

Paradoxical embolism: a hidden cause of acute lower limb ischaemia in a young adult with diabetes and an atrial septal defect: a case report

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Br J Diabetes 2025;25(2):98-101
<https://doi.org/10.15277/bjd.2025.494>

Key words: paradoxical embolism, acute limb ischaemia, atrial septal defect, type 2 diabetes, case report

Abstract

Paradoxical embolism is a rare but recognised cause of acute systemic arterial occlusion, particularly in the presence of intracardiac defects such as atrial septal defects (ASDs). We report the case of a 36-year-old female with type 2 diabetes (T2DM) who presented with acute right lower limb ischaemia. Initial investigations revealed extensive lower limb arterial occlusions without evidence of underlying atherosclerosis, thrombophilia or arrhythmia. A transoesophageal echocardiogram identified a previously undiagnosed secundum ASD with bi-directional shunting. The patient was diagnosed with paradoxical embolism and initially managed with anticoagulation. Despite medical therapy, she developed limb-threatening ischaemia and underwent bilateral iliac embolectomy and a kissing common aorto-iliac revascularisation procedure. Autoamputation of the second right toe eventually occurred. She underwent percutaneous ASD closure using an Amplatzer™ device.

This case highlights the diagnostic challenges of paradoxical embolism in young patients, particularly when confounded by co-morbid conditions such as diabetes. Clinicians should maintain a high index of suspicion for structural cardiac anomalies in patients with acute arterial occlusion and no clear embolic source. Prompt recognition and closure of ASDs can prevent recurrent embolic events and improve outcomes. Transcatheter ASD closure remains a safe and effective treatment strategy in such cases.

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Introduction

The correlation between secundum atrial septal defects (ASDs) and paradoxical embolism in adults is a rare but documented occurrence.¹ Paradoxical embolism arises when a venous thrombo-embolus bypasses the pulmonary circulation traversing a cardiac or extracardiac defect, thereby entering the systemic arterial system.² Among such defects, a patent foramen ovale (PFO) is often implicated as the underlying anomaly, particularly in cases of embolic stroke of undetermined source.³ In patients with a secundum ASD, transient right-to-left shunting—typically occurring during early ventricular systole or with the Valsalva manoeuvre—can redirect vena caval blood through the atrial defect into the left atrium and subsequently the systemic circulation. We present the case of a young person with type 2 diabetes (T2DM) who developed acute right lower limb ischaemia and was subsequently diagnosed with a secundum ASD.

Case presentation

Patient information and clinical findings

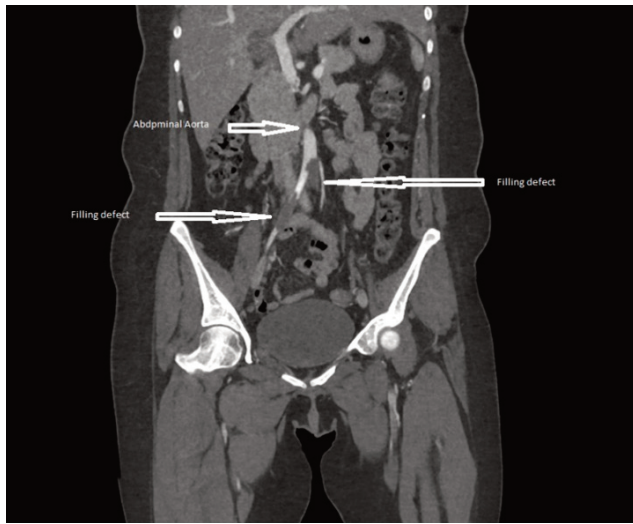
A 36-year-old Southeast-Asian female presented to her local urgent care centre in December 2023 with a one-week history of right leg and foot pain, associated with occasional altered sensation over the preceding months. She was a non-smoker and had a known history of type 2 diabetes (T2DM) [HbA_{1c} 8% (64mmol/L)] and iron-deficiency anaemia but she had no significant familial medical history and was on no regular medications. A diagnosis of presumed diabetic neuropathy was made, in the setting of untreated T2DM, and she was managed with analgesia, with advice to re-attend if symptoms worsened. A vascular examination was not documented at this timepoint.

Hours later, with worsening pain, reduced sensation and weakness, she attended the Emergency Department of our tertiary hospital. Examination revealed a cold, pale, painful leg with weak pulses. Acute right lower limb ischaemia was suspected, and she was urgently referred to the vascular surgery team.

Diagnostic assessment and initial intervention

An arterial Duplex ultrasound identified subacute tight stenosis of the distal aorta, with occlusion of the right external iliac artery

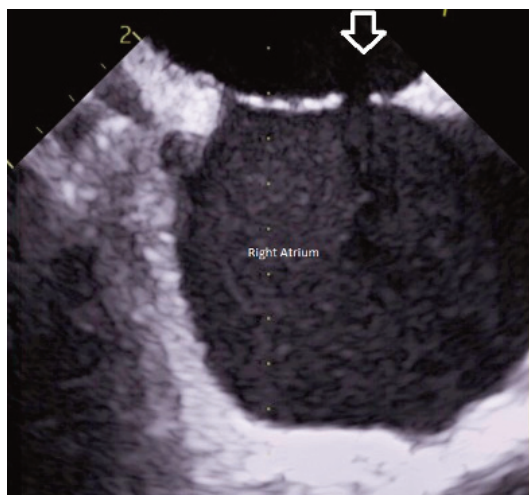
Figure 1a. Computed tomography angiogram (CTA) scan, showing bilateral occlusions of the common iliac arteries



and right trifurcation. Computed tomography (CT) angiography demonstrated a small filling defect of the distal aortic arch, bilateral occlusions of the common iliac arteries (figure 1a), and occlusion of the right tibio-peroneal trunk.

Extensive thrombophilia screening did not identify any underlying predisposition to thrombosis, and no predisposing medications (such as oral contraceptive pill use) were implicated. A 24-hour cardiac tape demonstrated sinus tachycardia with no arrhythmias. Trans-oesophageal echocardiogram (TOE) revealed an asymptomatic secundum ASD (figure 1b), with left-to-right shunting and no associated risk factors. A diagnosis of paradoxical embolism causing bilateral arterial lower limb ischaemia, particularly affecting the right foot, was made. No viable options for revascularisation were identified. She was managed medically with an

Figure 1b. Trans-oesophageal echocardiogram (TOE) before vascular repair, showing a secundum ASD



unfractionated heparin infusion. This was switched to treatment dose subcutaneous dalteparin alongside warfarin until a target international normalised ratio of 2-3 was achieved. Lifelong anticoagulation and ASD closure were recommended, with cardiology follow-up scheduled. The patient was advised to contact the vascular team if she had any concerns relating to changes in her leg.

Clinical course

Six weeks later, while attending for a Monofer infusion for iron-deficiency anaemia, she reported to the medical day unit team that she had noticed some purple discolouration of the toes of her right foot. An urgent vascular review was arranged. Arterial Duplex ultrasound showed multiple occlusions in the lower limb arteries, characterised by monophasic waveforms and limited perfusion. She continued on anticoagulation. The case was discussed at the vascular multidisciplinary team (MDT) meeting, where it was agreed to prioritise closure of the ASD, given the absence of a clear indication for revascularisation at that stage. At her two-week vascular follow-up review, limb-threatening ischaemia was evident, with apical gangrene of the right second toe and hallux embolic patches (figures 2a and b). Toe pressures were absent bilaterally. The right ankle-brachial pressure index (ABPI) was too faint to assess, while the left measured 0.5, consistent with moderate arterial insufficiency.

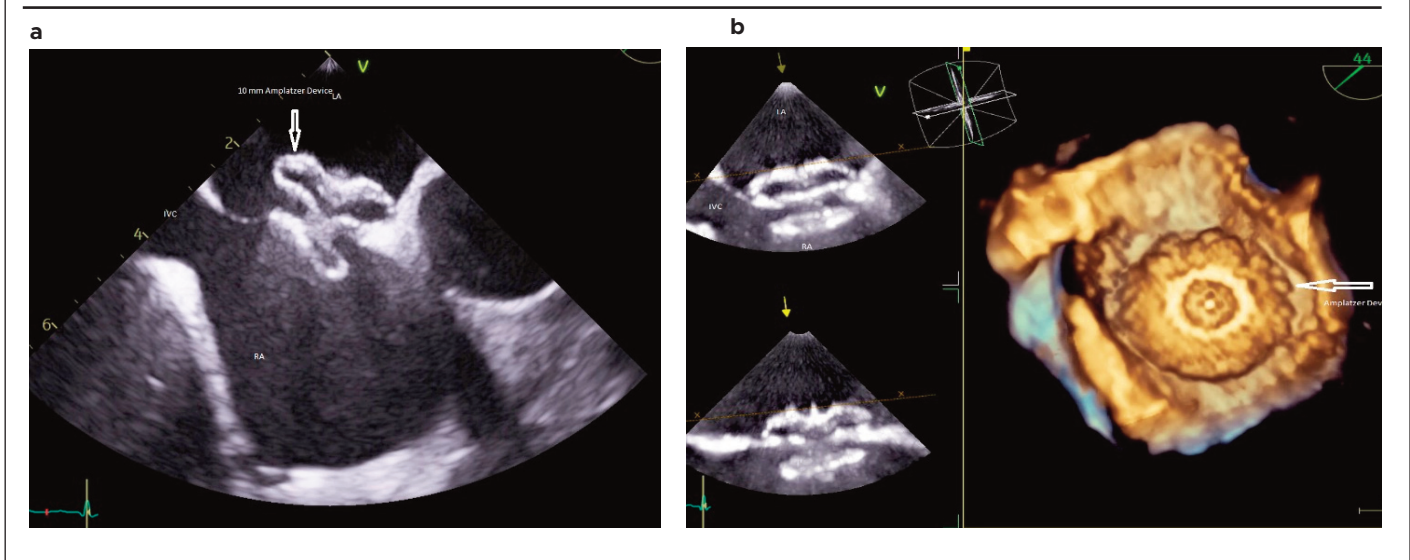
Figure 2. Photographs of the right foot at vascular review, showing apical gangrene of the right second toe



Therapeutic intervention

With limb-threatening ischaemia identified, bilateral iliac embolectomy and a kissing common aorto-iliac revascularisation procedure took place. Following recovery from this, in July 2024, she underwent successful ASD Amplatzer™ device closure (figures 3a and b).

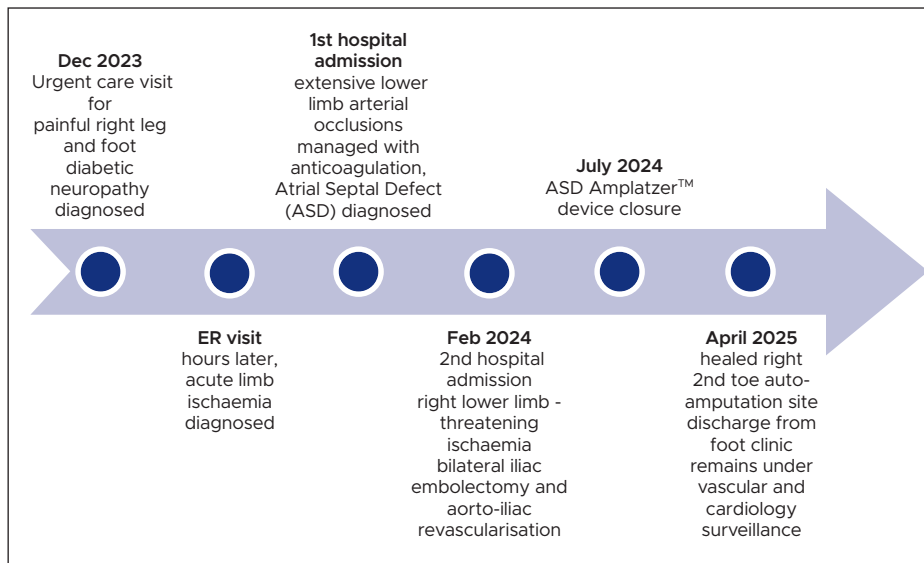
Figure 3. A TOE of the ASD after repair



Follow-up and outcome

The right second toe subsequently autoamputated. The patient was discharged from the Multidisciplinary Diabetes Foot Clinic in April 2025 as the amputation site ulcer had completely healed and vascular supply remained optimised. She continues long-term warfarin therapy and has follow-up with both the vascular and cardiology specialists.

Case timeline



Discussion

Acute lower limb ischaemia, often resulting from arterial occlusion, is a sudden and rapidly developing reduction in limb perfusion, with new-onset or worsening symptoms that threaten limb viability. Extensive venous occlusion is rarely contributory.⁴ The incidence per year is approximately 1.5 cases per 10,000 persons.⁵ The risk of developing peripheral arterial disease (PAD) is increased in older patients, smokers, and those with conditions such as dyslipidaemia, diabetes, hyperviscosity syndromes and hypercoagulable states that often progress from claudication to rest pain and to ischaemic ulcers or gangrene. Diabetes increases the risk of PAD 3-4 fold and, in the

presence of diabetic neuropathy, leads to an increased risk of foot ulcers and infections.⁴

In previously asymptomatic patients, lower limb ischaemia could be the result of an acute embolic or thrombotic event. Regardless, the incidence of lower limb ischaemia arising from embolic or thrombotic events has reduced because of fewer cases of rheumatic valvular heart disease and the increased use of anticoagulation in atrial fibrillation.

Initial assessments should include visual inspection of limb appearance, palpation of pulses including Dopplers, assessment of temperature difference, and testing for sensation and motor strength in order to stage the severity of ischaemia as viable, threatened or non-viable.⁶ This staging guides choice of further evaluation and mode of revascularisation intervention.

Most arterial emboli that travel to the extremities originate in the heart, from a thrombus arising from an atrium, left ventricle, prosthetic or infected cardiac valve. They frequently lodge in the common iliac arteries, femoral and popliteal artery bifurcations, as occurred in our patient.⁷ Paradoxical embolism, although more commonly associated with cryptogenic strokes and a patent foramen ovale, is a rare source of embolus causing acute lower limb ischaemia. ASDs typically lead to a left-to-right shunt. A transient increase in



Key messages

- ▲ In people with diabetes, acute onset of unilateral leg or foot pain and/or paraesthesia should prompt further assessment. Urgent review of skin colour, temperature, pulses and neurology is imperative, with a low threshold for consideration of acute lower limb ischaemia as a potential cause in this setting
- ▲ Acute lower limb ischaemia can, rarely, result from a paradoxical embolism through an atrial septal defect. Clinicians should maintain a high index of suspicion, in the absence of atherosclerosis, arrhythmia or thrombophilia
- ▲ Timely vascular assessment and intervention are critical to optimise outcomes and prevent limb loss

right heart pressure causes a reversal of blood flow across the shunt. The deep venous thrombi then traverse the interatrial defect to access the arterial circulation. In some cases, a pre-existing bi-directional shunt precipitated by the Valsalva manoeuvre or during early ventricular systole might account for the paradoxical embolism. This has been demonstrated in some transcranial Doppler studies.⁸ Indeed, in our patient, there was also evidence of a right-to-left shunt on bubble study. In a single-centre analysis of patients undergoing percutaneous ASD device closure, up to 14% of cases were associated with paradoxical embolism.⁹ These patients were often younger, likely to be female and had smaller atrial septal defect size, as in our case (0.4cm x 0.5cm).

A TOE showing a pulmonary-to-systemic flow ratio (Qp/Qs) of 1.6:1 is indicative of a significant left-to-right shunt. Along with paradoxical embolism, it was an indication for closure of the atrial communication in our patient.

Conclusion

This is a rare case of acute limb ischaemia resulting from a paradoxical embolus from an undiagnosed congenital ASD in a young woman. Interatrial septal abnormalities are the most encountered congenital heart defects in adult cardiology; hence, clinicians should have a high index of suspicion for cardiac sources of embolism in the setting of a young patient with acute limb ischaemia but without a history of atherosclerosis, thrombophilia or vasculitides. Although our patient had untreated diabetes, which was initially thought to be the cause of her symptoms, structural cardiac disease should be strongly considered as a differential in patients especially if there is no identifiable thrombotic or embolic phenomenon. Diagnosis can be challenging but requires prompt intervention

to salvage extremities in patients with limb-threatening ischaemia. Paradoxical embolism is an indication for closure of secundum ASD defects,¹⁰ and transcatheter device closure is safe and effective.

Patient perspective

From the patient's point of view, it is important that clinicians carefully check and investigate problems that keep coming back, such as a painful foot. She was surprised by the diagnosis and felt that early examination and investigation can help ensure the right treatment is given and prevent the condition from getting worse.



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Conflict of interest None to declare.

Funding None.

Patient consent Obtained.

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