"We do, we mend": peripheral arterial pseudoaneurysm

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Authors: D. Soliva Martínez1, T. Martínez Fernández2, I. Belda Gonzalez3, L. Hernandez Munoz4, P. Fernández Iglesias2, J. A. Martínez Yunta2, R. Soliva Martínez2, M. Soliva Martínez2, T. Bernfield2; 1Tarancón/ES, 2Cuenca/ES, 3Jódar/ES, 4MADRID/ES
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Learning objectives

The goal of this poster is to know the most important aspects of the following points:

- Causes, evidence, diagnosis, treatment and management of peripheral arterial pseudoaneurysm.

- Practical value of image techniques on diagnosis and monitoring of a pseudoaneurysm.

- Advantages and disadvantages of the treatment options.

- Posttreatment monitoring.
Background

The true aneurysm and false aneurysm (pseudoaneurysm) are histologically different and have different origins and treatment. Whereas most true aneurysm occur as a consequence of arterial wall degeneration from atherosclerosis, pseudoaneurysm occurs as a result of arterial injury or anastomotic disruption (1), so the wall of the true aneurysms has three layers (intima, media and adventitia), but no pseudoaneurysm wall.

In current clinical practice, pseudoaneurysms are usually a complication from femoral or brachial artery puncture (postcatheterization).

Pseudoaneurysm are a blood extravasation through a defect in the vessel wall (site of puncture), that is contained by the surrounding soft tissues (1).

The incidence of iatrogenic pseudoaneurysm has increased significantly due to a higher number of diagnostic and therapeutic invasive procedures made by both radiologists and other specialists.

The typical clinical signs are painful pulsatile mass, which rapidly grows, in patients with a history of punctured artery in that location, but may be asymptomatic and detected only incidentally during radiologic studies of other conditions or during surgery.

Pseudoaneurysm are more common in women, obese patients, and patients under anticoagulant therapy or with vascular calcifications (1). They are frequent when large bore catheters are used, after punctures in unusual areas, in therapeutic procedures, and after manual compression. Therefore, these patients should be more closely monitored.

Pseudoaneurysm complications as a rupture, infection, distal embolization, pain, femoral vein compression, neuropathy and local skin ischemia, forces us to diagnose and treat it, in order to avoid associated morbidity and mortality risk.
Imaging findings OR Procedure details

Differential diagnosis imaging techniques normally available are ultrasonography (US), CT-angiography, MRI-angiography and conventional angiography.

The diagnostic workup should proceed with the choice of noninvasive studies first.

Ultrasound is the first line technique because of it is available, quick, fast, cheap, harmless, noninvasive and involves no ionizing radiaton or renal toxic contrast material and first of all because of its availability. Its main disadvantage is that it is operator dependent.

Gray-scale and color doppler US diagnostic sign would be an anechoic cystic structure, with a swirling motion blood flow inside (ying-yang sign), adjacent to the punctured artery, with a neck communicating both structures with a systolic flow in the pseudoaneurysm direction and diastolic flow in the opposite direction (Fig.3.).

US has a high sensitivity and specificity in the detection of postcatheterization pseudoaneurysm.

Gray-scale US can demonstrate the morphology (simple or complex), the size of the sac, its connection to the artery, the length and width of the pseudoaneurysm neck, and concentric layers of hematoma.

CT-angiography, MRI-angiography and convetional angiography should be used for differential diagnosis, during therapeutic procedures or for surgery planning.

CT-angiography (contrast-enhanced MDCT) may demonstrate a contrast material filled sac, however a low attenuation area may remain within the pseudoaneurysm indicating partial thrombosis. The donor artery is adjacent to the pseudoaneurysm and can usually be seen communicating with it (2).

CT-angiography is less operator dependent and has a shorter acquisition time. Three dimensional images allows visualization of the lesion from all angles, which is not posible with angiography. In addition, this technique provides a global perspective on the entire vasculature. Diagnostic information is enough for surgical planning. The usefulness of CT angiography is still limited by imaging metallic artifacts. In general, more contrast
material is needed for CT-angiography than for conventional angiography. In addition, endovascular therapy cannot be performed at the time of diagnosis (2).

Three dimensional gadolinium enhanced MR-angiography allows visualization of the pseudoaneurysm in any projection. Furthermore, much like with CT-angiography, no iodinated contrast material or ionizing radiation is needed, making it a valuable tool in patients with impaired renal function and allergies to CT contrast material. Axial T1 weighted images allow visualization of intraluminal thrombus. This technique remains time consuming compared with US or CT, and has limited availability in patients connected to imaging incompatible equipement. Movement, metal, vessel crookedness, turbulent flow or pulsatility of the vessels are the main artifacts (2).

Angiography remains the standard of reference for the diagnosis of pseudoaneurysm. An important advantage of angiography is the possibility of real time hemodynamic assessment of a particular vascular bed, which includes identifying collateral vessels to assess the expendability of the donor artery. Such assessment is important in treatment planning. A selective angiography performed to identify the characteristics of the pseudoaneurysm, including the size of its neck. In addition, angiography provides a diagnostic tool that allows concomitant therapeutic procedure if indicated. The principal disadvantage as a diagnostic modality is its invasive nature, use ionizing radiation and iodinated contrast material, each with its own risks and complications. Another limitation of angiography is that it does not help accurately assess the size of a pseudoaneurysm that contains a thrombus. Angiography should be used as a focused diagnostic modality to complement and to compensate for pitfalls of other diagnostic modalities and as a prelude to endoluminal treatment of pseudoaneurysm (2).

Once the diagnosis is confirmed, the proper management option can be selected. The therapeutic options should be tailored to the location, rupture risk, morphologic features and clinical setting of the pseudoaneurysm and to any patient comorbidities.

There are a number of minimally invasive techniques used to achieve occlusion of a pseudoaneurysmal sac, including regular monitoring, US guided compression, US-guided percutaneous thrombin injection, and endovascular therapy. However, not all pseudoaneurysm can be managed by the minimally invasive, so open surgical repair may be necessary in some instances.

These techniques are used to achieve exclusion of the pseudoaneurysmal sac from the arterial circulation:

- Expectant management: small asymptomatic pseudoaneurysm may undergo spontaneous thrombosis (there is no way to predict it), so the
regular monitoring may be appropriate in patients without risks factors. In this case, a reasonable tracking time must be set. Therefore, these pseudoaneurysm must be treated if they do not resolve, or if they enlarge or become symptomatic (Fig. 1.).

- US-guided compression with the ultrasound transducer performed to obliterate the flow inside the sac without stopping the flow in the underlying artery. Compression is performed in 10-20 minutes sessions until the pseudoaneurysm is thrombosed. Sessions are repeated 3-5 times. The major drawbacks are the pain and the significant failure rate in anticoagulated patients. Rare complications such as venous thrombosis, skin necrosis and rupture have been reported (1,2) (Fig. 2.).

- US-guided percutaneus thrombin injection. Before injecting thrombin, it is important that patients undergoing pseudoaneurysm injection have a high quality ultrasound to evaluate the size of the pseudoaneurysm sac, the location of the adjacent vessels, the size of the neck and its connection to the native artery as well as the characteristics of the Doppler waveform within the pseudoaneurysm (3). A solution of preferably human thrombin (500 U/mL) is prepared and loaded into a 1 mL syringe attached to a 22 G needle. The linear ultrasound transducer (4-7 Mhz) is placed over the pseudoaneurysm and under aseptic technique the needle is introduced with the tip in the center of the sac with gray scale ultrasound guided. Using real time ultrasonography, thrombin is continuously injected until the 1000 U limit or until flow (color-doppler) within the sac ceases (thrombus has filled the entire sac)(4). This technique is little painful, cheaper than endovascular therapy without radiation exposure and useful in anticoagulated patients. Autologous thrombin is cheaper than comercial bovine or human thrombin. Thrombin leakage into donor artery during percutaneous treatment is a possible complication, despite the fact that clinical significant arterial thrombosis or distal embolization is rare due to the protective effect of the physiological anticoagulant mechanism. Where the neck of de pseudoaneurysm is absent or is short and wide, percutaneous thrombin injection can theoretically be safer with simultaneous ballon occlusion across the entry site of the sac previous to thrombin injection. We should suspect an extensive damage to arterial wall if we need a dose > 1000 U or in case of treatment failure. In the case of thrombin failure a second attempt can be made before resorting to surgery (5). US guided percutaneous thrombin injection can be regarded as the therapy of choice for postcatheterization pseudoaneurysm management (6) (Fig. 3; Fig. 4.).

- Endovascular therapy consists peripheral arterial pseudoaneurism exclusion from the circulation placing a stent thats obstructs the in-flow with subsequent thrombosis of the sac. Endovascular therapy is gaining
popularity as a therapeutic alternative to open surgery. These procedures can be performed under local anaesthesia, are well tolerated by the patient and are associated with a shorter hospitalization time than surgery. This avoid the need for general or locorregional anesthesia in a group of patients who are often affected by advanced cardiovascular disease and cannot tolerate vascular reconstruction and bleeding. Covered stent can be a reliable minimally invasive option for peripheral aneurysm that cannot be repaired with US guided thrombin injection. These stent should be used with caution in long life expectancy patients. Other limitations are extreme elongation and tortuosity of the iliac arteries prohibiting contralateral femoral access, location close to the femoral artery bifurcation, potential deformation or fracture at a site of mobility near the hip; restrictions to re-use the groin for access in the future; and risk of contrast induced nephrotoxicity and radiation exposure (2) (Fig.5; Fig. 6.).

• Surgery is the gold standard against wich all other therapies should be compared (1) and it is the choice for the pseudoaneurysm that cannot be treated by percutaneous methods. Surgical treatment is also reserved for rare selected cases. These include a rapidly expanding pseudoaneurysm due to continuous bleeding in a relatively fit young patient; infection; local compression; skin and surrounding soft tissues ischemic changes; hemodynamic instability; distal limb ischemia. The success of surgical repair of iatrogenic pseudoaneurysm is nearly 100%, but this treatment is associated with a high postoperative morbidity and mortality rate due to the significant comorbidities of the treated patients. Complications of surgery include bleeding, neuralgia and death (5).

Treated patients remained in bed for variable time depending on the procedure. Distal pulses should be checked before and after procedure. Patients should be monitored immediately postprocedure, the day after, and at four weeks after the procedure unless there was a clinical indication to perform this check sooner.

Both color Doppler US and contrast-enhanced MDCT are valuable noninvasive imaging modalities used to follow treated pseudoaneurysm. These modalities will detect treatment failure by demonstrating blood flow within the aneurismal sac (presence of colour doppler or filling contrast material within the sac respectively).
Fig. 1: Postcatheterization pseudoaneurysm. (a,b) Gray scale US image shows an ovoid anechoic cystic structure, and (c) colour Doppler image shows a swirling motion blood flow inside (ying-yang sign). (d) After a few weeks, colour doppler US image shows a complete absence of colour doppler in the sac without treatment. (e) Donor artery is permeable.

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Fig. 2: Postcatheterization pseudoaneurysm. Colour Doppler US: (a) It is not possible to obliterate the flow inside the neck of the sac (a: compression; b: no compression). (c) After a week, donor artery is permable and (d) the pseudoaneurysm spontaneously thrombosed.

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Fig. 3: Pseudoaneurysm in a patient who had undergone cardiac catheterization. (a) Gray scale US image shows an anechoic cystic structure, (b) that on colour doppler US image shows a swirling motion blood flow inside (ying-yang sing), (c) adjacent to the punctured artery, with a neck communicating both structures with a systolic flow in the pseudoaneurysm direction and diastolic flow in the opposite direction.

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Fig. 4: Treatment of previous patient with US guided thrombin injection. (a) Gray scale US image shows the needle in the center of the sac. (b) On a Color Doppler US image obtained after percutaneous injection of 200U of thrombin, no flow is seen in the sac. (c) 24 h later, color doppler US image shows complete absence of flow within the sac, and (d) donor artery is permeable.

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Fig. 5: Postcatheterization pseudoaneurysm. (a) Gray scale US image shows an anechoic cystic structure, (b,c) that on colour doppler US image shows a turbulent flow. (d) Femoral vessels are permeables. Previous images shows an adjacent hematoma. (e) MRI angiography shows a pseudoaneurysm that depends of the superficial femoral artery. Previous image correlates with (f) angiography pre-treatment (covered stent: Fig. 6.).

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Fig. 6: (a) Angiography image shows an extravasation of contrast material adjacent to the superficial femoral artery (pseudoaneurysm). (b) Covered stent placed distal to femoral bifurcation without deep femoral artery obstruction. (c) Covered stent has excluded the pseudoaneurysm from the circulation.

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Conclusion

The incidence of iatrogenic pseudoaneurysms has increased significantly due to a higher number of diagnostic and therapeutic invasive procedures made by both radiologists and other specialists.

Appropriate diagnosis and treatment of pseudoaneurysm is critical as some of the associated complications can develop unpredictably and may be associated with life-threatening complications.

Conventional angiography remains the standard of reference for diagnosis but is an invasive technique, so the diagnostic workup should proceed with the choice of noninvasive studies first.

A complete work-up to determine the location of the pseudoaneurysm and to evaluate surrounding structures and relevant vascular anatomy is essential in the selection of the procedure.

Treatment options should be tailored to the location, rupture risk, and clinical setting of the pseudoaneurysm and to any patient comorbidities.

Minimally invasive endovascular and percutaneous approaches, due to their lower morbidity and mortality have substantially decreased the role of conventional surgery.

US-guided percutaneous thrombin injection is a quick, effective, successful and safe treatment for iatrogenic peripheral pseudoaneurysm. As such, this method should be considered as the first line treatment.

Both color Doppler US and contrast-enhanced MDCT are valuable noninvasive imaging modalities frequently used to follow treated pseudoaneurysm. Preferably US, because it is cheap, accessible, causes no ionizing radiation, doesn`t need intravenous contrast material, and usually eloquently demonstrates the pseudoaneurysm. These modalities will detect treatment failure by demonstrating blood flow within the aneurismal sac.
References


