

## Iatrogenic Pseudoaneurysm in Cardiac Catheterisation. Prevention, Diagnosis and Treatment with POCUS

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## 1. Abstract

Coronary angiography is currently a common technique in all cardiology departments. Whichever access is chosen (femoral or radial), multiple studies have shown that ultrasound-guided catheterization reduces the incidence of vascular complications. The role of Point-Of-Care Ultrasound (POCUS) in coronary angiography is therefore multiple, because it allows:

- Check for the existence of collateral flow before puncture.
- Choose the best entry point, avoiding collateral branches or atheromatous plaques.
- Assess the caliber of the artery to select the appropriate catheter.
- Direct the puncture avoiding injuring adjacent structures.
- Check hemostasis and recanalization of the vessel after catheter removal.
- Early diagnosis of vascular complications.

We report three cases of arterial punctures for angiography complicated by pseudoaneurysm and discuss the usefulness of POCUS in the prevention, diagnosis, and treatment of vascular complications of the radial approach.

At present, coronary angiography is common practice in every cardiology service. Whichever the chosen access point (femoral or ra-

dial), multiple studies have proven that echoguided catheterization decreases the incidence of vascular complications.

We provide three cases of arterial punctures performed for angiographies which were complicated with pseudoaneurysms and comment on the usefulness of POCUS in the prevention, diagnosis, and treatment of the vascular complications of radial approach.

## 2. Clinical Cases

### 2.1. Case 1

83 year old diabetic and hypertense male, with chronic renal failure and a moderate aortic valve stenosis.

This patient comes to the hospital because of dyspnea on exertion. An ischemic cardiopathy is suspected and a coronary angiography is conducted.

Initially, there was an attempt to canalize the right radial artery but it was not possible. Finally, the procedure was done via the femoral access. A compression bandage was placed on the failed radial access.

The coronarography showed a triple-vessel disease, but due to the patient's age it was decided to only treat the anterior descending artery, in which two stents were successfully implanted.

After the intervention, and once the compression bandage was removed, there was a hematoma in the radial puncture site. (Video 1)

**2.2. Case 2**

73 year old male, sufferer of dyslipidemia with a severe peripheral vasculopathy and intermittent claudication.

This patient presented the clinic associated with a progressive angina pectoris of effort with a normal electrocardiogram and a positive ergometry. An angiography was performed via the left radial artery. This showed a double-vessel disease of two main vessels in which two stents were successfully implanted. After the removal of the catheter, a pneumatic compressor was placed over the arterial access. The compressor was progressively deflated as the hours went by.

After the withdrawal of the compressor a hematoma was palpable over the puncture site. (Video 2)

**2.3. Case 3**

72 year old male, diagnosed with hypertension, obesity, dyslipidemia, a known ischemic cardiopathy, and several previous stents which were implanted without complications.

This patient suffered a progressive angina pectoris of effort and dyspnea. In the electrocardiogram there was a depression of the ST segment and the markers for myocardial ischemia were positive. The conducted coronary angiography showed several injuries in main vessels and stents were implanted in the anterior descending and circumflex arteries. The technique was conducted via the right femoral artery.

The injector was extracted after controlling, via a blood analysis, that the coagulation had normalized. After the extraction, the common femoral artery was manually compressed for 15 minutes, even though it was complicated because of the patient’s obesity.

A small, painless, hematoma was left on the puncture site and, after being left in observation for 24 hours, the patient was discharged.

The next day, he came to the Emergency Service because he noticed the appearance of an inguinal tumoration. (Video 3)

In the first and second cases the pseudoaneurysm was successfully treated using echoguided compression. In the third case the Vas-

lar Surgery Service had to intervene to evacuate the hematoma and suture the artery’s bleeding spot.

**3. Conclusions**

Presently, radial access is the first choice for the majority of hemodynamic cardiologists when performing an angiography because the incidence of complications is lower when compared to those that appear when using a femoral access.

Its main limitations are that the catheterisation is more difficult technically, with a more prolonged learning curve, and that the procedure time is longer and, thus, the radiation dose given to the patient is bigger.

A significant amount of these complications and limitations can be avoided by using POCUS, which has a fundamental role in the selection of the access point, guiding the procedure and allowing the diagnosis and early treatment of the most frequent complications.

**3.1. Selection of the puncture site**

Classically it’s considered that the patients more suitable for radial access are those younger than 70 years old, who are hemodynamically stable and have a strong radial pulse with a normal Allen test.

Regardless of the laterality (left or right) or the dominance (left- or right-handed) the radial artery has a bigger caliber and less flux than the cubital artery and both are of a bigger diameter and flux in men than in women, even though it is common to find radial dominance in patients who smoke because in them the artery most affected by arteriosclerosis is always the ulnar.

With echography the flux of both arteries can be evaluated, thus avoiding the need to perform the Allen test and choosing the radial artery of the bigger caliber and lesser technical complication.

(Table 1. Caliber and flux of the arteries of the wrist)

The arteries found on the wrist are studied with the high frequency linear probe, around two centimeters above the palmar crease. First with the transducer on a transversal position to value the caliber and later on a longitudinal position, applying color and pulsed-wave doppler to measure the flux.

(Video 4)

**Table 1:** Caliber and flux of the arteries of the wrist

CALIBER AND FLUX OF THE ARTERIES OF THE WRIST		
	DIAMETER (mm)	FLUX VELOCITY (cm/s)
<b>RADIAL</b>	22-28 (24)	39-62 (48)
<b>ULNAR</b>	18-25 (22)	39-70 (54)

**3.2. Echoguided puncture**

Arterial canalization can be especially difficult in obese, oedematous or shocked patients. This causes the need to make several puncture attempts, which in turn produces a greater vasospasm, difficulting the catheterisation more each time.

Most complications depend on:

- Multiple failed catheterisation attempts.
- Puncturing an inadequate spot on the artery, a bifurcation or a distal branch.
- The use of injectors of a big diameter in narrow arteries, or those with atheroma plaques.
- Deficient systemic anticoagulation.

- Prolonged occlusion during hemostasis.

This means that a clean securing of the access is crucial to diminish the risk of complications and echoguided puncture increases the probability of a successful cannulation at first try (by up to 70%).

(Video 5)

### 3.3. Diagnosis and treatment of the complications.

#### 3.3.1. Occlusion of the artery

Occlusion is strongly tied with the patient's prothrombotic state, the diminished distal flux and, especially, with the denudation of the endothelium produced by the injector.

It is detected by the absence of doppler flux in the radial artery and, in the vast majority of the cases, it is clinically asymptomatic due to the hand's double perfusion system.

That is why it is important for the hemodynamist to evaluate the permeability of the radial artery using echocardiography at the end of the procedure and, once again, at discharge.

If the occlusion is acute it can be reversed by performing a compression of the ulnar artery guided by echography. This will increase the flux to the radial artery, canalizing it once again.

If the occlusion is detected once it has reached a chronic state, the patient will need to be coagulated for, at least, 4 weeks using low molecular weight heparin.

#### 3.3.2. Arterial spasm

It is a very common complication, which often causes the access to be a failure.

Once again, the cause of the spasm is the friction between the artery's internal wall and the injector, which means that the best way to prevent it is to do a clean puncture and use spasmolytic cocktails (nitroglycerin, verapamil, heparin).

To obtain the cannulation in the first try it is essential to know the disposition and the state of the arteries and choose the one with the best access and bigger diameter.

#### 3.3.3. Hematoma

It is generally produced by an inadvertent perforation of secondary branches of the radial artery during the access. In extreme cases, it can produce compartment syndrome.

#### 3.3.4. Pseudoaneurysm

When the puncture site is inadequate or the hemostasis is insufficient, the perforation in the artery is left open and the blood flows to the tissues, where it is contained.

It is manifested hours or days after the procedure as a painful and throbbing swelling in the wrist, often with an audible murmur. The diagnosis is confirmed using echography. In 2D mode a hematoma with dynamic content can be appreciated. When applying color doppler, a turbulent flux can be seen in the inside.

If an early diagnosis is made, the treatment is echoguided compression. Sometimes a thrombin injection (which is also applied using echography) or even a surgical repair are needed.

#### 3.3.5. Arteriovenous fistula

If the puncture is blind, the needle can pierce the artery's posterior wall and reach a tributary vein. Most times this communication is spontaneously closed; however, if this does not happen and a fistula is formed, the patient will present pain, paresthesias in the whole hand, edema and thrill at the palpation of the radial pulse. The echography will, once again, confirm the diagnosis.

The fistula can be treated via an echoguided compression, even though, occasionally, a stent needs to be implanted or a surgical repair is needed.

We think that with the current availability of portable equipment and the dissemination of knowledge and abilities relating to POCUS, hemodynamic cardiologists and health care professionals should be acquainted with the technique and systematically use it in the monitoring and in the follow-up of coronary angiography.

### 3.4. POCUS moments in coronary angiography.

1. Examination of both radial arterial and ulnar arteries before the procedure to determine:

- Flux of the arteries of the wrist.
- Diameter of the radial arteries, which will help in the selection of the inductor's diameter.
- Presence of arteriosclerotic plaques.
- Tortuosity.

2. Examination of both femoral arteries before the procedure to choose the best access in case the use of the radial access is not possible.

3. Examination before the procedure to determine the presence of early complications:

- Arterial spasm.
- Occlusion.
- Hematoma.
- Pseudoaneurysm.
- Arteriovenous fistula.

4. Examination at discharge to confirm the presence of flux and the absence of abnormalities in the artery.

It would be extremely cumbersome for the patient (and costly for the hospital) having to send them to the radiodiagnostic service to do a proper vascular echography each time.

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