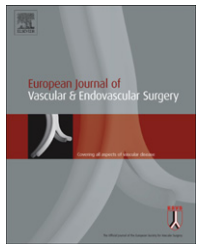
Eur J Vasc Endovasc Surg (2010) **40**, 209–215



Packing Technique for Endovascular Coil Embolisation of Peripheral Arterial Pseudo-aneurysms with Preservation of the Parent Artery: Safety, Efficacy and Outcomes

R. Loffroy [a,*], P. Rao [a], S. Ota [a], M. De Lin [a], B.-K. Kwak [a], D. Krause [b], J.-F. Geschwind [a]

[a] *The Russell H. Morgan Department of Radiology and Radiological Science, Division of Cardiovascular and Interventional Radiology, The Johns Hopkins Hospital, 600 North Wolfe Street, Blalock 545, Baltimore, MD 21287, USA*
[b] *Department of Vascular and Interventional Radiology, University of Dijon School of Medicine, Bocage Teaching Hospital, 2 bd du Maréchal de Lattre de Tassigny, BP 77908, 21079 Dijon, France*

Submitted 27 January 2010; accepted 4 March 2010
Available online 17 April 2010

KEYWORDS
Artery;
Pseudo-aneurysm;
Hemorrhage;
Trans-catheter Embolisation;
MR angiography

Abstract *Objectives:* To evaluate the endovascular treatment of pseudo-aneurysms (PAs) with super-selective coil embolisation using the 3D packing technique.
Design: Retrospective study of consecutive patients in one academic centre.
Materials: From 2002 to 2009, 16 patients (mean age 51.6 years, range 24–82) underwent PA sac packing with coils. Four patients were asymptomatic, nine had PA rupture, and three had other symptoms. Lesion location was as follows: splenic artery (8), carotid artery (2), hepatic artery (2), superior mesenteric artery (1), cystic artery (1), uterine artery (1), and hypogastric artery (1).
Methods: The sac was packed with 0.018-inch controlled-detachable microcoils, preserving the parent artery. Magnetic resonance angiography was done within 6 months, at 12 months then yearly.
Results: Technical success rate was 100%. Complete definitive PA exclusion was achieved with a single procedure in 15 (93.8%) patients. One patient with a secondary bleeding arterio-digestive fistula underwent successful surgery. No major complications or late recanalisations occurred during follow-up (mean, 24.7 months; range 6–49).
Conclusions: Coil PA embolisation by 3D sac packing is safe and effective and may induce less morbidity than complete parent vessel occlusion, stent placement, or open surgery. This procedure should be used whenever possible, as it preserves parent artery patency.

* Corresponding author. Tel.: +1 410 955 6081; fax: +1 410 955 0233.
E-mail address: romaric.loffroy@yahoo.fr (R. Loffroy).

1078-5884/$36
doi:10.1016/j.ejvs.2010.03.009

Pseudo-aneurysms (PAs) are rare, but are clinically important because they carry a risk of rupture with severe bleeding. PAs arise when inflammation, trauma, cancer or surgery causes injury to an artery with extravasation of blood into the surrounding tissues and development of a fibrous capsule around the lesion.[1] Without treatment, bleeding from PAs is often fatal.[2–4] Traditionally, open surgical repair or laparoscopic resection was performed.[5] Recently, endovascular treatment with covered stent placement or trans-catheter embolisation has emerged as the treatment of first choice for PAs.[6,7] However, the only available data on trans-catheter arterial embolisation for the first-line treatment of PAs come from case-reports and small series.[3,8–11] Moreover, little is known about long-term outcomes. Stent-grafting is often technically impossible because of the location of PAs, and embolisation traditionally compromises the patency of the native vessel.

Here, we evaluated the treatment of peripheral PAs with a technique generally used for endovascular occlusion of intracranial aneurysms, namely, super-selective coil embolisation with sac packing and parent artery preservation. We retrospectively assessed the effectiveness, immediate advantages and short- and long-term outcomes of this procedure in 16 consecutive patients.

Materials and methods

Patient population

The medical records of 47 consecutive patients who were diagnosed with PA from April 2002 to March 2009 at our institution were retrospectively reviewed. We identified 16 (34%) patients who underwent endovascular PA management with selective microcoil embolisation using the packing technique: seven men and nine women with a mean age of 51.6 years (range: 24–82 years). Patients were selected to be treated with this endovascular technique as the first approach based on the following criteria: PA involving a major peripheral or visceral arterial branch, presence of a thin neck and size $\leq$50 mm. The distal location at the level of a small terminal or intra-parenchymal branch was an exclusion criterion. Each patient had a single PA. Causative factors are presented in Table 1. The diagnosis of PA was established in all patients by multi-slice helical computed tomography (CT) angiography. Four patients had asymptomatic lesions that were discovered incidentally. Three patients presented with isolated abdominal pain. The remaining nine patients experienced rupture of their lesions with haemorrhagic shock. Lesion diameter varied widely and showed no obvious relationship to the clinical presentation: 15–30 mm for ruptured lesions, 22–45 mm for un-ruptured symptomatic lesions and 20–30 mm for asymptomatic lesions. Overall, the median diameter was 24 $\pm$ 7.9 mm. The PA locations and main clinical data are reported in Table 1. The 31 (66%) remaining patients who did not meet the inclusion criteria were treated with different techniques including surgery, covered stenting, sandwich coil embolisation of the parent vessel covering both sides of the PA neck, distal coil or glue embolisation of the terminal feeding artery and ultrasound-guided compression. This retrospective study was performed in compliance with the requirements of our institutional review board. Informed consent was not required.

Endovascular procedure

All 16 patients underwent emergency diagnostic angiography and same-stage trans-catheter arterial embolisation under local anaesthesia by two experienced interventional radiologists. Selective angiography of the parent artery was performed routinely using 5-Fr standard catheters (Cordis Johnson&Johnson®, Roden, The Netherlands) inserted through a 6-Fr sheath placed in the common femoral artery. In all cases, embolisation was achieved using a super-selective coaxial technique with a Tracker-18 microcatheter (Target Therapeutics®, Fremont, CA, USA) placed into the pseudo-aneurysmal sac. The endovascular procedure was performed with 0.018-inch controlled-detachable non-fibred microcoils (DCS, Standart or Soft Detach-18 Embolisation Coil System, Cook®, Bjaeverskov, Denmark) of various lengths and diameters. PA coiling usually consisted in the delivery across the neck of a straight complex microcoil to create a good basket followed by smaller helical microcoils to concentrically fill the residual lumen (packing technique) while preserving the parent artery (Figs. 1–4). All sizes from 6 to 30 mm in diameter and 10–50 cm in length were available. A total of 101 microcoils were used. The microcoils passed easily through the microcatheter with no friction in all cases. In each PA, four to 14 microcoils (mean per patient: 6) were placed to obtain good packing. The main technical data are reported in Table 1.

Immediate outcome and patient follow-up

Follow-up information was available for all patients but one. Clinical surveillance was complemented by a review of the medical records from the outpatient department or primary care physician. Procedural success was defined as complete exclusion of the PA on the post-embolisation arteriogram. Clinical success was defined as cessation of bleeding and stabilisation of haemodynamic parameters. All patients underwent follow-up imaging including magnetic resonance (MR) imaging and three-dimensional (3D) MR angiography (MRA) within 6 months of the procedure, at 12 months and yearly thereafter to assess the long-term exclusion of arterial lesions and enhancement of downstream organ parenchyma. Follow-up imaging was available for all patients except one, with a mean follow-up of 24.7 months (range: 6–49 months). Major and minor complications were evaluated according to Society of Interventional Radiology reporting standards.[12]

Results

Endovascular treatment was technically successful at the first attempt in all 16 (100%) patients, with complete angiographic exclusion of the PA and preserved patency of the parent artery on the post-embolisation arteriogram. In all cases, 3D packing was achieved by filling the PA sac in a concentric fashion. Immediate coil detachment occurred consistently. There was no coil rupture, coil migration or involuntary coil detachment. No technical complications

Table 1 Clinical and technical data, angiography findings, and outcomes of selective coil embolisation using the packing technique in 16 patients with arterial pseudoaneurysms. F, female; M, male; y, years; mo, months; NA, not applicable; LCCA, left common carotid artery; LECICA, left extra-cranial internal carotid artery; SA, splenic artery (*middle segment, †distal segment); RHA, right hepatic artery; LHA, left hepatic artery; SMA, superior mesenteric artery; CA, cystic artery; LUA, left uterine artery; RIIA, right internal iliac artery.

Patient No./ sex/age	Presenting symptoms	Cause of PA	PA size and location	Technical success	Angiographic exclusion Cessation of bleeding	30-Day complications	Outcome follow-up
1/F/82 y	Rupture	Accidental puncture	24 mm LCCA	Yes	Complete Yes	Groin hematoma	Excluded 22 mo
2/F/47 y	Asymptomatic	Behcet's disease	30 mm LECICA	Yes	Complete NA	None	Excluded 48 mo
3/F/74 y	Rupture	Pancreatic surgery	15 mm SA*	Yes	Complete Yes	None	Excluded 49 mo
4/F/48 y	Pain	Chronic pancreatitis	40 mm SA†	Yes	Complete NA	None	Excluded 40 mo
5/M/34 y	Pain	Acute pancreatitis	45 mm SA†	Yes	Complete NA	None	Excluded 43 mo
6/M/48 y	Asymptomatic	Acute pancreatitis	28 mm SA†	Yes	Complete NA	None	Excluded 14 mo
7/M/78 y	Rupture	Mycotic infection	23 mm SA*	Yes	Complete Yes	None	Excluded 34 mo
8/F/26 y	Asymptomatic	Blunt trauma	20 mm SA*	Yes	Complete NA	Fever	Excluded 16 mo
9/M/37 y	Rupture	Unknown cause	18 mm SA*	Yes	Complete Yes	None	Excluded 17 mo
10/M/63 y	Pain	Acute pancreatitis	22 mm SA*	Yes	Complete NA	Secondary rupture	Surgery 9 mo
11/M/71 y	Rupture	Liver biopsy	30 mm RHA	Yes	Complete Yes	None	Died at 9 mo
12/F/65 y	Asymptomatic	Blunt trauma	24 mm LHA	Yes	Complete NA	None	Lost to follow-up
13/F/55 y	Rupture	Acute pancreatitis	29 mm SMA	Yes	Complete Yes	None	Excluded 37 mo
14/F/41 y	Rupture	Cholecys-tectomy	22 mm CA	Yes	Complete Yes	None	Excluded 12 mo
15/F/32 y	Rupture	Cesarean delivery	30 mm LUA	Yes	Complete Yes	None	Excluded 14 mo
16/M/24 y	Rupture	Mycotic infection	27 mm RIIA	Yes	Complete Yes	None	Died at 6 mo

occurred. Embolisation ensured immediate bleeding cessation in all nine patients with ruptured lesions. There were no symptoms or laboratory data suggesting organ infarction in any of the patients. There was one major and two minor procedure-related complications. Immediately after the procedure, one patient experienced a fever (patient 8). In another patient, a hematoma developed in the groin area (patient 1). Both patients recovered fully within a few days with symptomatic treatment. A third patient experienced abdominal pain with hypovolaemic shock 3 weeks after embolisation of a splenic artery PA (patient 10) and before the control MRA. Emergency CT of the abdomen revealed active extravasation of contrast medium in keeping with secondary aneurysmal sac rupture. Diagnostic laparotomy showed fistulisation of the embolised pseudo-aneurysmal sac to the transverse colon with intestinal bleeding and coil migration into the colon. Splenectomy and segmental colectomy were performed, and the postoperative course was uneventful. A patient with chronic pancreatitis who was managed with embolisation as a temporising measure underwent successful delayed elective surgical drainage of a growing pseudocyst to prevent secondary complications (patient 4). In a patient treated for a ruptured uterine artery PA following caesarean section (patient 15), percutaneous drainage of the pelvic hematoma was performed under CT guidance via the anterior approach to prevent secondary infection; the post-procedural course was uneventful. There were no perioperative deaths. The patient who required embolisation for post-traumatic PA of the left hepatic artery was lost to follow-up after an early MRA at 2 months showed no complications. In the remaining 15 patients, mean follow-up was 24.7 months (range: 6—49 months) and MR monitoring revealed no late complications, organ infarction or

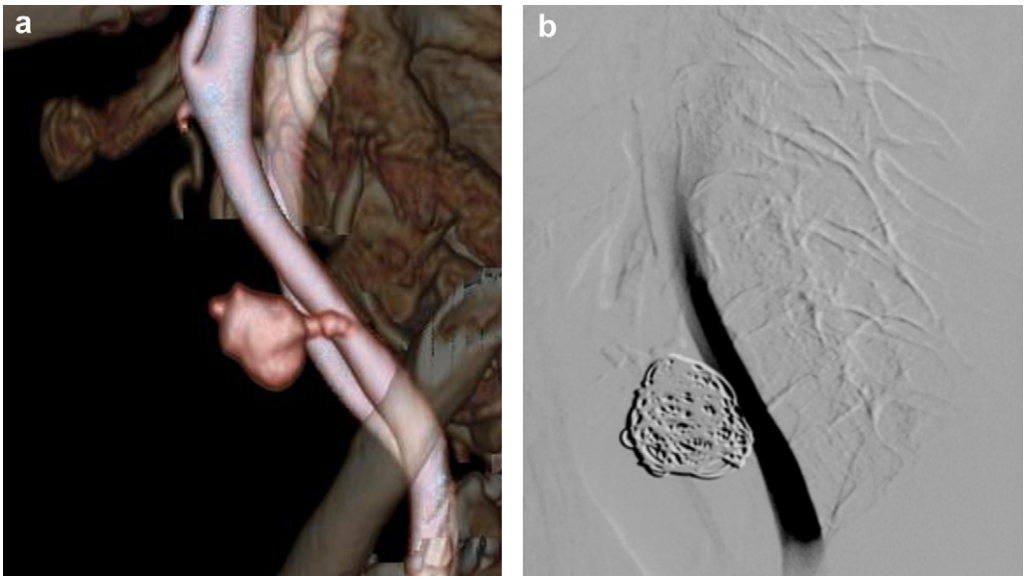


Figure 1 Patient 1: This 82-year-old woman presented with a left cervical hematoma two days after open thoracic repair of type A dissection. (a) Contrast-enhanced multi-slice helical computed tomography of the neck with three-dimensional reconstruction using a volume-rendering technique showed a pseudoaneurysm (PA) arising from the left common carotid artery. (b) Super-selective coil embolisation of the arterial lesion was achieved using the packing technique: post-embolisation angiography showed complete occlusion of the PA with preserved patency of the main common carotid artery. The post-procedural course was uneventful.

Figure 2 Patient 4: 48-year-old woman with a history of chronic pancreatitis. (a) Pre-embolisation angiogram: pseudoaneurysm (PA) involving the middle part of the splenic artery. (b) Angiography after PA sac packing with coils preserving the main splenic artery: complete occlusion of the PA. (c) Three-dimensional contrast-enhanced magnetic resonance angiography 12 months later: total occlusion of the arterial lesion and clear visualization of normal flow into the main splenic artery.

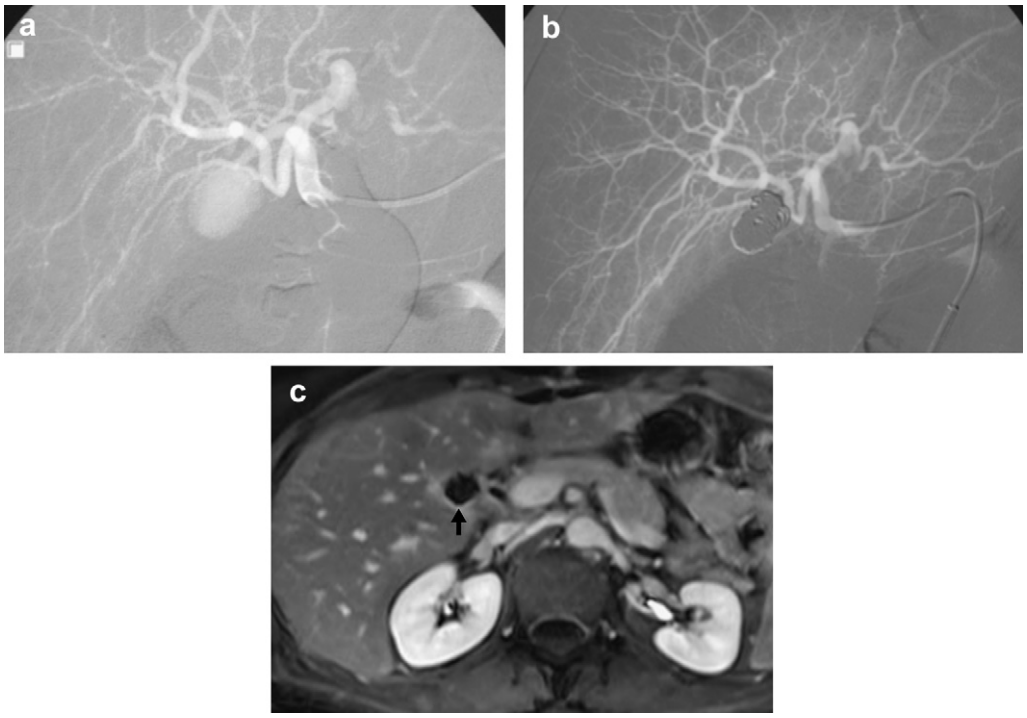


Figure 3 Patient 14: A 41-year-old woman presented three weeks after laparoscopic cholecystectomy with right upper abdominal pain and haemobilia. (a) Selective hepatic arteriogram demonstrating a pseudoaneurysm of the cystic artery stump. (b) Control angiography after coil embolisation of the aneurysmal sac across the neck using the packing technique showing complete occlusion of the false aneurysm and preservation of the main and distal hepatic artery. (c) At 6 months, control magnetic resonance imaging demonstrated total occlusion of the arterial lesion and normal enhancement of the liver parenchyma, without infarction.

PA re-permeabilisation. Of the 16 patients, two died (6 and 9 months after the procedure, respectively) due to unrelated causes: one was an intravenous drug abuser with hepatitis C and human immunodeficiency viruses co-infection who died of multi-organ failure and severe sepsis (patient 16) and the other had a fatal myocardial infarction (patient 11). In both patients, the embolised arterial lesion was completely excluded on the last imaging study. The main results are reported in Table 1.

Discussion

The best management strategy depends on the location, size and cause of the PA. Covered stenting is a minimally invasive procedure that has emerged as an interesting alternative to surgery in the treatment of PAs.[8,13–15] However, this endovascular technique has several disadvantages. First, stent placement is often impossible or technically difficult because of the small size and tortuosities of the peripheral parent arteries, especially the visceral arteries. Second, extensive manipulation of large intra-luminal devices close to the PA sac may result in micro-embolism. Finally, treatment with commercially available covered stents may carry a relatively high rate of in-stent re-stenosis and thrombosis,[14,16] requiring long-term preventive anticoagulant and/or anti-platelet treatment, which is associated with a risk of bleeding.

Recently, endovascular trans-catheter embolisation has generated considerable interest as the first-line therapeutic method for PAs. The success rate is high, ranging from 62% to 100% in visceral PAs, and the morbidity and mortality rates are low.[6,7] Most investigators agree that coils are the most appropriate embolic material.[2,10,11] However, the traditional technique for PA embolisation includes isolating the lesion by deploying coils in the parent artery, covering both sides of the PA neck to prevent back-bleeding via collaterals.[2,10] Embolisation of PAs using a combination of gelfoam pledgets and coils, *n*-butyl cyanoacrylate and coils, coils alone or *n*-butyl cyanoacrylate has also been described.[3,10,11] The main drawback of these techniques is the compromised patency of the parent vessel. Carotid arteries must be left patent, and compromising the patency of visceral vessels may cause ischaemic complications. Good results have been reported with percutaneous ultrasound-guided compression repair or thrombin injection to treat post-catheterisation femoral PAs.[17,18] However, with carotid or visceral PAs, this method is unfeasible, technically difficult or associated with a high risk of complications. In our series, the embolisation technique was modified to preserve the patency of the parent artery: super-selective arterial embolisation was achieved by 3D coil-packing of the PA sac using controlled, detachable microcoils placed in a concentric fashion. This technique was feasible in approximately one-third of all PA cases diagnosed during our study period. As far as we know, there have been no studies evaluating this packing technique for the endovascular treatment of peripheral arterial PAs. This endovascular technique is generally used for the treatment of intracranial aneurysms,[19] often with the remodelling technique to avoid coil protrusion into the parent artery because of an unfavourable neck-to-sac ratio.[20] In all our patients, the PA neck was thin,

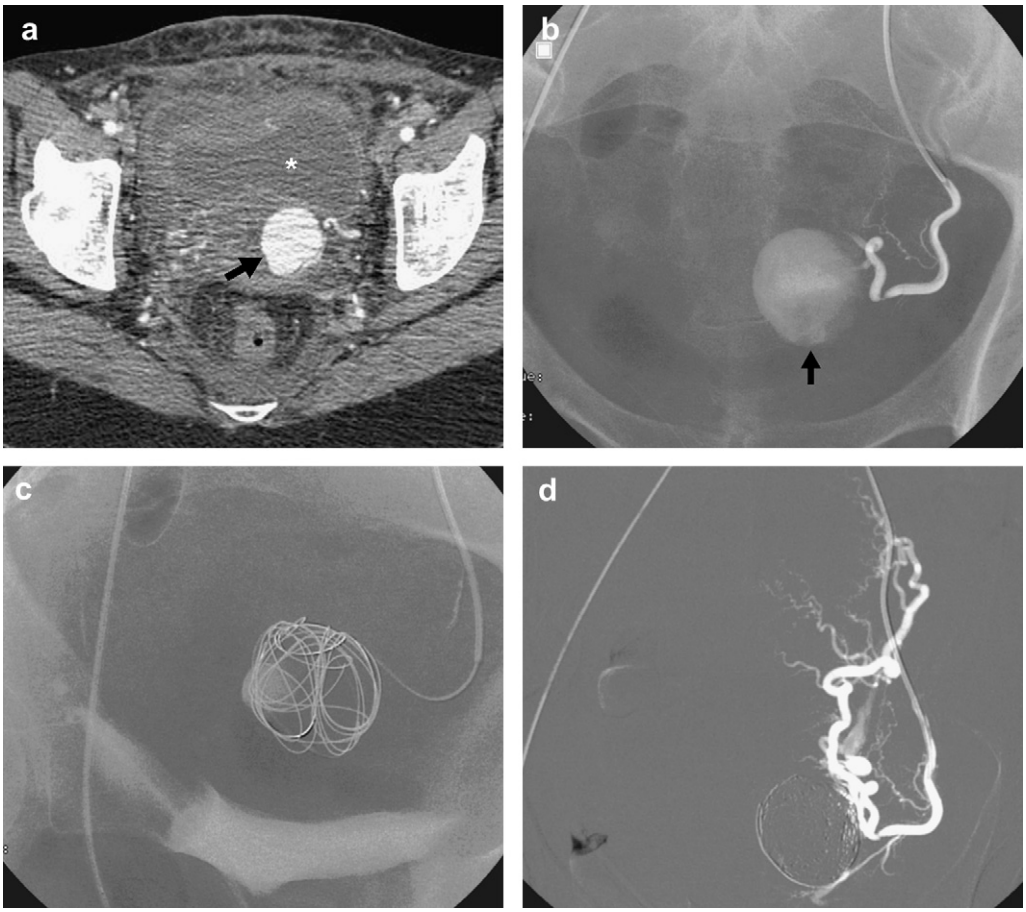


Figure 4 Patient 15: A 32-year-old woman presented to the emergency department with fever and pelvic pain 10 days after caesarean delivery. (a) Pelvic post-contrast axial multi-slice spiral computed tomography (CT): pelvic mass that shows contrast filling at the arterial phase (*arrow*) with an anterior collected hematoma (*asterisk*). (b) Selective left uterine arteriogram showing filling of a pseudoaneurysm (PA) (*arrow*) arising from the uterine artery pedicle. (c) Coil embolisation of the aneurysmal sac across the neck using the three-dimensional packing technique through a microcatheter. (d) Control angiography showing complete occlusion of the PA and preservation of the main and distal uterine artery.

making balloon-remodelling unnecessary. Although endovascular treatment is not recommended for mycotic PAs, two high-risk surgical patients were successfully treated with coil embolisation in our series. This technique was preferred because of their severe co-morbidities. Neither of them underwent subsequent surgical intervention. One of them died because of recurrent drug abuse. The optimal management of mycotic PAs remains controversial, but some authors have also reported successful outcomes after embolisation in this indication.[21] We believe that microcoil embolisation should be considered a viable option in selected high-risk patients.

Our method has several potential limitations. The main technical drawback is that the microcatheter must be placed in the PA sac. Considerable experience is required to pass through the neck, which is typically slender in peripheral PAs. The other limitation concerns the number of coils required for complete occlusion of the PA sac, especially those of large size, and consequently the cost of the procedure. Hence, PA $>$50 mm in diameter is considered as a contraindication for treatment using packing technique in our department. Compared to non-fibred coils, fibred coils have greater occlusive power, allowing occlusion with a smaller number of coils. Controlled, detachable fibred microcoils are now commercially available. Furthermore, we believe that complete occlusion is easier to achieve with a PA sac than with an aneurysmal sac, because of the specific nature of the lesion and small size of the neck, both of which lead to rapid and complete angiographic PA exclusion even when 3D coil-packing of the sac is incomplete. The case of secondary rupture in our series 3 weeks after embolisation of a splenic artery PA is probably related to over-packing of the sac. Our experience and the lack of data in the literature suggest that complete angiographic sac exclusion may be less important with PAs than with aneurysms, although determining when to stop packing is difficult. Packing 80—90% of the sac probably provides complete sac exclusion while avoiding complications such as secondary rupture. Few centres combine the use of detachable microcoils with an injection of ethylene vinyl alcohol copolymer (Onyx, MicroTherapeutics, Irvine, CA, USA) into the pseudo-aneurysmal sac to reduce the amount of coils and the risk of over-packing.[22] This embolic agent is used for embolisation of brain arteriovenous malformations. The coil mesh proved to be very effective for capturing Onyx and facilitated complete occlusion of

a challenging lesion. However, a limitation to the selection of Onyx for peripheral indications is its relatively high cost compared with microcoils. In addition, its use may add to the complexity of embolisation procedures because a balloon-assisted remodelling technique is often necessary. No procedure-related deaths occurred in our study, and the immediate and long-term anatomic and clinical results were excellent in all patients.

In conclusion, our study provides the first data on the feasibility of 3D sac packing with detachable microcoils for the endovascular treatment of peripheral arterial PAs. Our results show that arterial PAs can be safely packed with controlled, detachable coils placed concentrically, regardless of the clinical presentation, cause or location of the lesion at the level of major peripheral or visceral arterial branches. We suggest that this conservative therapeutic option may induce less morbidity than stent placement or open surgery and may deserve to be used whenever possible, as it preserves the patency of the parent artery. Overpacking should probably be avoided given the possible risk of secondary rupture. In this small series of PAs exhibiting features that predicted stable long-term results from coiling, no recurrences were seen over the mean 24.7-month follow-up. Nevertheless, additional larger series with long-term follow-ups are needed to confirm these preliminary results.

Conflict of Interest/Funding

None.

References

1 Clark ET, Gewertz BL. Pseudoaneurysms. In: Rutherford RB, editor. *Vascular surgery*. 4th ed. Philadelphia: WB Saunders, 1995:1153—61.

2 Loffroy R, Guiu B, Cercueil JP, Lepage C, Cheynel N, Steinmetz E, et al. Transcatheter arterial embolisation of splenic artery aneurysms and pseudoaneurysms: short- and long-term results. *Ann Vasc Surg* 2008;**22**:618—26.

3 Tokuda T, Tanigawa N, Shomura Y, Kariya S, Kojima H, Komemushi A, et al. Transcatheter embolisation for peripheral pseudoaneurysms with n-butyl cyanoacrylate. *Minim Invasive Ther Allied Technol* 2009;**18**:361—5.

4 Carr JA, Cho JS, Shepard AD, Nypaver TJ, Reggy DJ. Visceral pseudoaneurysms due to pancreatic pseudocysts: rare but lethal complications of pancreatitis. *J Vasc Surg* 2000;**32**:722—30.

5 De Perrot M, Buhler B, Delgadillo X, Mentha G, Morel P. Management of bleeding pseudoaneurysms in patients with pancreatitis. *Br J Surg* 1999;**86**:29—32.

6 Tulsyan N, Kashyap VS, Greenberg RK, Sarac TP, Clair DG, Pierce G, et al. The endovascular management of visceral artery aneurysms and pseudoaneurysms. *J Vasc Surg* 2007;**45**:276—83.

7 Christiansen S, Eiberg JP, Hansen MA. Common carotid artery pseudoaneurysm treated with a stent-graft. *Eur J Vasc Endovasc Surg* 2002;**24**:555—7.

8 Assali AR, Sdringola S, Moustapha A, Rihner M, Denktas AE, Lefkowitz MA, et al. Endovascular repair of traumatic pseudoaneurysm by uncovered self-expandable stenting with or without transstent coiling of the aneurysm cavity. *Catheter Cardiovasc Interv* 2001;**53**:253—8.

9 Butori N, Coulange L, Filipuzzi L, Krausé D, Loffroy R. Pseudoaneurysm of the uterine artery after cesarean delivery: management with superselective arterial embolisation. *Obstet Gynecol* 2009;**113**:540—3.

10 Lau KY, Wong TP, Wong WWC, Chan JKW, Kan WK, Chan YF, et al. Transcatheter embolisation of visceral pseudoaneurysms — technical difficulties and modification of embolisation technique. *Eur J Vasc Endovasc Surg* 2005;**30**:133—6.

11 Yamakado K, Nakatsuka A, Tanaka N, Takano K, Matsumura K, Takeda K. Transcatheter arterial embolisation of ruptured pseudoaneurysms with coils and n-butyl cyanoacrylate. *J Vasc Interv Radiol* 2000;**11**:66—72.

12 Drooz AT, Lewis CA, Allen TE, Citron SJ, Cole PE, Freeman NJ, et al. Society of Interventional Radiology Standards of Practice Committee. Quality improvement guidelines for percutaneous transcatheter embolisation. *J Vasc Interv Radiol* 2003;**14**: S237—S242.

13 Cox MW, Whittaker DR, Martinez C, Fox CJ, Feuerstein IM, Gillespie DL. Traumatic pseudoaneurysms of the head and neck: early endovascular intervention. *J Vasc Surg* 2007;**46**: 1227—33.

14 Beregi JP, Prat A, Willoteaux S, Vasseur MA, Boularand V, Desmoucelle F. Covered stents in the treatment of peripheral arterial aneurysms: procedural results and midterm follow-up. *Cardiovasc Intervent Radiol* 1999;**22**:13—9.

15 Rossi M, Rebonato A, Greco L, Citone M, David V. Endovascular exclusion of visceral artery aneurysms with stent-grafts: technique and long-term follow-up. *Cardiovasc Intervent Radiol* 2008;**31**:36—42.

16 Becker GJ, Benenati JF, Zemel G, Sallee DS, Suarez CA, Roeren TK, et al. Percutaneous placement of a balloon-expandable intraluminal graft for life-threatening subclavian arterial hemorrhage. *J Vasc Intervent Radiol* 1991;**2**:225—9.

17 Cox GS, Young JR, Gray BH, Grubb MW, Hertzer NR. Ultrasound-guided compression repair of postcatheterization pseudoaneurysms: results of treatment in one hundred cases. *J Vasc Surg* 1994;**19**:683—6.

18 La Perna L, Olin JW, Goines D, Childs MB, Ouriel K. Ultrasound-guided thrombin injection for the treatment of post-catheterization pseudoaneurysms. *Circulation* 2000;**102**: 2391—5.

19 Lubicz B, Leclerc X, Gauvrit JY, Lejeune JP, Pruvo JP. Three-dimensional packing with complex orbit coils for the endovascular treatment of intracranial aneurysms. *AJNR Am J Neuroradiol* 2005; **26**:1342—8.

20 Moret J, Cognard C, Weill A, Castaings L, Rey A. The reconstruction technique in the treatment of wide-neck intracranial aneurysms: long-term angiographic and clinical results. *J Neuroradiol* 1997;**24**:30—44.

21 Mullen R, Suttie SA, Bhat R, Evgenikos N, Yalamarthi S, McBride KD. Microcoil embolisation of mycotic cystic artery pseudoaneurysm: a viable option in high-risk patients. *Cardiovasc Intervent Radiol* 2009;**32**:1275—9.

22 Vanninen RL, Manninen I. Onyx, a new liquid embolic material for peripheral interventions: preliminary experience in aneurysm, pseudoaneurysm, and pulmonary arteriovenous malformation embolization. *Cardiovasc Intervent Radiol* 2007;**30**: 196—200.