

Tortuous treatment process of a complex femoral pseudoaneurysm following atrial fibrillation ablation: a case report

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Background

Although the rate of vascular complications following catheter ablation has been decreasing in the past 10 years, it remains a common and thorny problem in clinical settings. For the majority of iatrogenic pseudoaneurysms (PSAs), non-surgical therapeutic approaches such as ultrasound-guided compression repair (UGCR) and ultrasound-guided thrombin injection (UGTI) have been used as first-line regimens. However, suitable treatment for PSA mainly depends on the characteristics of the PSA.

Case summary

This report presented the case of a 75-year-old woman who suffered from a beaded multi-chamber femoral PSA combined with arteriovenous fistula between the superficial femoral artery and the common femoral vein following radiofrequency ablation of atrial fibrillation. The treatment process of the PSA was tortuous. After a UGCR attempt, the PSA was not occluded. The UGTI successfully clotted the superficial and middle chambers of the PSA. After repeat UGCR, the residual deep chamber of the PSA was expanded, and the skin deteriorated. The complicated PSA was finally treated with surgical repair.

Discussion

Appropriate treatment for PSA depends on the anatomical characteristics of the PSA and indications of various treatment measures.

Keywords

Pseudoaneurysm • Arteriovenous fistula • Atrial fibrillation ablation • Ultrasound-guided thrombin injection • Ultrasound-guided compression repair • Case report

ESC Curriculum

2.2 Echocardiography • 5.3 Atrial fibrillation • 7.4 Percutaneous cardiovascular post-procedure • 9.3 Peripheral artery disease • 4.11 Endocarditis

Learning points

- A beaded multi-chamber pseudoaneurysm could lead to force dispersion during ultrasound-guided compression repair.
- Incomplete occlusion of a multi-chamber pseudoaneurysm and continuous compression could expand the residual chamber rather than close it.
- Full understanding of the characteristics (size, chamber, morphology, and structure) of the PSA is important when choosing the optimal strategy for successful treatment.

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Introduction

Vascular complications are common during a catheterization procedure. In cardiac electrophysiology (EP) procedures, the rates of femoral pseudoaneurysm (PSA) and femoral arteriovenous fistula (AVF) were up to 0.4–0.9% and 0.2–0.5%, respectively.^{1–3} Although the rate of vascular injuries following catheter ablation (CA) of atrial fibrillation (AF) has been decreasing over the recent decade, it is still a common and inconvenient problem in clinical settings.⁴ For the majority of post-catheterization PSAs, ultrasound-guided compression repair (UGCR) and ultrasound-guided thrombin injection (UGTI) have been employed as first-line regimens in turn since the 1990s.⁵ However, surgical repair is still necessary in some complex instances.

Timeline

Time	Events
Procedure (Day 0)	The patient underwent AF radiofrequency ablation under uninterrupted anticoagulation strategy by performing femoral vascular access without vascular ultrasound guidance.
Day 1	The patient complained of left groin pain and swelling. Vascular ultrasound showed a beaded PSA with three chambers combined with an AVF. Initially, ultrasound-guided therapy was chosen to treat the uncomplicated PSA. Considering that the combination with AVF was a relative contraindication of UGTI and the PSA possessed a narrow neck, we used UGCR for 2 days as the first attempt.
Day 3	The size and velocity of the PSA and AVF were not improved by UGCR. The two most superficial chambers of the PSA were not close to the AVF, and the deep chamber was small. Thus, thrombin was injected into the middle chamber and clotted the middle and superficial chamber using the 'three-way stopcock technique' of UGTI. A repeat UGCR was attempted to close the deep chamber.
Day 6	Vascular ultrasound showed that the deep chamber of the PSA remained, and UGCR was performed continually.
Day 11	Vascular ultrasound revealed that the deep chamber of the PSA was expanding, and the skin deteriorated after repeated UGCR. The patient finally received surgical repair.
Day 14	The patient was discharged home.
Follow-up (3 months)	The patient remains asymptomatic and vascular ultrasound revealed a total recovery of the PSA and AVF.
Follow-up (2 years)	The patient did not experience any other AF-related complications including recurrence.

Case summary

A 75-year-old woman with a history of hypertension underwent radiofrequency ablation for persistent AF. Her body mass index was 31.6 kg/m², and CHA₂DS₂-VASc score and HAS-BLED score were 4 and 1 point, respectively. Uninterrupted administration of dabigatran was initiated for perioperative anticoagulation. Bilateral femoral vein (FV) accesses

were performed without vascular ultrasound guidance. An 8-F short sheath and an 8.5-F long sheath were introduced via the right FV for positioning of the decapolar catheter and the 3.5-mm cooled saline-irrigated ablation catheter. An 11-F sheath was introduced into the left FV for the placement of the intracardiac echocardiography. After successful bilateral pulmonary vein isolation and sheath removal, a routine 8-h bandage compression was applied. She complained of left groin pain on the day after AF-CA. The left inguinal region was swelling, whereas the dorsalis pedis was palpable and there were no signs of skin damage or neurological deficit. The haemoglobin decreased from 11.5 to 9.2 g/dL with haemodynamic stability. The vascular ultrasound revealed a PSA from the superficial femoral artery (SFA) with a narrow neck (length, 6 mm; width, 2.5 mm) and bead-like chambers (three chambers: superficial, 5.0 × 3.6 × 2.2 cm; middle, 2.6 × 2.2 × 1.1 cm; deep, 1.0 × 0.6 cm; peak systolic velocity, 500 cm/s; peak diastolic velocity, 300 cm/s) combined with an AVF (SFA to the common FV, peak systolic velocity > 200 cm/s) (Figure 1A).

Ultrasound-guided compression repair was first taken following an uncomplicated PSA diagnosis (Figure 1B) with one dabigatran dose omitted because the patient had a high risk of stroke. However, after a routine 2 × 24 h compression (30-min UGCR followed by bandage compression for 24 h), the patient was experiencing pain, and the PSA was not occluded. Considering that a PSA directly connected to the AVF is a contraindication for UGTI, injections in the superficial and middle chambers were prioritized with the deep chamber (close to the AVF) shelved temporarily. Specifically, thrombin was injected into the middle chamber using the 'three-way stopcock' UGTI technique (Figure 2A), and the superficial and middle chambers were successfully occluded (Figure 2B). The day after UGTI, vascular ultrasound reconfirmed a successful occlusion of the two chambers. In the remaining deep chamber, repeat UGCR therapy was tried (Figure 2C). Unfortunately, along with prolonged compression, the deep chamber gradually enlarged to 3.3 × 1.4 cm (Figure 3A), and the groin skin deteriorated. On Day 11 after AF-CA, surgical debridement and repair were finally performed (Figure 3B). During surgical repair, bridging heparin was performed. The patient was discharged home on Day 14. At the 3-month follow-up visit, vascular ultrasound showed total recovery without skin damage or functional deficit. The patient experienced no other AF-related complications including recurrence in the following 2 years.

Discussion

Although most iatrogenic PSAs are not fatal, the treatment processes may be painful and tortuous, especially for complex cases. Thus, appropriate treatment for PSA depends on the full understanding of its anatomical characteristics and the indications of different therapeutic measures.

A complicated PSA is defined as the presence of any of haemodynamic instability, neurologic deficit, or pulse deficit, expanding haematoma, extensive skin and subcutaneous damage, or concern for soft tissue infection.⁶ Although non-surgical measures can deal with most uncomplicated cases, rare complex PSAs (i.e. multiple chambers with/without AVF) secondary to catheterization are challenging. Pseudoaneurysms with multiple chambers are formed when the pressure of the PSA exceeds the strength of the initial chamber wall, and multi-chambers could be connected in series or parallel. For AF-CA, uninterrupted anticoagulation was associated with low rates of stroke/transient ischaemic attack, which led to a positive attitude towards uninterrupted anticoagulation in AF management.^{7,8} However, a puncture track may tend to be the breakthrough for the PSA chamber wall, creating beaded PSA chambers under continuous anticoagulation.

Ultrasound-guided compression repair can accurately locate the compression site and block the flow at the PSA neck, which shows a

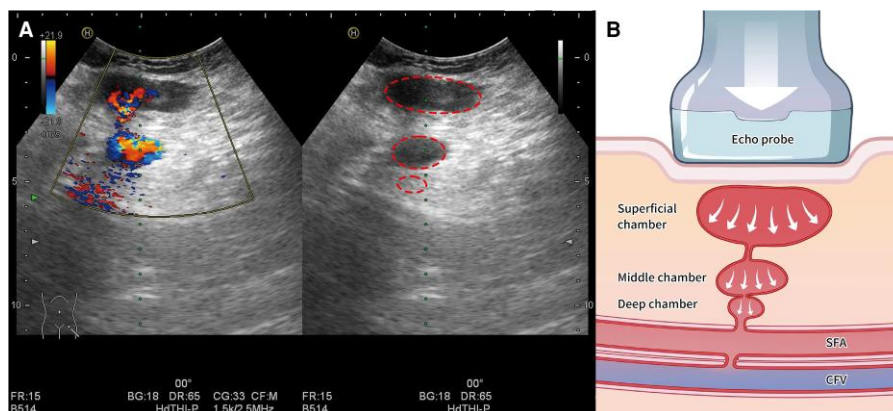


Figure 1 Ultrasound imaging of the multi-chamber pseudoaneurysm and schematic diagram of ultrasound-guided compression repair. (A) Doppler ultrasound imaging of the left femoral pseudoaneurysm with three chambers (dotted circles). (B) Schematic diagram showing the dispersion of the compression force to the deep chamber. CFV, common femoral vein; SFA, superficial femoral artery.

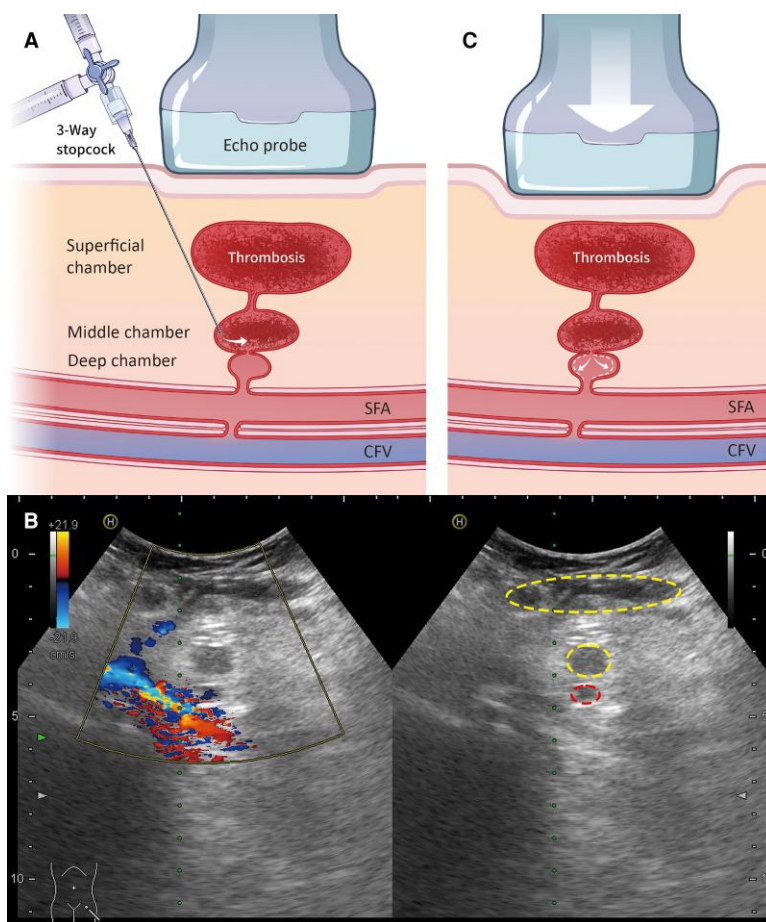


Figure 2 Ultrasound-guided thrombin injection and following ultrasound-guided compression repair resulting in pseudoaneurysm variation. (A) Schematic diagram showing that thrombin was injected into the middle chamber under ultrasound guidance with the ‘three-way stopcock’ technique. (B) Duplex ultrasonography imaging demonstrating that the two most superficial chambers (yellow-dotted circles) of the pseudoaneurysm were completely thrombosed following thrombin injection, and the deep chamber remained (red dotted circles). (C) Schematic diagram showing that ultrasound-guided compression repair led to the expansion of the deep chamber of the pseudoaneurysm. CFV, common femoral vein; SFA, superficial femoral artery.

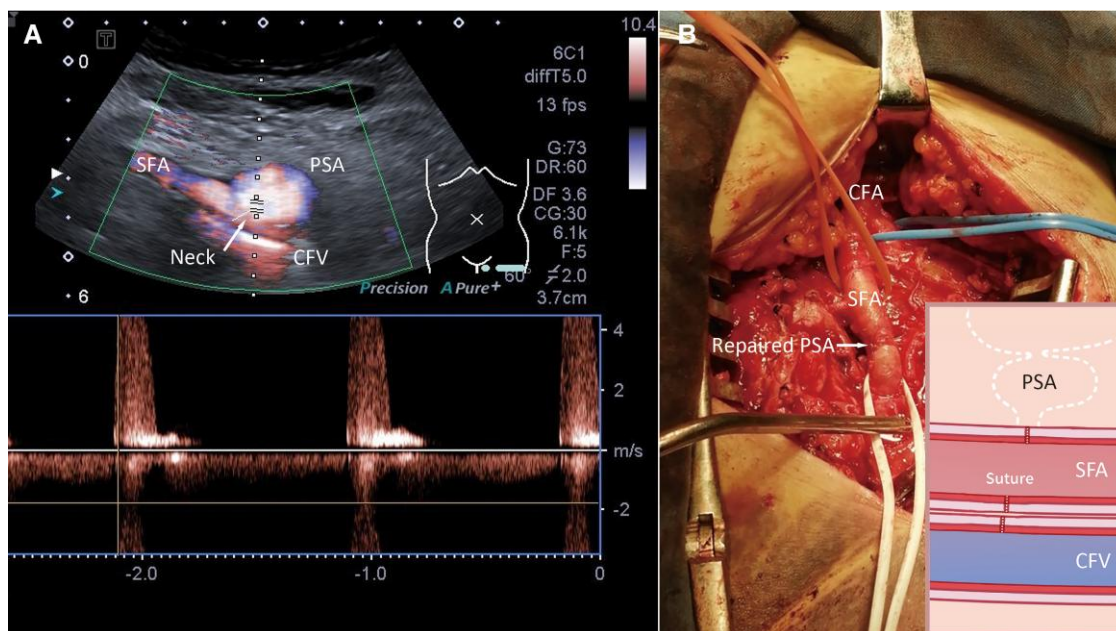


Figure 3 Ultrasound imaging of the residual deep chamber of the pseudoaneurysm and surgical repair. (A) Duplex ultrasonography imaging demonstrating a short, wide track of the residual femoral pseudoaneurysm deep chamber communicating to the arteriovenous fistula. (B) Surgical repair image and schematic diagram of the pseudoaneurysm with an arteriovenous fistula. CFA, common femoral artery; CFV, common femoral vein; PSA, pseudoaneurysm; SFA, superficial femoral artery.

fairly high success rate (75–98%).⁹ Although its leading position has been replaced by UGTI, UGCR is usually applied in clinical settings as it is easier to perform. However, the size, depth, and number of PSA chambers, continuous anticoagulation, and patient condition limit UGCR success. For post-catheterization femoral PSA, favourable anatomy [long (≥ 10 mm) and narrow neck (≤ 3 mm)], single/smaller chamber, and appropriate puncture site with better compression platform are suitable conditions for UGCR.¹⁰ In the presented case, the PSA was uncomplicated when first identified, and the deep chamber was connected to the SFA with a narrow neck despite the three chambers combined with AVF. Thus, we attempted to treat the PSA with UGCR initially, which subsequently was proved to be an unwise choice. Several points should be considered for the failure of UGCR in the present case: (i) the PSA track in a deeper/lower position (SFA) caused the dispersion of pressure, and beaded PSA chambers aggravated the invalidation of compression; (ii) continuous anticoagulation is also a disadvantage; and (iii) prolonged continuous compression expanded the deep chamber rather than closed it.

Compared with UGCR, UGTI is less painful, safer, and more effective (91–100%) and will not be limited by obesity, larger size/multi-chambers of the PSA, and continuous anticoagulation.¹¹ The rates of UGTI-related complications and embolic events are at low levels, with 1.3% and 0.5%, respectively.⁵ For multi-chamber PSA, thrombin injection into the deeper chamber will almost certainly obliterate the tract and all chambers. However, PSA with a short, wide track and those combined with AVF may increase the risk of ectopic embolism, which is usually considered a relative contraindication for UGTI.⁵ Thus, UGTI was not considered initially in this case. Previous studies have shown that UGTI to the superficial chamber first usually resulted in thrombosis of all chambers.¹² In this case, the two most superficial chambers were not close to the AVF. Thus, we subsequently

performed UGTI for the middle chamber of the PSA after failed UGCR attempts.

Surgical repair is an important and necessary management strategy for PSA but is rarely applied to most iatrogenic cases. Notably, surgical repair should be considered for complex PSA and/or cases combined with complications such as bleeding/rupture, infection, neuralgia, chamber rapid expansion, or UGCR/UGTI failure. After failed UGCR/UGTI attempts, chamber expansion, and skin damage, the uncomplicated PSA worsened. Thus, surgery became the last but indispensable choice, which may be delayed in this case.

For vascular complications, effective prevention is superior to treatment. Ultrasound-guided puncture is efficient in reducing puncture time and attempts and is useful in reducing the incidence of major and minor vascular complications.^{13,14} In this case, the vascular complication probably could have been prevented by identifying the precise location of the high common FV bifurcation with ultrasound guidance. Thus, ultrasound guidance should be routinely obtained, especially in patients with obesity, deep vessels, uninterrupted anticoagulation, and using large-size sheaths.

Conclusions

Ultrasound-guided compression repair, UGTI, and other interventional modalities have become an important alternative to surgical repair for post-catheterization PSA. However, for PSA with complex structure, UGCR and UGTI may lead to delayed treatment because of compression force dispersion and incomplete occlusion. Thus, full understanding of the size, chamber, and morphological and structural characteristics of the PSA is necessary when choosing the optimal strategy for successful treatment.

Lead author biography



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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 the case report including images and associated text has been obtained from the patient in line with the COPE guidance.

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Data availability: The data underlying this article are available in the article and in its online supplementary material.

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