 Launcher catheter, a Fielder FC (Asahi Intecc) guidewire was introduced into the RCA. The guidewire tip formed a loop on the way, which was further advanced and parked in the posterior descending branch (PDA) of RCA (*Figure 3A and B*). After dilatation of the lesion using a 2.0 mm × 12 mm semi-compliant balloon, a Vivo ISAR (Translumina Health Care, India) DES of size 2.75 mm × 21 mm was deployed at 10 atm. It was subsequently dilated with a 3.0 mm × 12 mm non-compliant balloon. The patient was haemodynamically stable while shifting to the coronary critical care unit after the procedure. Two hours later, she developed hypotension, and a bedside echocardiogram showed a large pericardial collection. A pigtail was inserted and the drained blood was continuously autotransfused. RCA angiogram showed contrast extravasation from the PDA branch (*Figure 3C*). The site of perforation was very distal, and the vessel injury was probably caused by the hard part of the looped wire in the distal branch of the artery. A Corsair (Asahi Intecc) microcatheter over a Sion Blue guidewire (Asahi Intecc) was placed in the distal PDA, 10 mm proximal to the site of perforation. Meanwhile an incision was made in the patient's right groin region, and a small piece of fat was harvested from the thigh and broken into small pieces. With the procedure described above, it was introduced along with iodine contrast into the distal part of PDA just proximal to the site of perforation. Angiogram taken just after the embolization of fat showed an immediate closure of perforation with no dye extravasation into the pericardium (*Figure 3D*). Over the next 48 h, there was no haemodynamics or echocardiographic evidence of re-accumulation, and the pericardial pigtail catheter was removed 36 h after the procedure.

Discussion

Coronary artery perforation is a dreaded complication of PCI. It is most commonly caused by oversized stent placement or balloon dilatation (balloon 1.2 times larger than artery),[6] high-pressure inflation of semi-compliant balloons, extensive dissection, lack of vessel wall integrity, abnormal migration of coronary guidewire into smaller branches, or out of coronary vasculature. Coronary artery perforations were conventionally classified into four types.[7] Muller *et al.*[8] modified the classification to accommodate for the distal coronary perforations related to the guidewire (Type V). Once recognized immediate sequence of steps are required to stop further extravasation and definite sealing of the perforation. These measures are guided by the site, severity, and haemodynamic state of the patient. The first step is often to inflate a balloon already in the catheter proximal to or at the site of perforation at the lowest possible pressure to just seal the leak. Cardiac tamponade, if present, needs to be relieved by pigtail drainage of pericardial blood, and the same can be infused through a peripheral or central venous access to reduce hypovolaemia. Vessel perforation at a site of large calibre can be immediately closed using covered stents, while distal coronary perforation is more challenging to manage with various coronary artery to deliver the covered stents or distal closure material (dual catheter or ping-pong technique).[9] Reversal of anticoagulation is usually avoided and should be restricted to cases in which sealing of perforation is unsuccessful.

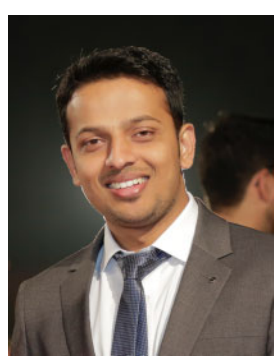
Distal vessel perforation is commonly due to inadvertent migration of coronary guidewire into small vessels or out of the coronary vasculature. Wire induced perforation amounts to up to 60% of the cause of coronary perforation in some series, and the risk is more common with hydrophilic guidewires (70%).[4] Dilatation of a balloon proximal to the site of perforation leads to closure of the perforation in most of the cases, and persistent extravasation will require one of many embolization techniques to cut off flow into the distal vessel. Various materials have been adopted for the definite closure, including occlusive coils, gel foam, and thrombin injection.[10,11] These materials may not be available in all the centres immediately, warranting the use of instantly preparable materials. One such innovative approach is to use autologous subcutaneous fat particles to occlude the vessel proximal to the perforation causing total occlusion of the distal vessel bed. This technique has only been reported scarcely in the literature, limited to case reports and case series.[12,13] Through a small incision in the exposed part of the upper thigh close to the site of femoral access, one can obtain a small amount of subcutaneous fat (*Figure 2*). The tissue is then pulverized to form smaller fat particles of up to 1 mm, which is then injected into the distal vessel, and the diluted contrast serves as an indicator. Adipose tissue is lighter than iodine contrast; hence one has to keep the syringe with tip upside so that the fat globule first enters the microcatheter. Visible contrast filling of the desired segment from the microcatheter indicates embolization. Repeat angiogram few minutes later can confirm successful embolization and occlusion. Considering the ease and effectiveness, it is desirable for every interventional cardiologist to be aware of this life-saving technique.

Looping or knuckling of the coronary wire tip is often considered to reduce the risk of coronary perforation and gives the operator more confidence to advance the wire across the vessel. However, one has to be cautious about the configuration the wire assumes once the knuckling or looping begins. Knuckling may sometimes be related to the tip creating or entering the mouth of dissection from where further advancement can potentially damage the vessel wall leading to the abrupt closure of the vessel or its perforation. The high elastic recoil related to bulkier leading portion and the rigid material of the looped wire's leading edge can also perforate the distal coronary vessel, as illustrated in the index cases.

Conclusion

Looped wire configuration can occasionally lead to vessel injury, hence further advancement needs special caution especially when it is into smaller branches. Autologous fat embolization is a quick, effective, and readily available technique for the management of distal vessel perforation.

Lead author biography



Atit A. Gawalkar graduated from Bangalore Medical College in 2014. He finished his Internal Medicine Residency and is currently receiving Cardiology training at the prestigious Post Graduate Institute of Medicine and Research, Chandigarh, India. He has interest in structural intervention, electrophysiology, and cardiovascular imaging. He has presented challenging interventional case and original study at national cardiology conferences. Having authored many peer-reviewed articles in indexed journals, he has a growing interest in medical research too.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

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