

## Surgical management of iatrogenic femoral artery pseudoaneurysms: A 10-year experience

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### Abstract

**Background:** Vascular complications of cardiac catheterization have increased in line with increasing number of percutaneous interventions. Open repair is the standard method of treatment for true and false aneurysms of femoral artery. We report results of patients operated due to femoral artery pseudoaneurysm after cardiac catheterization.

**Methods:** Data from 12,261 patients who underwent percutaneous intervention for cardiac catheterization between January 2003 and January 2013 were evaluated. Diagnosis of pseudoaneurysm was established mainly by doppler ultrasonography in patients with complaints of pain and hematoma at the intervention site. Pseudoaneurysms less than 2 cm in diameter were treated non-operatively and were followed up by regular ultrasonographic examination at the outpatient clinic. Pseudoaneurysms with a diameter of 2 cm or more underwent primary repair. All patients were followed up for one year.

**Results:** We detected 55 (0.44%) patients with femoral artery pseudoaneurysm and 42 of them were operated. The mean age was  $60.7 \pm 6.3$  years. Thirty nine (94.5%) patients underwent elective surgery, three (5.5%) patients were operated on under emergency conditions. Operation was performed under local anesthesia in 32 patients, under local anesthesia and sedation in eight patients, and under general anesthesia in three patients. Location of the pseudoaneurysm was the superficial femoral artery in 29 (69%), the common femoral artery in nine (21.4%), and the deep femoral artery in four (9.6%) patients. No limb loss occurred, no patient died and no recurrence was detected during the follow up.

**Conclusions:** Performing vascular reconstruction before the rupture of pseudoaneurysm is important in terms of morbidity and mortality. We concluded that surgical repair in pseudoaneurysms larger than 20 mm is safe and essential. Hippokratia 2013; 17 (4): 332-336.

**Keywords:** Cardiac catheterization, iatrogenic, femoral artery, pseudoaneurysm

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### Introduction

Rapid increases in the use of cardiovascular interventional procedures have led to an increase in the complication rates. While intervention-related complications are encountered less frequently in diagnostic procedures, vascular complications following therapeutic interventions are encountered more frequently<sup>1</sup>.

Since the femoral artery is used for percutaneous cardiac interventions in general, most of the complications are associated with the femoral artery<sup>2,3</sup>. These complications include bleeding, hematoma, pseudoaneurysm, arteriovenous fistula, and arterial occlusions. Among these, pseudoaneurysms are of particular importance due to the facts that they are the most frequent complications and that they may be overlooked because they do not cause any complaints in more than half of the patients.

The aim of this retrospective study was to evaluate cases undergoing surgery in our clinic due to femoral ar-

tery pseudoaneurysm (FAP) following cardiac catheterization in accordance with the literature data.

### Materials and Methods

Data of 12,261 patients who underwent percutaneous cardiac catheterization between January 2003 and January 2012 were evaluated retrospectively. Diagnosis of FAP was established by doppler ultrasonography performed in patients with complaints of pain and hematoma at the intervention site. While doppler ultrasonography was adequate in establishing the diagnosis of many patients, the diagnosis was also verified by magnetic resonance (MR) angiography in seven patients (Figure 1). Pseudoaneurysms less than 2 cm in diameter were treated non-operatively and were followed up by regular ultrasonographic examination at the outpatient clinic. Pseudoaneurysms with a diameter of 2 cm or more underwent primary repair. All patients were followed up for one year.



**Figure 1:** Magnetic resonance angiography imaging showing a right femoral pseudoaneurysm.

#### Anesthesia

Surgery was performed under general (sevoflurane 2-2.5 MAC + vecuronium bromide 0.1 mg/kg + thiopental 5-7 mg/kg + fentanyl 50 µg) and/or local anesthesia with 2% lidocaine up to 3 mg/kg dosage. Mild sedation (10 mL of 50 mg midazolam) was also performed in patients who received local anesthesia if necessary. Patients who received general anesthesia were those operated on under emergency conditions due to rupture.

#### Surgical Method

Following appropriate anesthesia, the patients were placed in the supine position. The common, deep, and superficial femoral arteries were explored through a vertical incision in the femoral region, encircled with silastic loops and controlled. Heparinization was performed with 5,000 U standard heparin intravenously by maintaining the activated clotting time (ACT) of over 200 seconds in case when it is necessary to clamp the artery in order to repair the arterial defect. Pseudoaneurysm pouch was accessed through a place close to the possible intervention site, and the bleeding focus was detected. Intervention site on the artery was primarily repaired with 5-6/0 polypropylene suture. After bleeding control and a small hemovac drain was placed, tissues were closed in layers and the procedure was ended.

#### Results

Among 12,261 patients who underwent percutaneous intervention for cardiac catheterization, pseudoaneurysm was detected in 55 (0.44%) patients. While surgical procedure was performed on 42 (76%) of these patients, local compression therapy was performed on 13 (24%) patients with pseudoaneurysms less than 2 cm in diameter and they were followed

by regular ultrasonographic examination. None of the patients with a femoral artery pseudoaneurysm less than 2 cm required further intervention at the follow up. The mean age of these 55 patients [39 (70.9%) females and 16 (29.1%) males] was  $60.7 \pm 6.3$  years (23-84 years). Of them, 21 had pulsatile mass, 19 had pain, four had extremity ischemia, and three had rupture during admission. The extremity ischemia resolved in all four patients after operation, since the pseudoaneurysm sac was compressing the superficial femoral artery and symptoms were due to mass effect. Infection due to *Escherichia coli* (*E. coli*) was observed in one of the ruptured pseudoaneurysms. Appropriate antibiotic treatment was commenced according to tissue culture results. This patient healed after antibiotic treatment without any problem. While 39 (94.5%) patients underwent elective surgery, three (5.5%) were operated on under emergency conditions. Forty-two (76.4%) of 55 patients developed pseudoaneurysm following coronary stent implantation, whereas 13 (23.6%) developed pseudoaneurysm after coronary angiography. Operation was performed under local anesthesia in 32 patients, under local anesthesia and sedation in eight patients, and under general anesthesia in three patients (Table 1). In five patients, repair was performed by clamping the common femoral artery under heparinization.

Among operated patients, the location of the pseudoaneurysm was the superficial femoral artery in 29 (69%), the common femoral artery in nine (21.4%) and the deep femoral artery in four (9.6%) patients. The mean body mass index (BMI) was  $33.7 \pm 6.3$  (26.2-41.7) kg/m<sup>2</sup>. The mean pseudoaneurysm size measured by Doppler ultrasonography was  $36.8 \pm 18.2$  mm (31-62 mm). The mean time from intervention to sheath removal was  $35.4 \pm 4.1$  hours. The mean pseudoaneurysm age at the time of surgery was  $16.6 \pm 4.7$  days (3-60 days). The mean duration of postoperative hospital stay was  $10.2 \pm 3.4$  days (3-25 days); the longest duration resulted from *E. coli* sepsis due to pseudoaneurysm infection. No limb loss occurred. No intraoperative or postoperative mortality was observed. No recurrence was detected during the follow and no wound infection was observed.

#### Discussion

The number of cardiovascular interventional procedures are increasing and they bring a variety of vascular complications. These may include intervention site-associated complications such as severe bleeding, femoral and retroperitoneal hematoma, pseudoaneurysm development, arteriovenous fistula formation, arterial occlusion and neuropathy. Among these, femoral hematoma and pseudoaneurysms are the most commonly encountered complications<sup>3,4</sup>.

Pseudoaneurysms most commonly result from extravasation of blood from the defect in the vascular wall, which occurs due to inadequate hemostasis following iatrogenic (mostly) or traumatic arterial wall injury, and its being surrounded by a pseudocapsule. Various studies have reported the frequency of pseudoaneurysms following diagnostic or therapeutic percutaneous interventions to be between 0.2% and 6%<sup>3-5</sup>. While pseudoaneurysms mostly occur in the superficial femoral artery, they may also be encountered in the

**Table 1:** General and perioperative characteristics of the patients.

Characteristics	Patients (n=55)
Age	60.7 ± 6.3 (23-84)
Gender	
Female	39 (70.9)
Male	16 (29.1)
BMI	33.7 ± 6.3
Location of the pseudoaneurysm	
Superficial femoral artery	29 (69)
Main femoral artery	9 (21.4)
Deep femoral artery	4 (9.6)
Complaint/Sign	
Pain	19
Ischemia	4
Pulsatile mass	21
Rupture	3
Surgery	
Emergency	3 (5.5)
Elective	39 (94.5)
Anesthesia	
Local	31 (73.8)
Local+sedation	8 (19)
General	3 (7.2)
Diagnosis	
Ultrasound	48 (87.2)
Ultrasound+MRA	7 (12.8)
Ultrasound	
Size (mm)	36.8
Age (days)	16.6 ± 4.7 (3-60)
Intervention	
Angiography	13 (23.6)
Stent	42 (76.4)
Time from intervention to sheath removal (hours)	35.4 ± 4.1
Total number of percutaneous intervention for cardiac catheterization	12,261
Postoperative hospital stay (days)	10.2 ± 3.4 (3-25)

Data are presented as mean ± standard deviation, n (%) or n, where appropriate.

BMI: body mass index, MRA: magnetic resonance angiography.

deep femoral artery, at the junction points of deep and superficial femoral arteries, and in the common femoral artery<sup>4</sup>.

Since the femoral artery is the most commonly used location for intervention, pseudoaneurysms of the femoral artery are more frequently encountered than pseudoaneurysms of the brachial and radial arteries. The incidence of FAP following interventional procedures varies between 0.2% and 6%<sup>3,4</sup>. In their study, Lazarides et al. reported that iatrogenic vascular injuries accounted for 36% of overall vascular injuries, the majority of which constituted pseudoaneurysms<sup>6</sup>. Another study reported pseudoaneurysms to be the most frequent among vascular complications<sup>7</sup>. In the present study, the frequency of pseudoaneurysms was found to be 0.44%. However, we consider that the real incidence would probably be higher than that found in the present study. The results of the present study reflected only the results of examinations performed depending on complaints, since no complaints suggestive of pseudoaneurysm were observed in substantial amount of patients developing pseudoaneurysm.

In addition to many risk factors including advanced age, female gender, diabetes, obesity, chronic obstructive pulmonary disease, peripheral artery disease, hypertension and inadequate compression, one of the most important risk factors in the development of femoral artery pseudoaneurysms is the puncture of other arteries (superficial femoral artery, deep femoral artery and external iliac artery) instead of common femoral artery<sup>1,4</sup>. In fact, external iliac artery puncture may also lead to more severe complications such as retroperitoneal hematoma<sup>4</sup>. Puncture that is performed below the common femoral artery bifurcation increases the risk of pseudoaneurysm development, as post-procedure compression is not effective. Moreover, the walls of the superficial and deep femoral arteries are thinner than the wall of the common femoral artery; thus, these arterial walls are easily damaged during interventional procedures and pseudoaneurysms may occur easily. In the present study, the superficial femoral artery ranked first among pseudoaneurysm locations with 29 (69%) patients, followed by the common femoral artery [9 (21.4%) patients] and the deep femoral artery [4 (9.6%) patients].

Pseudoaneurysm is more common following therapeutic invasive procedures as compared to diagnostic catheterization<sup>8-10</sup>. Although the catheters' being larger (> 7F) is not effective alone in the development of pseudoaneurysm, concomitant use of potent anticoagulants, antiaggregants and thrombolytics are known to be the risk factors for the development of pseudoaneurysms after the intervention. It is also known that the risk of pseudoaneurysm is high in patients undergoing an intraaortic balloon pump insertion, during which larger (8F, 9F) sheaths are used<sup>11</sup>. In the present study, pseudoaneurysm developed following stent implantation in 42 (76.4%) patients and following coronary angiography in 13 (23.6%) patients.

Complaint of the patient is the most important sign for the diagnosis of FAP. A patient complaining about pain and swelling at the intervention site should be paid attention and evaluated by a careful physical examination and Doppler ultrasonog-

raphy. The indications for operative treatment are ruptured aneurysm, limb ischemia, vein, artery or nerve compression signs, infection, cutaneous ischaemia over an aneurysm, large aneurysm diameter and failed conservative management<sup>12</sup>. Although pain and swelling are the most common findings, signs secondary to pseudoaneurysm such as neuropathy due to local nerve injury, thrombosis, extremity ischaemia due to embolization, pulsatile mass, rupture, and skin necrosis and associated infection may also be frequently encountered. In the present study, the most common complaints were pain and pulsatile mass. In four patients, the pseudoaneurysm sac was compressing the superficial femoral artery and symptoms were due to mass effect. Moreover, three patients presented to the emergency service with bleeding due to pseudoaneurysm rupture in the early period after hospital discharge and were operated on under emergency conditions. Additionally, one patient had pseudoaneurysm infection of which *E. coli* was the causative agent.

Timing of elective surgery and decision-making for emergency surgery in pseudoaneurysms are of great importance. Since these patients have an underlying coronary artery disease, repair of pseudoaneurysm before its rupture or before causing distal embolization play an important role on the morbidity and mortality rates. In the present study, 39 (94.5%) patients underwent elective surgery, whereas three (5.5%) required surgery under emergency conditions. One of these patients was in hypovolemic shock caused by rupture on the 22<sup>nd</sup> day after hospital discharge. No mortality or limb loss were observed in the present study; this might have resulted from early diagnosis and surgical intervention performed for pseudoaneurysms.

Open repair is the standard method of treatment for true and false aneurysms of femoral artery<sup>13</sup>. Current treatment of FAP also includes non-surgical treatment approaches such as ultrasound-guided thrombin injection, ultrasound-guided compression, biodegradable collagen injection, coated stents, coil embolization, and use of various vascular closure devices<sup>3,7,14-16</sup>. There are situations in which these methods may be either advantageous or disadvantageous. There are several complications of thrombin injection: femoral artery thrombosis or embolism, femoral vein thrombosis, infection within aneurysm sack, allergic reactions including anaphylactic shock<sup>12</sup>. Ultrasound guided compression is also another treatment of choice, but it has major limitations such as patient intolerance despite sedation and operator's ability to maintain adequate pressure<sup>12</sup>. Predictors of negative outcome also include large pseudoaneurysm, obese patients and patients who are receiving anticoagulants<sup>3,12</sup>. Nevertheless, the most important factors of treatment approach are the diameter of pseudoaneurysm and co-morbidities. The patients of the present study were mostly obese with a mean body mass index of  $33.7 \pm 6.3$  kg/m<sup>2</sup>. Moreover, the mean diameter of the pseudoaneurysms was 36.8 mm. Preferential surgery was planned due to the fact that success of non-surgical treatment approaches is generally low in such patients, the diameter of pseudoaneurysm was large, and three patients developed rupture. Small pseudoaneurysms with less than 20 mm in diameter arising from arterial puncture disappear within 4 weeks

via spontaneous thrombosis<sup>17-19</sup>. We as well performed local compression in the pseudoaneurysms that were detected in the early period and had a diameter smaller than 20 mm, and observed pseudoaneurysm thrombosis on ultrasonography performed during follow-up in all patients. These patients had no complication at follow-up.

In conclusion, femoral arteries are the most common sites of complications such as pseudoaneurysm and hematoma developed after diagnostic or therapeutic interventions. Pseudoaneurysms are important complications that may cause important morbidity and mortality such as potential local pressure, rupture, bleeding, infection and thrombosis, which may be threatening to the related extremity, and even to the patient's life. Although pseudoaneurysms can be treated by a simple surgical technique under local anesthesia, they may increase duration of hospital stay, morbidity and mortality. Our opinion is that performing surgical therapy under elective conditions, without any delay in the period when the patient's general status is available, would not only increase the success of surgery, but also minimize perioperative complications.

#### Conflict of Interest

Authors declare no conflict of interest.

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#### Ethical approval

Institutional ethical approval has been taken for the study from the local ethics committee of Trakya University.

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