

Key words: thrombin; pseudoaneurysm; embolisation

Management of post-catheterisation pseudoaneurysms

Graham John Munneke, Robert Morgan and Anna-Maria Belli

Department of Vascular Radiology, St George's Hospital, London, UK

Address for correspondence:

Dr Graham John Munneke, MRCP, FRCR

Department of Vascular Radiology
St George's Hospital, Blackshaw Road
London SW17 0QT UK

Tel: +44 (0)208 725 3298

Fax: +44 (0)208 725 2936

Email: grahamm@doctors.org.uk

Abstract

Post-catheterisation pseudoaneurysms (PCPA) can develop when there is inadequate haemostasis at an arterial puncture site and occur at a rate of 7.7% following catheterisation. Risk factors for the development of PCPA and subsequent complications are described. Intravascular injection of thrombin has replaced ultrasound-guided compression as treatment for PCPA. Thrombin injection offers advantages including reduced procedure time, no requirement for sedation or local anaesthetic and a high technical success rate. A method is described for the slow injection of thrombin into the periphery of a pseudoaneurysm under continuous ultrasound scanning, which enables resolution with minimal risk of complications. A treatment algorithm for PCPA using thrombin injection is proposed.

Introduction

The exponential rise in the number and complexity of trans-catheter vascular interventional procedures has led to a similar rise in access site complications. A prospective study found the rate of post-catheterisation pseudoaneurysms (PCPA) to be 7.7%.¹

Aetiology

Pseudoaneurysms develop when there is inadequate haemostasis at the arterial puncture site. Blood flows into the perivascular space, forming a pulsatile haematoma contained by surrounding soft tissue, hence the name pseudoaneurysm.

Risk factors for the development of PCPA

- Interventional procedure or prolonged catheterisation
- Obesity
- Anticoagulation or thrombolysis
- Large sheath size (>7 French)
- Inadequate compression
- Faulty puncture technique, e.g. superficial or profunda femoris artery puncture
- Aberrant anatomy – high branching common femoral artery
- Calcified artery
- Hypertension

Diagnosis

PCPA is suspected on clinical grounds when there is a pulsatile mass following recent arterial puncture. The diagnosis is easily confirmed on Doppler ultrasound (Figure 1).

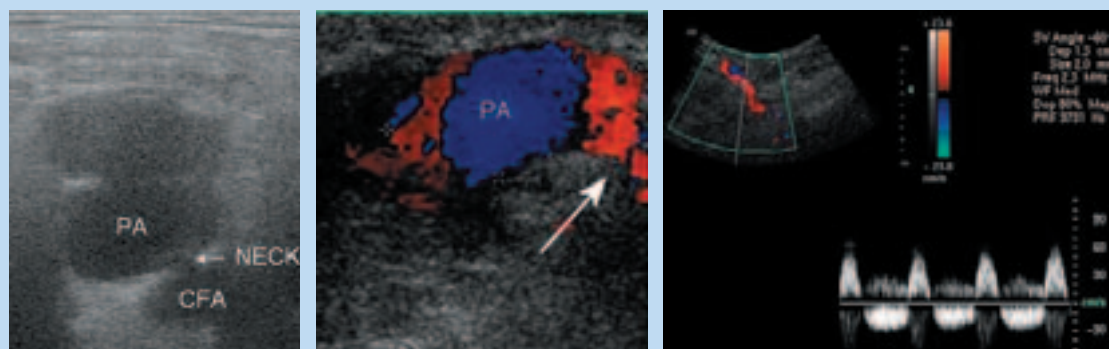


Figure 1. (a) Greyscale ultrasound image of the groin at the level of the common femoral artery (CFA). A bi-lobed pseudoaneurysm (PA) is present. The pseudoaneurysm neck is arrowed. (b) Swirling pattern seen on colour Doppler ultrasound. The pseudoaneurysm neck is arrowed. (c) Spectral Doppler trace from the neck of a pseudoaneurysm. Note the characteristic "to and fro" flow pattern.



Dr Graham Munneke,

MRCP, FRCR is an Interventional Radiology Fellow at St George's Hospital, London, where he has trained for the last 5 years. His interests include oncological and vascular intervention.

Rob Morgan MRCP, FRCR, is a Consultant Radiologist and also specialises in interventional radiology. He is a member of the Council of the British Society of Interventional Radiology (BSIR) and the Cardiovascular and Interventional Radiology Society of Europe.

Anna-Maria Belli, FRCR, is a Consultant Radiologist and Reader in Interventional Radiology at St George's Hospital, specialising in vascular interventional radiology. She is the immediate Past President of the BSIR.



Complications of PCPA

- Rupture – risk increases with size
- Persistent pain
- Distal embolisation
- Pressure necrosis of overlying skin
- Compression of adjacent vascular and neural structures
- Infection

Treatment

Until recently, pseudoaneurysms were treated surgically. In 1991, Fellmeth *et al*² described the technique of ultrasound-guided compression. In this, ultrasound is used to guide compression of the aneurysm neck, thus abolishing flow into the aneurysm leading to thrombosis. In the late 1990s, several papers described the use of percutaneous injection of thrombin to embolise pseudoaneurysms.³⁻⁵ The technique had in fact been reported a decade prior to this by Cope and Zeit⁶ but had not gained favour. In recent years, thrombin injection has largely replaced ultrasound-guided compression for the reasons listed in Table 1.⁷⁻⁹

Percutaneous thrombin injection has been used to treat PCPA in other areas such as the brachial and subclavian arteries, in children and in traumatic pseudoaneurysms.¹⁰

Embolisation of pseudoaneurysms with coils or materials such as ethylene vinyl alcohol copolymer (ONYX™)^{8,11} has not gained widespread favour as both methods leave a permanent lump in the groin. Others have advocated the use of covered stent grafts to exclude the aneurysms, but these may occlude and make further arterial access at the site difficult.⁸

Figure 2 displays a suggested treatment algorithm for PCPA.

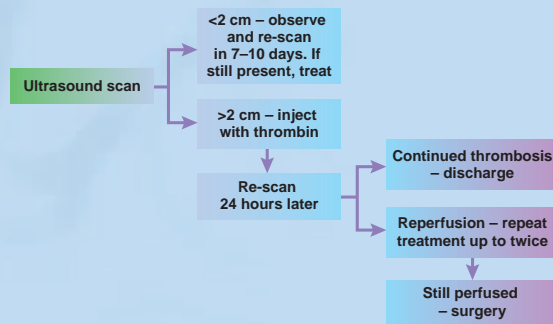


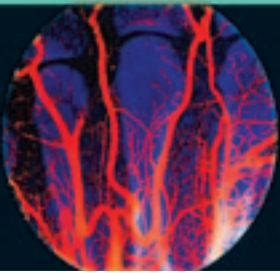
Figure 2. Suggested treatment algorithm for PCPA.

Table 1. Ultrasound-guided compression vs. thrombin injection for treating pseudoaneurysms

	Ultrasound-guided compression	Thrombin injection
Procedure time	≥60 minutes	<15 minutes
Pain	Painful	Painless – local anaesthetic not required
Intravenous sedation	Frequently required	Not required
Technical success	74% ⁷	93–100% ⁸
Effective with antiplatelet/ anticoagulant agents	Reduces efficacy	Yes
Recurrence	Up to 20% ⁹	Rare
Complications	Rare	0–4% ⁹

Management of post-catheterisation pseudoaneurysms *continued*

Graham John Munneke, Robert Morgan and Anna-Maria Belli



Thrombin for PCPA

Thrombin is the active form of prothrombin. Thrombin that inadvertently leaks into the circulation is rapidly diluted and antagonised by the anticoagulant factors thrombomodulin and antithrombin III.¹² After obtaining informed consent, and ensuring there are no contraindications (Table 2), an ultrasound examination is used to define the relationship of pseudoaneurysm, pseudoaneurysm neck and native vessels.

Table 2. Contraindications to the use of thrombin

- Local infection
- Allergy or previous treatment if bovine thrombin used
- Rapidly expanding pseudoaneurysm
- Arteriovenous fistula
- Rupture
- Limb ischaemia secondary to vascular compression

The peripheral pulses are then documented. Under sterile conditions, a 22-gauge spinal needle is inserted with ultrasound guidance into the periphery of the pseudoaneurysm (Figure 3).

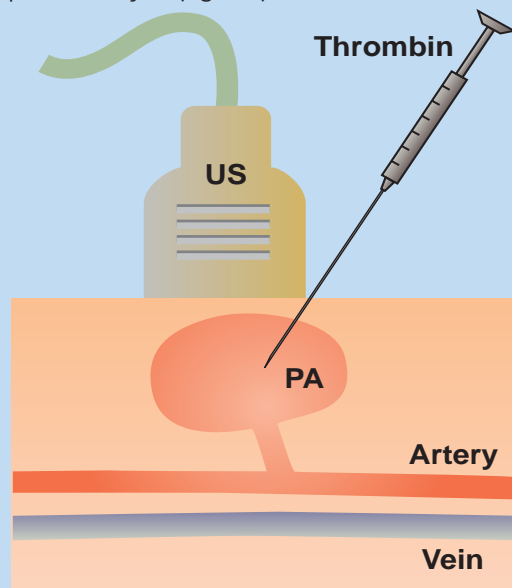


Figure 3. Ultrasound-guided puncture of pseudoaneurysm.

The needle tip should be placed as remote from the pseudoaneurysm neck as possible. Human thrombin at a strength of 1000 units/mL should be injected slowly via a 1 mL syringe. The pseudoaneurysm is scanned continuously and injection terminated when colour flow ceases (Figure 4)

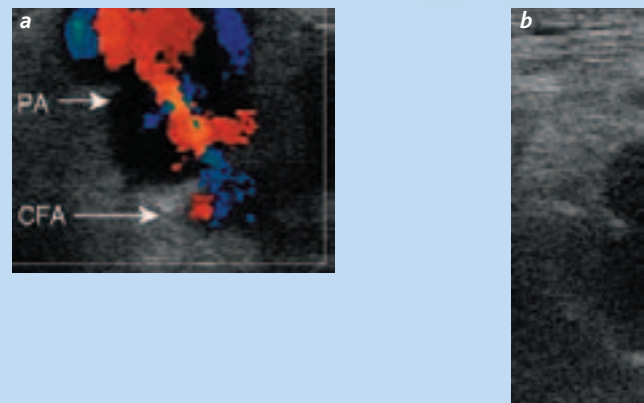
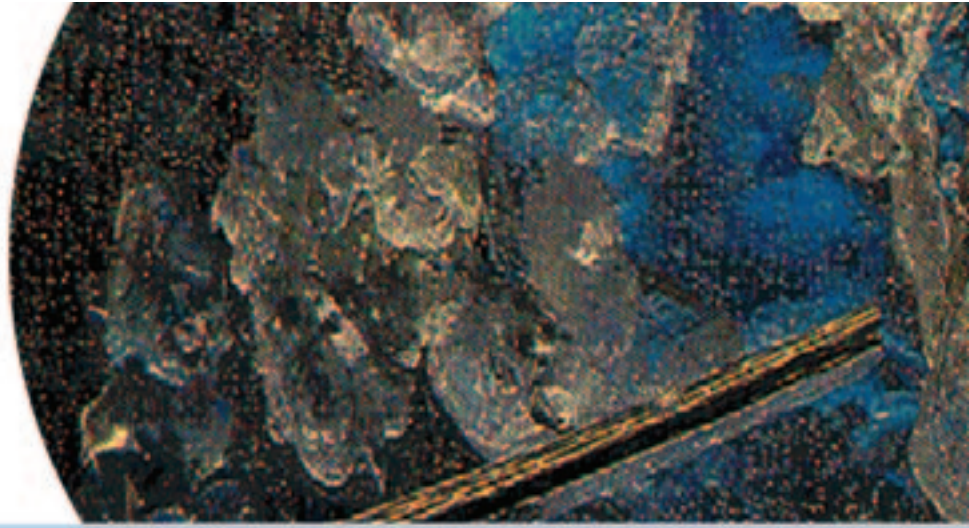


Figure 4. (a) Colour Doppler image from the same patient as Figure 1a. Blood is seen just away from the neck is punctured under ultrasound guidance. Greyscale imaging is used showing thrombosis of the most superficial locule. There is still flow within the deeper

If there is persistent flow after the first dose, a further dose should be prepared and injected. Many pseudoaneurysms will thrombose with as little as 0.2 mL (200 units) of thrombin. Multilocular pseudoaneurysms may require more than one puncture to thrombose all the locules. If the main pseudoaneurysm has thrombosed but there is still flow in the pseudoaneurysm neck, further thrombin should not be given. This risks distal embolisation of thrombin, and the pseudoaneurysm neck has been shown to spontaneously thrombose soon after the body of the pseudoaneurysm.¹³ The peripheral pulses are re-examined at the end of the procedure to exclude distal embolisation. Patients should have 4 hours of bed rest and be re-scanned at 24 hours (Figure 5).

Thrombin preparations

The various thrombin preparations available are not currently licensed for intravascular use and so must be used on a named-patient basis.



Bovine-derived thrombin (1000 units/mL; Johnson & Johnson, Middleton, WI) has been associated with documented allergic¹⁴ and anaphylactic reactions.¹⁵ In addition, there is concern that antibodies produced in response to bovine thrombin can cross-react with their human counterparts and produce haemorrhagic

successfully used to treat PCPA¹⁷ and avoids the theoretical risk of transmitting disease, but cannot be harvested from patients on anticoagulants.

Complications

Reported complication rates are less than 5%⁸ and many series quote a zero complication rate.^{7,9,13,18-21}

Complications broadly divide into immune responses and thrombotic events. The use of human thrombin avoids the risk of the former. Native vessel thrombosis has been described. The likely explanation is the injection of relatively large volumes of thrombin into small pseudoaneurysms.^{22,23} Injecting 1000 units/mL strength thrombin slowly, via a 1 mL syringe, and ceasing injection immediately when thrombosis occurs minimises this risk. Distal embolisation may occur when the pseudoaneurysm neck is wide. Lennox *et al.*²⁴ described thrombosis of the brachial artery following treatment of a pseudoaneurysm whose neck was the same width as the native artery. Inflation of a balloon catheter across the pseudoaneurysm neck during embolisation may prevent this.⁵ When it does occur, native vessel thrombosis may resolve spontaneously^{12,22} or may require intervention.²⁵

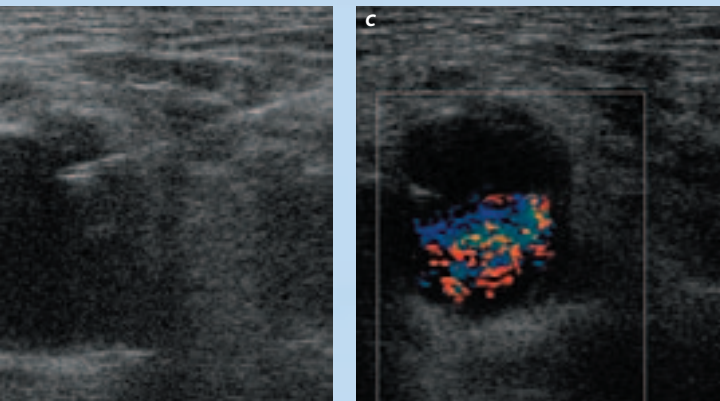


Figure 5. (a) Needle puncturing into the pseudoaneurysm (PA) from the common femoral artery (CFA). (b) The locule furthest from the needle during puncture, as the needle is most conspicuous in this mode. (c) Colour Doppler image showing absence of flow in the locule. This was subsequently punctured and embolised.

complications.¹⁶ For these reasons it is advisable to use human thrombin preparations - for example, Tisseel™ (Baxter, Glendale, CA) (Figure 6). Autologous thrombin derived from the patient's own blood has been



Figure 5. Ultrasound scan 24 hours following thrombin injection showing echogenic thrombus within the pseudoaneurysm and absence of flow on colour Doppler.



Figure 6. The Tisseel™ kit (Baxter, Glendale, CA) contains two components. The human thrombin in the black vial on the right is reconstituted with calcium chloride solution. The blue vials on the left contain a tissue adhesive consisting of other clotting factors that are reconstituted with bovine aprotinin solution. This component should not be used as the thrombin solution provides adequate thrombosis and avoids the use of a bovine product.

Management of post-catheterisation pseudoaneurysms *continued*

Graham John Munneke, Robert Morgan and Anna-Maria Belli

Acknowledgement

The authors thank Dr Arum Parthipun for supplying artwork for the article.

Key Learning

- Pseudoaneurysm is an access-site complication following catheterisation
- Diagnosis can be confirmed by Doppler ultrasound scanning
- Thrombin injection has replaced ultrasound-guided compression as treatment for post-catheterisation pseudoaneurysm
- Use of human thrombin preparations avoids allergic and anaphylactic reactions; these preparations must currently be used for intravascular use on a named-patient basis
- During continuous ultrasound scanning, thrombin is injected slowly into the periphery of the pseudoaneurysm, and injection is terminated when colour flow ceases
- Complication rates following treatment are 0–5%

References

- Katzenschlager R, Ugurluoglu A, Ahmadi A, *et al.* Incidence of pseudoaneurysm after diagnostic and therapeutic angiography. *Radiology* 1995;**195**:463–6.
- Fellmeth BD, Roberts AC, Bookstein JJ, *et al.* Postangiographic femoral artery injuries: nonsurgical repair with US-guided compression. *Radiology* 1991;**178**:671–5.
- Liau CS, Ho FM, Chen MF, *et al.* Treatment of iatrogenic femoral artery pseudoaneurysm with percutaneous thrombin injection. *J Vasc Surg* 1997;**26**:18–23.
- Kang SS, Labropoulos N, Mansour A, *et al.* Percutaneous ultrasound guided thrombin injection: a new method for treating post-catheterization femoral pseudoaneurysms. *J Vasc Surg* 1998;**27**:1032–8.
- Loose HW, Haslam PJ. The management of peripheral arterial aneurysms using percutaneous injection of fibrin adhesive. *Br J Radiol* 1998;**71**:1255–9.
- Cope C, Zeit R. Coagulation of aneurysms by direct percutaneous thrombin injection. *AJR Am J Roentgenol* 1986;**147**:383–7.
- Paulson EK, Sheafor DH, Kliwer MA, *et al.* Treatment of iatrogenic femoral arterial pseudoaneurysms: comparison of US-guided thrombin injection with compression repair. *Radiology* 2000;**215**:403–8.
- Morgan R, Belli AM. Current treatment methods for postcatheterization pseudoaneurysms. *J Vasc Radiol* 2003;**14**:697–710.
- Brophy DP, Sheiman RG, Amatulle P, *et al.* Iatrogenic femoral pseudoaneurysms: thrombin injection after failed US-guided compression. *Radiology* 2000;**214**:278–82.
- Engelke C, Quarmby J, Ubhayakar G, *et al.* Autologous thrombin: a new embolization treatment for traumatic intrasplenic pseudoaneurysm. *J Endovasc Ther* 2002;**9**:29–35.
- Cantasdemir M, Kantarci F, Mihmanli I, *et al.* Embolization of profunda femoris artery branch pseudoaneurysms with ethylene vinyl alcohol copolymer (ONYX). *J Vasc Interv Radiol* 2002;**13**:725–8.
- Ferguson JD, Whatling PJ, Martin V, *et al.* Ultrasound guided percutaneous thrombin injection of iatrogenic femoral artery pseudoaneurysms after coronary angiography intervention. *Heart* 2001;**85**:5e.
- Sheiman RG, Brophy DP. Treatment of iatrogenic femoral pseudoaneurysms with percutaneous thrombin injection: experience in 54 patients. *Radiology* 2001;**219**:123–7.
- Sheldon PJ, Oglevie SB, Kaplan LA. Prolonged generalized urticarial reaction after percutaneous thrombin injection for treatment of a femoral artery pseudoaneurysm. *J Vasc Interv Radiol* 2000;**11**:759–61.
- Pope M, Johnston KW. Anaphylaxis after thrombin injection of a femoral pseudoaneurysm: recommendations for prevention. *J Vasc Surg* 2000;**32**:190–1.
- Dorion RP, Hamati HP, Landis B, *et al.* Risk and clinical significance of developing antibodies induced by topical thrombin preparations. *Arch Pathol Lab Med* 1998;**122**:887–94.
- Quarmby JW, Engelke C, Chitolie A, *et al.* Autologous thrombin for treatment of pseudoaneurysms. *Lancet* 2002;**359**:946–7.
- Olsen DM, Rodriguez JA, Vranic M, *et al.* A prospective study of ultrasound scan-guided thrombin injection of femoral pseudoaneurysm: a trend toward minimal medication. *J Vasc Surg* 2002;**36**:779–82.
- Etemad-Rezai R, Peck DJ. Ultrasound-guided thrombin injection of femoral artery pseudoaneurysms. *Can Assoc Radiol J* 2003;**54**:118–20.
- Maleux G, Hendrickx S, Vaninbrouck J, *et al.* Percutaneous injection of human thrombin to treat iatrogenic femoral pseudoaneurysms: short- and midterm ultrasound follow-up. *Eur Radiol* 2003;**13**:209–12.
- Kruger K, Zahringer M, Sohngen FD, *et al.* Femoral pseudoaneurysms: management with percutaneous thrombin injections – success rates and effects on systemic coagulation. *Radiology* 2003;**226**:452–8.
- Pezzullo JA, Dupuy DE, Cronan JJ. Percutaneous injection of thrombin for the treatment of pseudoaneurysms after catheterization: an alternative to sonographically guided compression. *AJR Am J Roentgenol* 2000;**175**:1035–40.
- Sackett WR, Taylor SM, Coffey CB, *et al.* Ultrasound-guided thrombin injection of iatrogenic femoral pseudoaneurysms: a prospective analysis. *Am Surg* 2000;**66**:937–42.
- Lennox A, Griffin M, Nicolaidis A, *et al.* Regarding "Percutaneous ultrasound guided thrombin injection: a new method for treating post-catheterization femoral pseudoaneurysms" (letter). *J Vasc Surg* 1998;**28**:1120–1.
- Sadiq S, Ibrahim W. Thromboembolism complicating thrombin injection of femoral artery pseudoaneurysm: management with intraarterial thrombolysis. *J Vasc Interv Radiol* 2001;**12**:633–6.