Retrospective Analysis of 120 Cases of Iatrogenic and Traumatic Peripheral Arterial Pseudoaneurysms

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ABSTRACT

Objective: The pseudoaneurysm formation is the most common complication of arterial catheterization. This study aimed to report our clinical experience with the treatment of iatrogenic and post-traumatic pseudoaneurysms of the peripheral arteries.

Materials and Methods: One hundred twenty patients, who were treated with the diagnosis of arterial pseudoaneurysm of the lower or upper extremity artery between January 2010 and October 2017, took part in this study. Patients with pseudoaneurysms originated from the anastomotic line of the previous vascular operations were excluded from the study. The diagnosis of pseudoaneurysms was made using ultrasonography and confirmed by magnetic resonance imaging (MRI) or computed tomography (CT) scan when deemed necessary.

Results: The most frequent symptom was a pulsatile mass. The mean diameter of pseudoaneurysms was 4.7±1.8 cm (2.3-8 cm). Among 120, 108 patients underwent surgery, and 10 patients required a blood transfusion during the operation. Wound infection was reported in 20 (15.5%) patients as an early postoperative complication. Arterial thrombosis developed in 6 (4.5%) patients, venous thrombosis in 2 (1.7%) patients, and lymphorrhea in 15 (12.5%) patients. A male patient died on the postoperative 25th day, while two patients died on postoperative 10th and 12th days (2.5%).

Conclusion: Although lesser invasive treatment modalities have been described with some advantages or disadvantages, open surgical repair is the standard method of treatment for iatrogenic and traumatic peripheral arterial pseudoaneurysms.

Keywords: Pseudoaneurysm, femoral artery, surgical procedures

Introduction

Pseudoaneurysms are surrounded by a rather thin fibrous capsule instead of the true layer of the arterial wall, and occur following leakage from the arterial defect of peripheral tissue and/or associated hematoma. The pseudoaneurysm formation is the most common complication of arterial catheterization, and it is most commonly observed in the femoral artery that is often used for diagnosis and interventional procedures. Other causes include anastomotic leaks, infections, and trauma [1]. Anticoagulant therapies, thrombocytopenia, vessel wall calcification, and atherosclerosis increase the risk of the pseudoaneurysm formation [2]. Potential complications of these aneurysms include hemorrhage, thrombosis, peripheral embolism, dissection, the A-V fistula formation, and pressure on the surrounding tissues [3].

The diagnosis of pseudoaneurysm could be made by angiography, computed tomography (CT), magnetic resonance imaging (MRI), and scintigraphy. However, ultrasonography (USG) is the most commonly preferred technique [4]. Arterial examination with Doppler USG is considered the gold standard in the diagnosis of pseudoaneurysms, with 100% accuracy [5]. Experienced specialists may be able to diagnose by physical examination; however, USG is necessary to determine the treatment strategy.

Pseudoaneurysms, which are smaller than 2 cm, have a predisposition for spontaneous thrombosis, apart from patients using anticoagulants. USG-guided compression (UGC) may be effective for the majority of patients who do not receive anticoagulant therapy. USG-guided thrombin (UDTI) or glue injection, coil or coated stents and endovascular treatment consist of the other

alternative methods of treatment. Open surgical repair is considered the best treatment option for patients with massive hematomas, skin necrosis, and the risk of rupture [2-5].

In this study, we aimed to evaluate our clinical experiences on iatrogenic and post-traumatic pseudoaneurysms, new treatment modalities, and risk factors associated with the inadequacy of spontaneous arterial wall healing in the light of current literature.

Materials and Methods

In this study, 120 patients, who were treated following the diagnosis of pseudoaneurysm between January 2010 and October 2017, were retrospectively examined. Patients with pseudoaneurysms originating from the anastomotic line of the previous vascular operations were excluded from the study. The diagnosis of pseudoaneurysm in patients with trauma or hematomas and pain at the intervention area was made using Doppler USG. Although USG is sufficient to help arrive at a diagnosis in many patients, MRI or CT scan confirmed the diagnosis when necessary. Pseudoaneurysms less than 2 cm in diameter were non-operatively treated, and were followed up by regular ultrasonographic examination at the outpatient clinic. Pseudoaneurysms with a diameter of 2 cm or more underwent primary repair. Pseudoaneurysms with rapid expansion and concomitant distal ischemia or neurological deficit due to local pressure from the pseudoaneurysm, or distal embolization from within it and resulted from penetrating trauma were surgically treated. All patients were followed up for one year. The study was conducted according to the Declaration of Helsinki.

Statistical Analysis

Statistical analysis was performed using The Statistical Package for the Social Sciences (SPSS) version 20.0; (IBM Corp.; Armonk, NY, USA). Numerical variables were presented as mean±standard deviation (SD), and categorical variables were expressed as a number and/or percentage.

Results

General and perioperative characteristics of the patients are shown in Table 1. The mean age of the patients was 51.6±13.3 (range: 13-75) years. Among them, 85 (70.8%) patients were males, and 35 (29.2%) patients were females. The pseudoaneurysm was reported to have developed following penetrating traumas in 20 (16.7%) patients and following arterial puncture performed for diagnosis and treatment of cardiac diseases in 100 (83.3%) patients. A pulsatile mass was the most frequent symptom, while USG was the most frequently used diagnostic method. The mean pseudoaneurysm diameter was 4.7±1.8 (2.3-8) cm. Although the interval between the femoral arterial puncture in the cardiac catheterization laboratory and the diagnosis of pseudoaneurysm was between 2 and 21 days (mean: 8.3), the diagnostic periods of the development of pseudoaneurysm following penetrating trauma was between two months and one year (mean: 3.5 months). Atherosclerosis, obesity, and hypertension were observed in 60 of the 100 patients who developed pseudoaneurysm after the arterial puncture; diabetes mellitus and atherosclerosis in 20; Behçet's disease in 2; and only obesity in 12 patients. In the obese patients, punctures were made laterally in the artery and recurrently. Of the 20 patients who developed pseudoaneurysm following penetrating trauma, five patients had concomitant diabetes, eight had obesity, and five had hypertension. No other risk factor was reported in other patients.

Surgical procedures were performed under local anesthesia in 98 (81.7%) patients and under general anesthesia in 10 (8.3%) patients who were diagnosed with the pseudoaneurysm. Arterial reconstruction was performed in 93 (86.1%) patients by primary repair (aneurysmectomy + end-to-end anastomosis in eight patients and by lateral repair "primary suture" in 85 patients). Arterial integrity was provided in 8 (7.4%) patients by saphenous vein interposition. Because of the inability to use autogenous venous grafts, interpenetration with synthetic graft was performed in 5 (4.6%) patients. On the other hand, there was a false aneurysm in

Table 1. General and perioperative characteristics of the patients

Characteristics (n=120)	n% Mean±SD
Age (years)	51.6±13.3
Gender	
Female	35 29.2
Male	85 70.8
Location of the pseudoaneurysm	
Superficial femoral artery	68 56.7
Main femoral artery	33 27.5
Deep femoral artery	9 7.5
Radial artery	6 5
Brachial artery	2 1.7
Posterior tibial artery	1 0.8
Superficial temporal artery	1 0.8
Complaint/Sign	
Pulsatile mass	90 75
Pain	15 12.5
Rupture	12 10
Ischemia	3 2.5
Diagnosis	
Ultrasound	102 85
Ultrasound+MRA	8 6.7
Ultrasound+CT	10 8.3
Ultrasound	
Mean pseudoaneurysm diameter (cm)	4.7±1.8
Treatment	
Surgery	108 90
Ultrasound-guided compression	10 8.4
Coil embolization	1 0.8
Stent graft insertion	1 0.8

CT: Computed tomography; MRA: Magnetic resonance angiography; SD: Standard deviation

Table 2. Intraoperative parameters and postoperative early outcome of the patients

	n	%	Mean±SD
Surgery			
Emergency	15	12.5	
Elective	105	87.5	
Anesthesia			
Local	98	81.7	
General	10	8.3	
Need for blood transfusion	10	8.3	
Amount of intraoperative bleeding (mL)			250.3±185
Postoperative hematocrit levels (%)			26.3±1.3
Venous thrombosis	2	1.7	
Lymphorrea	15	12.5	
Wound infection	20	16.7	
Re-exploration for bleeding	5	8.3	
Revision for wound infection	15	12.5	
Hospital stay (days)			8.5±4.1
Hospital mortality	3	2.5	
Amputation	0		

SD: Standard deviation; mL: milliliter

the distal radial artery in one of the patients with adequate filling from the posterior ulnar artery. Aneurysmectomy+ligation was performed because no consequent structural and functional disorder was envisaged. In one case, a post-traumatic false aneurysm of the deep femoral artery was treated by profunda ligation. Embolectomy was performed in six patients who developed arterial thrombosis.

Heparinization was performed for two days in patients who underwent graft interposition, and then they were discharged with the administration of an antiaggregant. Postoperative heparinization was not performed in patients treated with primer repair and saphenous vein interposition, antiaggregant therapy alone was administered. Treatment with oral warfarin was initiated in two patients who developed venous thrombosis.

The most common involvement was within the femoral artery in 110 (91.6%) cases. Among operated patients, the location of the pseudoaneurysm was the superficial femoral artery in 68 (56.7%), the common femoral artery in 33 (27.5%), and the deep femoral artery in 9 (7.5%) patients. This was followed by the pseudoaneurysm of the radial artery in 6 (5%) cases and the brachial artery in 2 (1.7%) cases. Posterior tibial artery and superficial temporal artery pseudoaneurysms were also reported in two patients. While 108 patients underwent surgery, 10 patients were treated with UGC therapy, whereas one patient was treated with the coil, and one patient with a stent graft.

Intraoperative parameters and postoperative early outcome of the patients are shown in Table 2. During the operation, 10 (8.3%) patients required a blood transfusion. Intraoperative autotransfusion was used in three patients with major bleeding. Wound infection was reported in 20 (15.5%) patients as an early postoperative complication. Among these patients, 15 patients underwent surgery, but five patients were treated with medical treatment and wound care. Arterial thrombosis developed in 6 (4.5%) cases, and thrombectomy was performed. Venous thrombosis was followed up medically in two patients, while lymphorrhea developed in 15 patients. A 65-year-old male patient died on the postoperative 25th day because of multiorgan failure, while two patients who were admitted to the emergency unit because of the development of rupture died on postoperative 10th and 12th days. No late complications, such as local occlusions and recurrence, were observed during the one year follow-up period.

Discussion

In our study, most of the patients were males, which is in coherence with the results found by Becit et al. [6] and Balcı et al. [7]. The mean duration of presenting symptoms following femoral arterial puncture ranged between 2 and 21 days (mean: 8.3). A pulsatile mass with localized tenderness was the most common presentation in our study, as reported in others [2, 4-11]. The femoral artery (91.6%) was the most common artery affected followed by radial (5%) and brachial artery (1.7%). A total of 105 (87.5%) patients underwent elective surgery, whereas 15 (12.5%) required emergency surgery because of rapid pseudoaneurysm expansion and concomitant distal ischemia or neurological deficit.

Deterioration of the integrity of all components of the arterial wall may occur following vascular injury due to either trauma or arterial puncture and resulting in extravascular bleeding and hematoma. The hematoma enters into a fibrous organization and is surrounded by a thin-walled layer free of elastic and smooth muscle fibers. The difference of pseudoaneurysms from true aneurysms is the absence of all arterial wall layers. The morbidity and mortality rates in patients with ruptured pseudoaneurysm have been reported to be very high [6]. Peripheral artery pseudoaneurysms are very rarely encountered vascular pathologies that can occur because of penetrating or blunt trauma (62.5%) and to a lesser extent because of iatrogenic causes (37.5%) [7]. The incidence of the development of pseudoaneurysm following arterial catheterization has been reported in various literature publications as being between 0.2% and 0.3% [8].

The pseudoaneurysm can clinically present itself by a pulsatile mass. In addition, compression of peripheral nerve tissues by the aneurysmal sac of the clinic may result in pain and paresthesia [9]. USG was used as a diagnostic method in patients with complaints of swelling, pain, and palpation of pulsatile mass after trauma or arterial puncture, and MR or CT was used in patients requiring advanced techniques. In a study conducted by Johns et al. [10], arginylglycylaspartic acid was found to have a very high sensitivity and specificity in the detection of pseudoaneurysm following arterial catheterization or trauma. In this study, Doppler USG was the most common investigation employed.

Small masses of less than 2 cm may heal spontaneously over time without surgical treatment. However, larger aneurysms have a higher risk of rupture, and they may lead to venous thrombosis and paresthesia by compressing surrounding veins and nerves. Pseudoaneurysms have very low mortality and morbidity under elective conditions and when surgery is performed before the development of any complications (e.g., rupture, thrombosis, infection). Indications that require surgical repair include the symptomatic nature of the pseudoaneurysm, the predisposi-

tion for enlargement, concomitance with a large hematoma, and its prolonged persistence [11]. Skillman et al. [12] reported that the rate of developing complications from surgical intervention following rupture of pseudoaneurysm was 20%-28%. Hypotension due to sudden falls in circulating blood volume, local effect of hemorrhage in thigh tissues, and increase in morbidity rates due to secondary diseases are suggested as the cause of this increase. In this study, three patients who underwent a surgical operation for the rupture died during the postoperative period. Vascular reconstruction is very important before a pseudoaneurysm rupture with regards to morbidity and mortality rate, especially in patients with a cardiac disease. The low morbidity and mortality rates in our patients may be attributed to surgical intervention before any pseudoaneurysm rupture.

Various risk factors associated with the development of pseudoaneurysms include advanced age, female gender, diabetes mellitus, obesity, chronic obstructive pulmonary disease, peripheral artery disease, and inadequate compression. One of the most important risk factors for the development of iatrogenic pseudoaneurysm is the intervention into other arteries (superficial femoral artery, deep femoral artery, and external iliac artery) instead of the common femoral artery [13, 14]. The puncture of the external iliac artery may lead to severe complications, such as retroperitoneal hematoma [14]. The risk of development of pseudoaneurysm increases when the puncture is under the bifurcation of the common femoral artery because compression to this area after the procedure is not effective. Furthermore, the walls of the superficial and deep femoral arteries are thinner than that of the common femoral artery wall. As a result, this arterial wall can easily be damaged during the interventional procedures, and pseudoaneurysm can easily occur. In this study, the superficial femoral artery was the most common pseudoaneurysm location with 68 (56.7%) patients, followed by the common femoral artery in 33 (27.5%) patients and the deep femoral artery in 9 (7.5%) patients.

Open repair is the standard method of treatment for true and false aneurysms [15]. Current treatment of femoral artery pseudoaneurysm also includes non-surgical treatment approaches such as UGTI, UGC, biodegradable collagen injection, coated stents, coil embolization, and use of various vascular closure devices [16-20].

Open surgical repair can be performed under general or local anesthesia through a simple longitudinal incision [20]. Conventional repair involves taking the proximal and distal end of the artery under control before the opening of the sac. It involves the determination of the puncture area and suture repair. Femoral pseudoaneurysms can also be kept under control by transabdominal incision and external iliac artery in cases where the bleeding cannot be controlled. Other ways to control bleeding include balloon occlusion or digital pressure. The contralateral groin should be prepared for vein harvest in cases of extensive arterial injury.

The most common postoperative complication in our study was wound infection seen in 20 (16.7%) patients. Fortunately, we did not come across with anastomotic blowout that is a rare but devastating complication [19, 20]. In a prospective study [21] conducted on 79 surgically treated patients with femoral pseudoaneurysms, the most common complication was blood loss requiring transfusion. In that study, advanced age was noted to be a strong predictor for bleeding due to age-related alterations in tissues as well as in the arterial wall. In our study, this complication occurred in only 10 (8.3%) patients, and adjunctive blood transfusions were not needed. Our relatively younger patient population may explain this result. Broad-spectrum antibiotics effective against strains of Staphylococcus and Salmonella species should be initiated perioperatively in patients with infected pseudoaneurysms and continued for six weeks postoperatively [22]. Abscess drainage and debridement of necrotic tissue are the first steps in the treatment. In cases with extensive infection, arterial debridement and ligation (i.e., bypass with biological graft or saphenous vein or extra-anatomic bypass) should be performed.

The other management strategies of pseudoaneurysm include thrombin injection, coil embolization, and stent graft exclusion. UGC is also another treatment of choice that has been found to be successful in 66%-86% of femoral pseudoaneurysms, with compression times averaging between 30 and 44 minutes to achieve thrombosis; and UGTI has been reported to be 93%-100% successful in most series [23]. Thrombin injection has been associated with several complications including femoral artery thrombosis or embolism, femoral vein thrombosis, infection within aneurysm sack, and allergic reactions [24]. In our series, UGC was performed on 10 patients, and only one patient needed open surgical repair.

Coil embolization and stent graft exclusion are the most commonly described endovascular repair techniques, and they can be used either individually or in combination [25]. While stent placement for femoral pseudoaneurysms has been demonstrated to be technically feasible, patency rates of 43%-87% have been disappointing [23].

In a previous study [26], stethoscope-guided compression of femoral pseudoaneurysms was recommended as a safe and effective novel technique requiring less equipment and expertise than other contemporary methods. However, in that study, the sizes of the pseudoaneurysms were relatively small, and the effectiveness of the technique was not adequately tested in larger pseudoaneurysms.

Currently, to decrease the incidence of pseudoaneurysms, which are one of the late complications after intensive use of invasive procedures and vascular injuries, arterial puncture should be made at the correct site, from the anterior aspect of the artery and from the area where appropriate compression could be performed, and compression should be applied with an appropriate pressure and time after the procedure. Risky cases with a high predisposition for the development of a pseudoaneurysm such as obesity, hypertension, peripheral vascular disease, diabetes mellitus, and vasculitis should be predetermined and preventive measures should be taken accordingly.

In conclusion, pseudoaneurysms are important complications that may cause important morbidity and mortality such as potential local pressure, rupture, bleeding, infection, and thrombosis, which may threaten the related extremity and even the patient's life. Although pseudoaneurysms can be treated by several methods as mentioned earlier, surgical repair is the standard method of treatment for pseudoaneurysms of the peripheral arteries. The low morbidity and mortality rates in our patients with pseudoaneurysms may be attributed to surgical intervention before any aneurysmal rupture.

Several limitations should be addressed. First, this study was a retrospective study, and it had a relative small sample size. Second, the results must be interpreted with caution for small sample size; and the choice for surgery or other treatment options, especially in large pseudoaneurysms, still needs further researches.

Ethics Committee Approval: Ethical Committee approval is not required for this type of study.

Informed Consent: Informed consent is not necessary due to the retrospective nature of this study.

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