

Endovascular Balloon Occlusion in the Management of an Iatrogenic Superficial Femoral Artery Pseudoaneurysm

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Abstract

Iatrogenic arterial injuries, especially those leading to pseudoaneurysms, are common complications following percutaneous vascular access and interventional procedures. While small pseudoaneurysms may resolve spontaneously or be managed conservatively with observation and serial ultrasound follow-ups, larger or more complex pseudoaneurysms often require more advanced interventions. Ultrasound-guided compression (UGC) is a widely used first-line treatment due to its simplicity, non-invasive nature, and cost-effectiveness. However, its success is limited, particularly in the case of wide-neck pseudoaneurysms, as seen in this report. In a case where UGC failed to achieve thrombosis in a multilobed, wide-neck pseudoaneurysm, endovascular balloon occlusion was employed. This technique involved temporarily inflating a balloon at the pseudoaneurysm neck, effectively reducing blood flow to the sac and promoting thrombosis. The procedure successfully occluded the pseudoaneurysm, minimizing the risk of distal embolization and preventing the need for open surgical repair. This minimally invasive approach offers a promising alternative for the management of iatrogenic femoral artery pseudoaneurysms, particularly when conventional methods fail. The technique not only avoids the risks associated with surgery but also demonstrates a high level of efficacy in inducing thrombosis, ensuring the preservation of distal arterial flow and avoiding significant morbidity. This case underscores the utility of endovascular balloon occlusion in treating complex pseudoaneurysms and highlights its potential as a preferred method in certain clinical settings.

Keywords: Endovascular Balloon Occlusion; Pseudoaneurysm; Superficial Femoral Artery

Introduction

Iatrogenic arterial injuries leading to pseudoaneurysm formation remain a notable complication of percutaneous vascular access and interventional procedures. Reported incidences of iatrogenic superficial femoral artery pseudoaneurysms vary by procedure type, ranging from 0.1% – 0.2% following diagnostic angiography to 3.5% – 5.5% after interventional procedures, with some studies citing rates as high as 8% (Ibrahim *et al.*, 2017). Risk is increased in the presence of large-bore sheath use, anticoagulation, obesity, repeated arterial puncture, and difficult or improper puncture techniques (Mazurkiewicz *et al.*, 2024).

Small pseudoaneurysms with a narrow neck may thrombose spontaneously or respond well to ultrasound-guided compression. However, more complex lesions such as large sac dimensions, wide

neck, active extravasation, or large hematoma often necessitate a more definitive yet minimally invasive alternative to open surgical repair (Dzijan-Horn *et al.*, 2014).

In this case, we describe a successful use of endovascular balloon occlusion in managing an iatrogenic superficial femoral artery pseudoaneurysm following vascular access, highlighting the procedural considerations, technical advantages and disadvantages, as well as the role of this approach.

Case Presentation

A 53-year-old gentleman with morbid obesity, congestive cardiac failure (CCF) and underlying prolapsed intervertebral disc (PID) with bilateral L5 traversing nerve roots compression, presented to the emergency department with worsening lower back pain radiating to the left lower limb. He was found to be hypovolemic and hypoglycemic. Laboratory tests revealed markedly elevated serum urea (69.4 mmol/L), elevated serum creatinine (804 $\mu\text{mol/L}$), and severe hyperkalemia (7.4 mmol/L). He was diagnosed with CCF and advanced chronic kidney disease (CKD) in shock with symptomatic hypoglycemia. He was counselled for urgent hemodialysis, and a right femoral vein catheter (FVC) was inserted for Sustained Low-Efficiency Dialysis (SLED). He required hemodynamic support with an intravenous infusion of noradrenaline at 5.6 mL/hour.

After insertion of the right FVC, the patient was found to have swelling in the right inguinal region. Computed tomography angiography (CTA) of both lower limbs (Figure 1) revealed a multilobed, wide-neck pseudoaneurysm of the right superficial femoral artery (SFA). The right FVC remained in situ with its tip positioned in the right external iliac vein. Ultrasound-guided compression of the pseudoaneurysm neck was performed for 2 hours daily over three consecutive days; however, no thrombosis of the pseudoaneurysm was achieved. The patient was subsequently referred to the interventional radiology center for a digital subtraction angiogram (DSA) of the right lower limb and further management.



Figure 1: CTA of the Right Lower Limb

A multilobed pseudoaneurysm (arrowhead) was arising from the right superficial femoral artery (arrow).

On the day of the procedure, digital subtraction angiography (DSA) of the right femoral artery via retrograde crossover approach from contralateral common femoral artery (CFA) demonstrated a multilobed pseudoaneurysm (Figure 2) with neck measuring 7.2 mm in width, 7.0 mm in length, and parent artery measures 6.8 mm in diameter. An angioplasty balloon slightly larger than the parent vessel 7 mm in diameter and 40 mm in length was selected for endovascular balloon occlusion (Figure 3) at the neck of the right SFA pseudoaneurysm. It was inflated for 2 - 3 minutes for two cycles in suboptimal pressure up to 2 atmospheric (atm) pressure, with 1 minutes resting in between. Ultrasound evaluation during balloon inflation showed no color Doppler inflow into the pseudoaneurysm, indicating successful occlusion. However, the post-occlusion DSA demonstrated a small residual contrast opacification at the pseudoaneurysm neck with no contrast flow into the pseudoaneurysm sac indicating thrombosis. Three additional balloon occlusion attempts were performed, but similar findings persisted. The final post-

procedural DSA showed patent right femoral artery with preserved flow to its distal lower limb and branches.

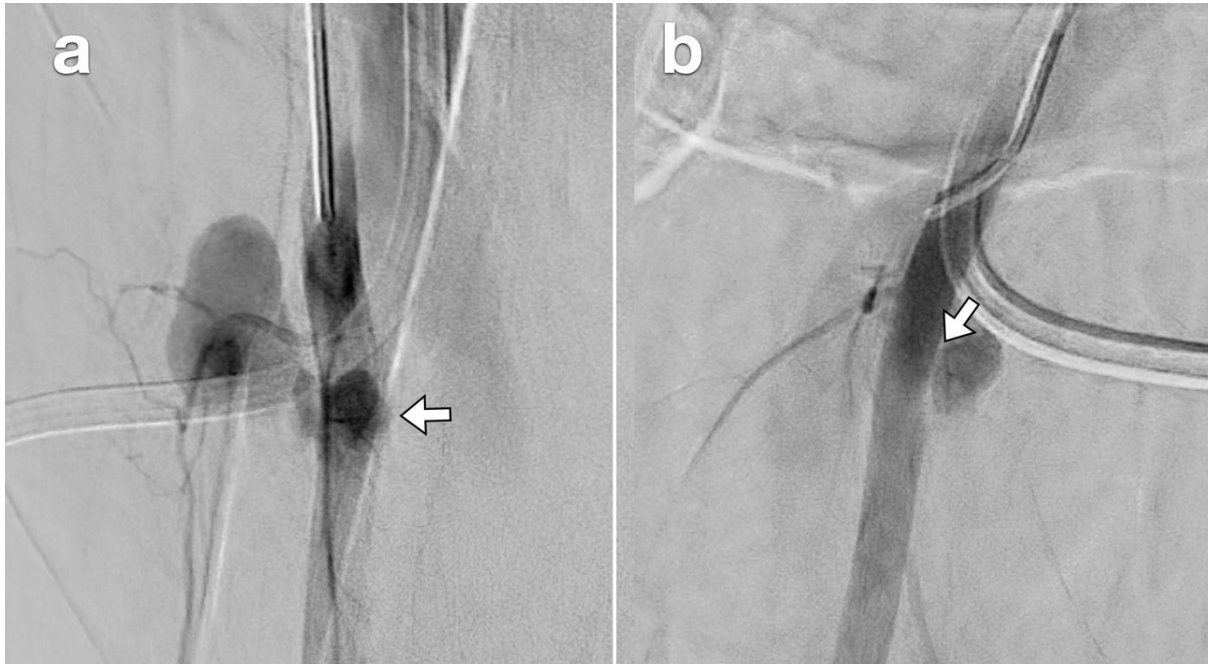


Figure 2: DSA of right superficial femoral artery (SFA). (a) The frontal view (PA) showed the multilobed pseudoaneurysm (arrow). (b) The right anterior oblique (RAO) view showed a better view of the neck of the multilobed pseudoaneurysm (arrow)

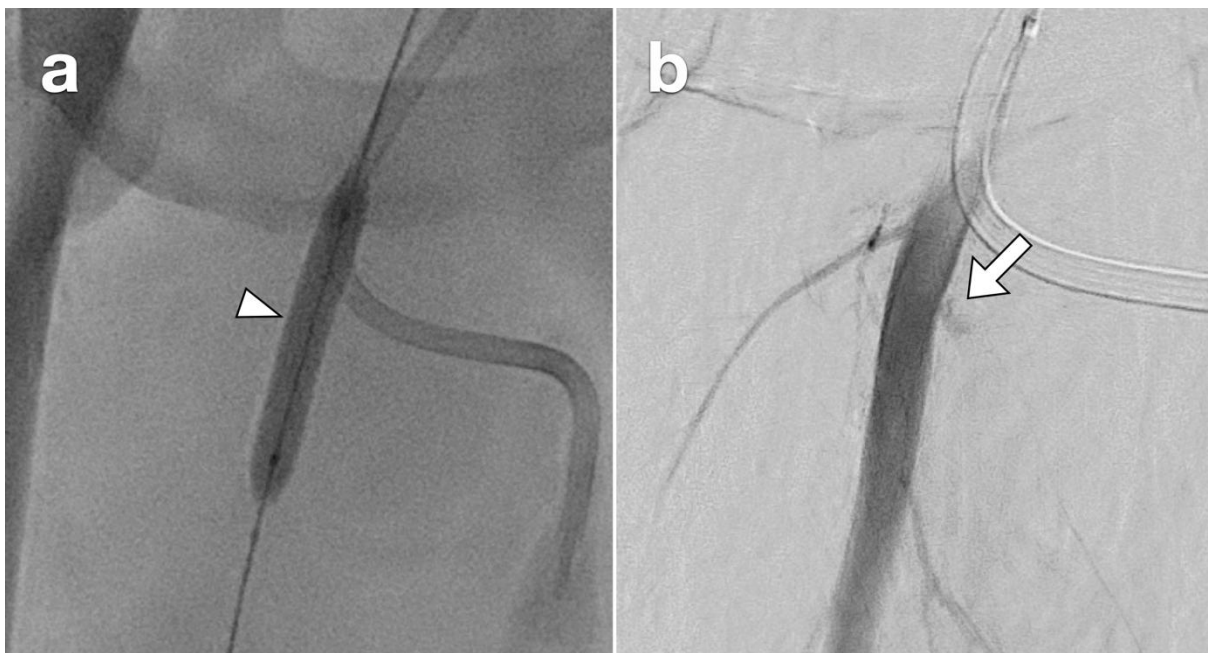


Figure 3: Angiographic images of the interventional procedure. (a) Balloon occlusion of the right SFA at the pseudoaneurysm neck region (arrowhead). (b) Post-procedure DSA showed the pseudoaneurysm was thrombosed with residual opacification of the neck of the pseudoaneurysm (arrow)

Ultrasound follow-up on the day after balloon occlusion demonstrated complete thrombosis of the right SFA pseudoaneurysm and its neck (Figure 4). The right inguinal hematoma had decreased in size, and the patient was subsequently discharged home after removal of the FVC.

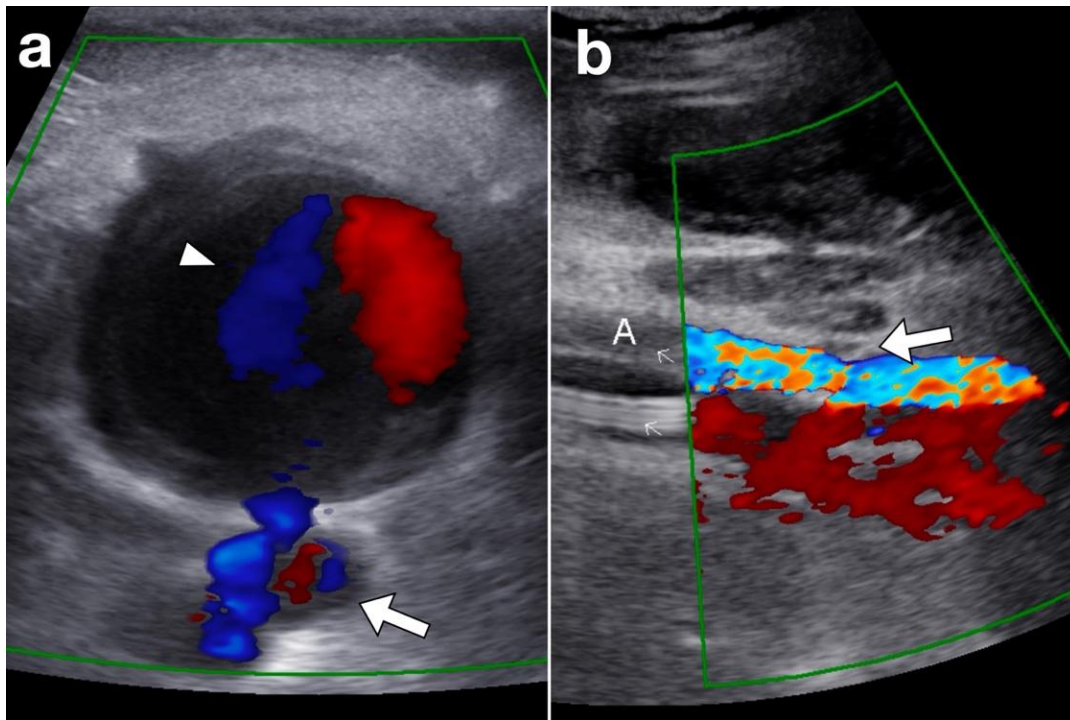


Figure 4: Ultrasound images of the SFA pseudoaneurysm. (a) The first ultrasound showed a multilobed pseudoaneurysm (arrow) with a yin-yang sign (arrowhead). (b) Post-balloon occlusion ultrasound on the next day showed complete thrombosis of the pseudoaneurysm and its neck

Discussion

Pseudoaneurysms smaller than 2 cm may resolve spontaneously and can be managed conservatively with observation and serial ultrasound follow-up (Toursarkissian *et al.*, 1997). Ultrasound-guided compression (UGC) is usually the initial treatment of choice because it is simple, inexpensive, and entirely non-invasive. The procedure is commonly performed by applying continuous, targeted pressure using an ultrasound probe at the neck of the pseudoaneurysm to occlude the inflow and promote thrombosis. Standard protocols typically recommend compressing the neck of pseudoaneurysm for 10 to 15 minutes, allowing a short rest of 5 to 10 minutes, and repeating up to three cycles or until thrombosis is achieved (Mazurkiewicz *et al.*, 2024). Despite its advantages, UGC is limited by patient discomfort, long procedure times, and a relatively high recurrence rate, particularly in individuals taking anticoagulants or those with a wide-neck pseudoaneurysm (Mazurkiewicz *et al.*, 2024). Pseudoaneurysms smaller than 2cm are more likely to thrombose, whereas lesions exceeding 4 cm have lower success rates. Wide-neck pseudoaneurysms also present a challenge because persistent arterial inflow makes complete neck compression and thrombosis more difficult (Mazurkiewicz *et al.*, 2024).

Ultrasound-guided thrombin injection (UGTI) induces rapid thrombosis by directly injecting thrombin into the pseudoaneurysm sac under ultrasound guidance, with success rates ranging from 85% to 100% (Mazurkiewicz *et al.*, 2024). However, this method carries a small risk of distal embolization, especially when the pseudoaneurysm neck is short or wide, allowing thrombin to pass into the parent artery unintentionally. Distal embolization can cause severe morbidity and mortality, including limb ischemia and amputation.

Endovascular balloon occlusion is a valuable method for managing pseudoaneurysms by temporarily inflating a balloon at the neck of the pseudoaneurysm, occluding blood flow into the pseudoaneurysm sac and promoting thrombosis within it. Additionally, embolic materials such as thrombin or n-Butyl-2-cyanoacrylate (nBCA) glue can be percutaneously directly injected with balloon occlusion to minimize the risk of distal embolization (Grivau *et al.*, 2018; Le *et al.*, 2021). In our center, balloon-assisted UGTI

was not performed because thrombin was unavailable. Balloon-assisted glue injection was also avoided due to concern that the balloon might become adherent to the arterial wall or pseudoaneurysm if the glue contacted the balloon surface and crystallized. Hence, endovascular balloon occlusion without percutaneous direct embolic material injection was performed. We selected the balloon diameter to match the parent artery, ensuring complete occlusion. A successful flow arrest can be confirmed with real-time ultrasound, showing an absence of color Doppler flow signals entering the sac. When the parent artery is adequately occluded, the balloon will remain stable against the arterial wall as well. Potential complications include arterial injury, dissection, or thrombosis of the parent vessel.

If simple balloon occlusion fails, balloon-assisted coil embolization may be considered by percutaneous direct coiling or by the endovascular route. However, coil placement can restrict subsequent shrinkage of the pseudoaneurysm and may act as a potential focus for infection. Direct coil embolization may also increase pressure within the pseudoaneurysm sac, which lacks the normal three-layered arterial wall, thereby increasing the risk of rupture (Mazurkiewicz *et al.*, 2024).

Stent placement is a treatment option for pseudoaneurysms with a wide neck, as it allows for the exclusion of the pseudoaneurysm from the arterial circulation; however, it is relatively costly. Bare-metal stents can be used in conjunction with coils deployed through the stent struts to promote thrombosis within the sac. Covered stents provide a practical and minimally invasive method for sealing the pseudoaneurysm neck. However, their use is best reserved for large, relatively straight vessels because small or tortuous arteries are associated with higher thrombosis rates (Mazurkiewicz *et al.*, 2024). Careful evaluation of vascular anatomy is essential before proceeding with stent placement. Patients who receive a stent usually require long-term anticoagulant therapy to prevent thrombosis and ischemic events. Stent fracture, particularly in the inguinal region due to frequent flexion, is another long-term risk that may lead to thrombosis or vascular injury.

Open surgical repair may be indicated in cases of hemodynamic instability, suspected infection, skin necrosis, or compression of adjacent structures that result in neuropathy, calcification, or critical limb ischemia (Mazurkiewicz *et al.*, 2024). Surgery carries inherent disadvantages such as the need for general anesthesia, potential wound complications, and risk of femoral nerve injury. Although uncommon, severe complications may result in limb loss or mortality.

Future Scope

This study is limited by its nature as a single case report, which restricts the generalisability of the findings to a wider patient population. Although endovascular balloon occlusion was successful in this case, the outcome may vary depending on pseudoaneurysm size, neck morphology, vascular anatomy, patient comorbidities, and availability of interventional resources. In addition, long-term follow-up was limited, so delayed complications such as recurrence, parent artery thrombosis, restenosis, or vascular injury could not be fully assessed.

Limitation

Future studies should include larger case series or prospective multicentre studies to further evaluate the safety, efficacy, recurrence rate, and long-term outcomes of endovascular balloon occlusion in managing iatrogenic femoral artery pseudoaneurysms. Comparative studies between ultrasound-guided compression, thrombin injection, balloon-assisted embolization, stent placement, and simple balloon occlusion may also help establish clear treatment guidelines for complex or wide-neck pseudoaneurysms.

Conclusion

Endovascular balloon occlusion is an alternative for managing iatrogenic femoral artery pseudoaneurysms when the compression technique is unsuccessful in cases of persistent or complex pseudoaneurysms. This minimally invasive technique provides temporary flow control, potentially eliminating the need for open surgery and its associated risks.

Instruction for AI Assistance Declaration

The author hereby declares that, during the preparation of this manuscript, generative AI tools such as ChatGPT, Microsoft Copilot, and Google Gemini were utilized to assist with language enhancement and grammar correction. Following the use of these tools, the author thoroughly reviewed and revised the content and takes full responsibility for the final version of the manuscript, ensuring its accuracy and adherence to the required academic standards.

Conflict of Interest

The authors declare that there is no conflict of interest as the research was not conducted for commercial or financial purposes.

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