CASE REPORT

Use of embolic protective devices in treating acute arterial occlusions: an interventional radiology and vascular surgery collaborative learning experience

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SUMMARY

A 43-year-old man presented to the emergency department with left leg claudication. CT angiogram confirmed an acute left leg arterial occlusion from a left ventricular thrombus. During intra-arterial thrombolysis, he developed severe abdominal pain and a CT angiogram confirmed an acute occlusive thromboembolism to his left renal artery. Prior to left renal artery intra-arterial embolectomy, temporary intra-arterial occlusion balloons were inflated within his (1) right renal artery to protect this kidney from acute embolism and (2) left iliac artery to protect his left leg from further clot burden. Following the left renal embolectomy, an angiogram demonstrated patent renal arteries, acute occlusion of the right common iliac artery and persistent clot in his left iliac/lower limb. These occlusions were retrieved by surgical embolectomy. Final angiogram demonstrated patent bilateral iliac/lower limb arteries. The patient was discharged on lifelong anticoagulation and remains asymptomatic with bilateral palpable distal pulses and normal serum creatine.

BACKGROUND

This case highlights many salient situations and challenges faced in a teaching hospital. First of all, it demonstrates the integral interdepartmental relationship present at our institution, as this case involved collaboration of both interventional radiology and vascular surgery. Second, this case evolved from a 'routine' endovascular treatment of an acute lower extremity arterial occlusion to an urgent case of acute renal artery occlusion from a left ventricular embolus, which required swift clinical judgement and management. Finally, our management involved an endovascular technique commonly referred to as intravascular 'embolic protection', which in this case involved occlusive balloons being expanded within an artery to protect the downstream occluded vessel from potential clot that may arise from an upstream thrombus during thrombectomy.

In our case, prior to endovascularly retrieving the acute left renal artery embolism, occlusion balloons were inflated (1) within the right renal artery to prevent acute occlusion of this artery and thereby theoretically preserving renal function and (2) within the left iliac system to prevent further burden of already diagnosed clot in his left lower extremity. Angiogram following intra-arterial retrieval of his left renal artery embolism revealed that clot had embolised from the left renal artery to his unprotected right common iliac artery. In

hindsight, it would have been prudent to protect his unaffected right iliac system instead of the left iliac artery we chose to protect, as the clot within his left lower extremity still required treatment and there was little to benefit by protectively occluding the left side. We also question the utility of balloon protecting his right renal artery prior to the left renal artery embolectomy, since the likelihood of causing an embolic occlusion of the contralateral renal artery during thrombectomy is conceivably very low given the high-velocity blood flow through the abdominal aorta. Also, by balloon occluding his right renal artery, we put the patient at risk for right-sided renal ischaemia.

Embolic protection of downstream arteries during percutaneous renal thrombectomy has not been well-described in the literature and we have learned greatly from these series of events and feel our colleagues and future endovascular physicians would benefit from our oversight.

CASE PRESENTATION

A 43-year-old man presented to our emergency department in September 2011 with sudden onset of left-sided calf pain. He has a history of myocardial infarction in 2007 where he had a left ventricular thrombus embolise to his left lower limb, underwent successful intra-arterial thrombolysis and was discharged on life-long anticoagulation. He represented in June 2011 with a recurrent thrombotic event of his left lower limb and was again thrombolysed successfully. He has a history of being non-adherent to his anticoagulation medication. He is a non-smoker, does not have diabetes and does not have a contributing family history.

On physical examination, he had a cold and pale left lower extremity. The left dorsalis pedis and left posterior tibial arterial pulses were not palpable. There was poor capillary refill in his left foot. There were no left lower extremity ulcers or signs of infarction. Serum laboratory results including serum creatine, were normal.

A CT angiogram demonstrated a left ventricular thrombus and emboli to his left tibial-peroneal trunk, left anterior tibial and left profunda femoris arteries (figure 1).

He was admitted for intravenous heparin and consideration for thrombolysis. Following 24 h of peripheral intravenous heparinisation in the intensive care unit he did not improve and was scheduled for intra-arterial direct thrombolysis. Initially, an antegrade approach via the left femoral artery

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Figure 1 (A) Arterial-enhanced CT demonstrates a left ventricular thrombus (arrow). (B) Three-dimensional CT angiography reconstruction demonstrates filling defects of emboli to the left proximal peroneal trunk (solid arrow) and left anterior tibial (dashed arrow). Multiple filling defects are seen along the peroneal artery. Leg demonstrates opacified vessels (R=right; L=left). (C) Digital subtraction angiography showing acute embolus in the left profunda femoris artery (arrow).

was planned but ultrasound demonstrated thrombus in the common femoral and proximal superficial femoral artery. Therefore, a retrograde approach was performed through the right common femoral artery. Intra-arterial bolus administration of 10 mg tPA was performed, immediately after which the patient developed severe abdominal pain. We were suspicious for mesenteric ischaemia despite the patient not elucidating any peritoneal signs. A bedside ultrasound demonstrated a patent superior mesenteric artery and coeliac artery. A CT ischaemic bowel protocol of his abdomen confirmed acute thrombus to his infrarenal abdominal aorta and left renal artery with complete occlusion of the left renal artery (figure 2A).

He was then taken to the operating theatre where an intra-arterial left renal artery thrombectomy was planned. From the left, intra-arterial common femoral artery occlusion balloons were inflated to protect the right renal artery and left iliac system. Following percutaneous over-the-wire Fogarty (5.5 French Edwards Lifesciences Fogarty catheter) embolectomy of the left renal artery embolus, angiography demonstrated normal perfusion of his left kidney (figure 2B). Further angiography revealed that the retrieved left renal embolus had lodged in the unprotected right common iliac artery (figure 2C) with persistent clot in the left profunda femoris, left popliteal and left tibial system. Given the amount of contrast (visipaque 270, 170 ml total injected. A typical CT scan with intravenous contrast uses approximately 75–100 ml of intravenous contrast depending on the protocol) and radiation (21.4 min fluoroscopy time of 541 mGy) he had already received, the emboli in the right common iliac, left profunda femoris, left popliteal and left tibial arteries were retrieved by surgical embolectomy. Following

surgical retrieval of these bilateral lower extremity emboli, a final angiogram demonstrated a patent right common iliac artery and left femoral, popliteal and left tibial arteries (figure 3).

OUTCOME AND FOLLOW-UP

The patient recovered and was again discharged on lifelong anticoagulation. At subsequent follow-up the patient remains asymptomatic with palpable distal pulses and normal serum creatine.

DISCUSSION

Embolic protection devices are generally divided into two broad categories: (1) devices that reversibly prevent downstream blood flow by occluding a vessel and (2) devices that maintain blood flow but 'catch' varying sized particles from travelling downstream. The former is usually composed of a guidewire with an occlusion balloon at the distal end, and the latter may be composed of varying designs such as wire nests or baskets attached to the distal end of a guidewire.

The use of occlusion balloon protection devices is common practice in the management of arterial disease in order to prevent downstream embolisation or to control blood loss during trauma or surgery. In terms of managing arterial disease, by temporarily occluding distal blood flow while an intervention is performed, any debris trapped in the static column of blood may be aspirated prior to balloon deflation. Advantages of balloon occlusion include capturing small particles that would normally be deposited downstream from an intervention site. Disadvantages include the complete occlusion of blood flow, which may make visualisation of distal lesions difficult;

Figure 2 (A) Arterial-enhanced CT demonstrates an acute left renal artery thrombus (arrow). (B) Digital subtraction angiography (DSA) at the level of the renal arteries demonstrating preleft and postleft renal embolectomy highlighting opacification of the left renal artery following the percutaneous embolectomy. Note occlusion catheters in the right renal and left common femoral arteries. (C) DSA showing acute embolus in the right common iliac artery.

Figure 3 (A) Digital subtraction angiography (DSA) of the left popliteal trifurcation to surgical embolectomy demonstrating an occluded left posterior tibial artery (arrow). (B) DSA following surgical embolectomy, demonstrating patent left lower extremity circulation at popliteal trifurcation.

theoretical formation of thrombus distal to the occlusion owing to stasis; and the potential for debris along the edge of the balloon to embolise downstream following balloon deflation.

Devices that do not occlude blood flow include placing a filter basket at the distal end of the guidewire to capture embolic debris while maintaining distal blood flow. Advantages include the continuity of blood flow, whereas disadvantages include the passage of small particles, capture efficiency and deployment of the filters.

Embolic protection devices are used in many different arterial systems. For example, in a registry of carotid artery stenting, Wholey *et al*¹ describes a 5.3% rate of stroke/mortality in an unprotected group versus a 2.2% stroke/death rate in an arterial protected group presumably protecting the downstream cerebral circulation from migrating plaque during the stenting procedure. There are, however, two small randomised control trials that suggest balloon occlusion devices may not be effective in reducing distal emboli.^{2–3} There are also studies that suggest similar stroke rates following occlusive balloon protection versus filter protection.^{4–5} Embolic protection devices have also been used to protect the vertebral arteries during subclavian artery stenting to protect the posterior circulation,⁶ although there is a lack of data supporting its use.

Embolic protection devices have also been used in renal artery stenting, based on the observation that up to 20% of patients undergoing renal artery stenting experience an acute decline of renal function.⁷ One proposed mechanism of this decline in renal function has been because of embolisation to smaller renal arteries distal to the stent, for which balloon occlusion has been hypothesised to reduce such events. A small randomised control trial, however, showed no significant improved renal function during distal protection during stent revascularisation except when an adjunctive glycoprotein IIb/IIIa receptor antagonist was concurrently used with the embolic protection device.⁸

There is little data describing the distal embolisation rates following intra-arterial acute renal embolectomy and as a result, is an area of future research.

In terms of aortoiliac and femoral artery interventions, published studies have reported distal embolic rates between 3.8% and 37% from thrombolytic therapy.^{9–11} It is therefore a common practice to consider distal protection in recanalisation in certain high-risk patients. There is data that highly supports the use of occlusive devices in mechanical thrombectomy¹¹ and lower extremity angioplasty and/or stent placement of high-grade or occluded arteries^{12–13} with data showing distal embolisation following balloon protection ranging between 0% and 33%.^{10–14} The study describing a 33% distal embolisation despite balloon protection had a very small sample size (nine patients), but most studies describe a distal embolic rate ranging from 0% to 3%,¹⁵ which falls below the non-protected rates of 3.8–37%, suggesting a benefit of balloon protection (although there are no randomised control trials to our knowledge that support this claim). Interestingly, the small percentage of patients with distal embolisation despite balloon protection did not demonstrate any clinical sequelae of their acutely occluded downstream vessels. To our knowledge, there are no published reports on embolic protective devices causing irreversible downstream ischaemia.

Learning points

- ▶ This case highlights patient care by an integral collaborative relationship between interventional radiology and vascular surgery and how lessons can be learned from unique cases to take back to their respective departments to teach their colleagues.
- ▶ Acute renal artery occlusion is a rare, but important clinical diagnosis that requires urgent identification and management.
- ▶ Embolic prevention during management of acute embolic disease has been shown to reduce downstream emboli and can be prepared for in different manners, particularly total and partially occlusive techniques.
- ▶ There is paucity of researches or cases describing embolic protection devices in endovascular retrieval of acute renal artery thrombectomy emboli, and this is an area of future research potential.
- ▶ There is paucity of data on whether or not contralateral renal arterial embolic protection is necessary when an endovascular renal embolectomy is performed. In an effort to save the patient from radiation, intravenous contrast and potential ischaemic damage to the contralateral kidney by prolonged occlusion, contralateral renal artery occlusion could have been bypassed. Alternatively, a non-occlusive contralateral renal artery embolic protective device could have been considered.

Competing interests None.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

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