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Characteristics of Pseudoaneurysms in Northern India; Risk Analysis, Clinical Profile, Surgical Management and Outcome

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ABSTRACT

Objective: To determine the risk factors, clinical characteristics, surgical management and outcome of pseudoaneurysm secondary to iatrogenic or traumatic vascular injury.
Methods: This was a cross-sectional study being performed in department of cardiovascular and thoracic surgery skims soura during a 4-year period. We included all the patients referring to our center with primary diagnosis of pseudoaneurysm. The pseudoaneurysm was diagnosed with angiography and color Doppler sonography. The clinical and demographic characteristics were recorded and the risk factors were identified accordingly. Patients with small swelling (less than 5-cm) and without any complication were managed conservatively. They were followed for progression and development of complications in relation to swelling. Others underwent surgical repair and excision. The outcome of the patients was also recorded.
Results: Overall we included 20 patients with pseudoaneurysm. The mean age of the patients was 42.1±0.6 years. Among them there were 11 (55%) men and 9 (45%) women. Nine (45%) patients with end stage renal disease developed pseudoaneurysm after inadvertent femoral artery puncture for hemodialysis; two patients after interventional cardiology procedure; one after femoral embolectomy; one developed after fire arm splinter injury and one formed femoral artery related pseudoaneurysm after drainage of right inguinal abscess. The most common site of pseudoaneurysm was femoral artery followed by brachial artery. Overall surgical intervention was performed in 17 (85%) patients and 3 (15%) were managed conservatively.
Conclusion: End stage renal disease is a major risk factor for pseudoaneurysm formation. Coagulopathy, either therapeutic or pathological is also an important risk factor. Patients with these risk factors need cannulation of venous structures for hemodialysis under ultrasound guide to prevent inadvertent arterial injury. Patients with end stage renal disease who sustain inadvertent arterial puncture during cannulation for hemodialysis should receive compression dressings for 5 to 7 days.

Keywords: Pseudoaneurysm; Risk factors; End stage renal disease; ESRD; Hemodialysis.

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Introduction

Iatrogenic pseudoaneurysms (IPA) form when an arterial puncture site fails to seal, allowing arterial blood to jet into the surrounding tissues and form a pulsatile hematoma [1]. These lesions are contained by surrounding shell of hematoma and the overlying soft tissues. It can present as a new thrill, bruit, pulsatile swelling, marked pain or tenderness. Complications of pseudoaneurysms include local pain, rupture, distal embolization, neuropathy and local skin ischemia. It may also result in local sepsis and abscess formation which may rupture and cause hemorrhage [2,3]. It is one of the most troublesome complications after various invasive cardiovascular procedures related to femoral arterial access site. Non-invasive ultrasound-guided compression repair has replaced the need for surgical repair of femoral artery pseudoaneurysm and has been shown to be safe and cost-effective method for achieving pseudoaneurysm thrombosis [4-6]. Recently percutaneous low dose thrombin injection in the femoral artery pseudoaneurysm has gained popularity. Other non-operative methods of treating pseudoaneurysms include placement of covered stents/endoluminal prostheses. Several studies have described the clinical characteristics and complication of pseudoaneurysms [7,8]. However data from India is scarce. Thus we performed this study in order to determine the risk factors, clinical characteristics, surgical management and outcome of pseudoaneurysm secondary to iatrogenic or traumatic vascular injury in those referring to our center in Northern India.

Materials and Methods

Study Population

This was a prospective cross-sectional study being performed in 20 patients during a 4-year period from 2010 to 2014. We included all the patients who developed pseudoaneurysm in various arterial structures after arterial and or venous puncture. Patients who developed pseudoaneurysm after vascular trauma and/or vascular repair were also included. Most of these patients were referred from the nephrology department and most of them had diabetic nephropathy. The study protocol was approved by institutional review board (IRB) of Sher-i-Kashmir Institute of Medical Sciences (SKIMS). All the patients provided their informed written consents before inclusion in the study.

Study Protocol

We received varied group of patients with arterial pseudoaneurysm in relation to different arteries either after an iatrogenic procedure or after trauma. All the patients underwent complete physical examination and a detailed history was obtained. The demographic information and the clinical findings were recorded. The risk factors of developing pseudoaneurysm were detected according to the patients' findings. Most of the patients were diagnosed after clinical evaluation and color Doppler ultrasonography. Patients with small swelling (less than 5-cm) and without any complication were managed conservatively. They were followed for progression and development of complications in relation to swelling. Patients with progressive increase in size of pseudoaneurysm more than 5-cm or development of complications were managed surgically. Patients who formed pseudoaneurysm after abscess drainage in vicinity of a vascular structure needed no conservative treatment even if it was less than 5-cm in size. Patients with end stage renal disease (ESRD) needed optimization of renal parameters, coagulation profile, blood sugar and electrolyte profile before surgical intervention for pseudoaneurysm. Patients with ESRD needed multiple sessions of hemodialysis before surgical intervention to optimize renal function. Patients were assessed for distal vascular (arterial or venous) compression and compression neuropathy. Local sepsis, ulceration or bleeding from pseudoaneurysm were looked for. Computerized tomography (CT) angiography of the affected arteries and digital subtraction angiography was performed in all the patients in order to determine the exact anatomy and vascular variations of the region for better surgical planning.

All patients received one state dose of heparin intra-operatively after closure of the arterial rent. Excision of pseudoaneurysm needed sharp dissection. All the operated patients were evaluated for development of any neurologic deficits. We put suction drain in all patients after surgical intervention for pseudoaneurysm. All the patients were followed for 4 months after the operation. The patency of the affected artery was evaluated by color Doppler ultrasonography and clinical examination. The neurologic examination was performed in follow-ups in order to determine the functional recovery.

Statistical Analysis

All the statistical analysis in the current study was performed by statistical package for social sciences (SPSS Inc., Chicago, USA). Descriptive data analysis was performed. Data is presented as mean±SD and proportions as appropriate.

Results

Overall we included total number of 20 patients with pseudoaneurysms in the current study. The mean age of the patients was 42±0.6 years. Among the patients there were 11 (55%) men and 9 (45%) women. The demographic and clinical characteristics as well as the risk factors of arterial pseudoaneurysm in our series in summarized in Table 1. Femoral artery was the most common site being reported in 14 (70%) patients. One (5%) patient with pseudoaneurysm in relation to brachial artery at brachiocephalic

Table 1. The demographic and clinical characteristics of 20 patients with pseudoaneurysm treated in our center during a 4-year period.

Variable	Value
Age (years)	42.1±0.6
Sex	
Men (%)	11 (55%)
Women (%)	9 (45%)
Site	
Femoral artery (%)	14 (70%)
Brachial artery (%)	4 (20%)
Management	
Surgery	17 (85%)
Conservative	3 (15%)
Risk factor	
Diabetes nephropathy (%)	11(55%)
Hypertensive nephropathy (%)	2 (10%)
Neck abscess (%)	1 (5%)
Inguinal abscess (%)	1 (5%)
Interventional cardiology procedure (%)	1 (5%)
Femoral artery embolectomy (%)	1 (5%)
Splinter femoral artery injury (%)	1 (5%)

arteriovenous (AV) fistula site for hemodialysis; two (10%) patients with pseudoaneurysm in relation to arterialized cephalic vein after radio-cephalic AV fistula at cannulation site for hemodialysis (one of them had multiple pseudoaneurysms along the course of arterialized cephalic vein); one (5%) patient with carotid artery related pseudoaneurysm on right side after inadvertent carotid arterial puncture while cannulating internal jugular vein for hemodialysis; one (5%) patient with carotid artery related pseudoaneurysm after inadvertently puncturing carotid artery while putting central line and one patient had subclavian artery related pseudoaneurysm. The patient with subclavian artery related pseudoaneurysm was operated for right supraclavicular abscess with mediastinal extension. The subclavian artery was injured during abscess evacuation which was repaired primarily, but patient reported with subclavian artery related massive pseudoaneurysm with significant sloughing of the skin after 35 days.

Out of 14 patients with femoral artery related pseudoaneurysm, 9 (45%) patients developed pseudoaneurysm after inadvertent femoral artery puncture while cannulating femoral vein for hemodialysis; two (10%) patients after interventional cardiology procedure; one (5%) patient developed bilateral femoral pseudoaneurysm after bilateral femoral embolectomy for cardiac origin embolus; one (5%) patient developed pseudoaneurysm after fire arm splinter injury thigh which was managed initially conservatively at the time of injury for non-expanding thigh hematoma and one (5%) patient formed femoral artery related pseudoaneurysm after drainage of right inguinal abscess. Patient with femoral artery related pseudoaneurysm after femoral embolectomy needed multiple sessions of femoral embolectomy for recurrent thrombosis. To prevent re-thrombosis and embolization, patient received anticoagulation therapy, but he developed bilateral femoral artery related pseudoaneurysm. This patient needed right sided above knee amputation for recurrent thrombosis.

The detailed risk analysis of the patients is summarized in Table 2. Twelve (60%) patients with femoral pseudoaneurysm were operated under general anesthesia and 1 (5%) patient was operated under epidural anesthesia. One (5%) patient with brachiocephalic AV fistula site pseudoaneurysm was operated under axillary block. One patient with multiple pseudoaneurysms along arterialized cephalic vein due to multiple arterial punctures for hemodialysis needed closure of radio-cephalic AV fistula under local anesthesia. Eleven (55%) patients with femoral pseudoaneurysm were operated through longitudinal incision, while 2 (10%) patients were operated through transverse incision of the inguinal area. Thirteen (65%) patients underwent evacuation of pseudoaneurysm with suture closure of the arterial rent through the cavity, and the wall of pseudoaneurysm was left behind. Three (15%) patients who needed early intervention underwent total excision with suture closure of arterial rent. Proximal and distal control of the vessel was taken before exploration of the pseudoaneurysm. Brachial artery based pseudoaneurysm was excised and brachiocephalic AV fistula was replaced by radio-cephalic AV fistula.

Conservative management was chose for 3 (15%) patients; 2 (10%) carotid artery based pseudoaneurysms and 1 (5%) femoral artery based pseudoaneurysm. These patients needed compression dressings. One (5%) patient with femoral pseudoaneurysm ulcerated his skin due to rapid expansion in size of pseudoaneurysm. In this patient pseudoaneurysm was evacuated

Table 2. Risk factor analysis in 20 patients with pseudoaneurysms evaluated during a 4-year period in our center.

Site of pseudoaneurysm	Artery related to pseudoaneurysm	Etiology	No. of patients	Risk analysis	Management
Inguinal area	Femoral artery	Inadvertent femoral artery puncture during hemodialysis	9	End stage renal disease	Evacuated (8)
					Excised (1)
		Interventional cardiology procedure	2	Deranged coagulogram due to heparinization	Evacuated
		Femoral embolectomy for recurrent thrombosis	1	Deranged coagulogram due to heparinization	Conservative
		Fire arm splinter injury	1	Contained femoral artery related hematoma	Evacuated
		Drainage of inguinal abscess	1	Femoral artery injury during abscess drainage	Evacuated
Right side of neck	Carotid artery	Inadvertent carotid artery puncture during hemodialysis	1	End stage renal disease	Conservative
		Inadvertent carotid artery injury while putting central line	1	Thrombocytopenia/coagulopathy due to massive transfusion	Conservative
Cubitus	Brachial artery	Brachio-cephalic AV fistula	1	End stage renal disease	Excised
Left forearm	Arterialized cephalic vein	Cannulation of arterialized cephalic vein for hemodialysis	2	End stage renal disease	Excised (1)
					AVF closed (1)
Right supraclavicular area	Right subclavian artery	Abscess drainage with subclavian artery injury	1	Subclavian artery injury with deranged renal parameters	Evacuated

and femoral artery was repaired. This patient had significant postoperative local sepsis and needed 3 week antibiotic coarse. This patient developed postoperative paresthesia on the medial aspect of thigh, which subsided after a follow-up of one year. Venous engorgement was also seen in this patient, but none of the patients had varicosity of veins. The fibrosed wall of femoral pseudoaneurysm was friable in patients with large pseudoaneurysm and with gangrenous overlying skin. One (5%) patient with subclavian artery related pseudoaneurym died due to massive hemorrhage during evacuation of pseudoaneurysm as both subclavian and carotid arteries were friable and sloughed.

Discussion

Internal jugular vein is the most common site for draining blood for hemodialysis, followed by femoral vein and then followed by other veins. From last twenty years there is an increasing trend to arterialize upper limb veins through AV fistula and using this arterialized vein for hemodialysis either before renal transplant or as a permanent but palliative treatment. Patients with ESRD usually have platelet dysfunction, which cause more than expected bleeding from any vascular injury. The therapeutic strategies for pseudoaneurysm include surgical repair, ultrasound-guided compression repair (UGCR) and percutaneous treatments (thrombin injection, coil embolization and insertion of covered stents) [1]. 85% patients were operated for pseudoaneurysm and 15% patients were managed conservatively. We did not use ultrasound guided or interventional vascular procedures in any of the patients. UGCR achieves pseudoaneurysm thrombosis but has long procedure time, gives discomfort to the patient and has a relatively high recurrence rate in patients receiving anticoagulant therapy (as high as 25% to 35%) [2]. Surgical repair becomes an emergency when there is a risk of bleeding or limb ischemia, otherwise conservative management is initially recommended. Strict bed rest, suspension of anticoagulation, and compression by inguinal bandage or guided by ultrasound over the aneurysmal neck can resolve over 75% of all cases [3]. We followed conservative methodology

on the basis of size, not on the basis of duration of pseudoaneurysm. Patients with inherent bleeding risks should be operated as early as possible, as there are chances of expansion of the pseudoaneurysm and its complications. Common femoral artery is the most common site for iatrogenic pseudo-aneurysms after arterial puncture for angiography, vascular intervention or partial/complete disruption of a vascular anastomotic suture line (most common with prosthetic conduits) [4]. Pseudoaneurysms develop in 3% of femoral anastomoses after a mean interval of 6 to 9 years [5]. False aneurysm of the femoral/external iliac arteries is often iatrogenic and could occur following percutaneous cannulations, or graft dysfunction [6,7].

Although femoral artery was the most common site of pseudoaneurysm formation, but the major cause was inadvertent femoral arterial puncture during hemodialysis for end stage renal disease. Although femoral pseudoaneurysm after femoral artery anastomosis was less in our study, but it increases significantly, when there is increased tendency of bleeding (inherent and/or iatrogenic). Synthetic graft for femoral anastomosis was not used in any of the patients. Risk factors include use of large-bore catheters, female gender, use of anticoagulants and thrombolytic agents and inadvertent cannulation of deep femoral or superficial artery [8]. The commonest risk factor for post-puncture pseudoaneurysm formation was the end stage renal disease in our study. We observed that deranged renal parameters cause platelet dysfunction with more chances of post-puncture bleeding from femoral artery and subsequently pseudo-aneurysm formation. Compression dressing repair may serve as an alternative method of femoral pseudoaneurysm management in patients with low forward and reverse velocities of the flow in pseudo-aneurysm neck [9]. Internal hemodynamics of pseudoaneurysm has not affected the role of compression dressings; it was observed that size, etiology, coagulopathy and site affect the role of compression dressings for the benefit of conservative treatment.

Pseudoaneurysm formation is the most common arterial complication of femoral artery catheterization [10]. Isolated catheterization with post-catheterization compression dressings does not increase chances of pseudoaneurysm formation, unless there are risk factors for it. There is a report of blood access puncture point pseudoaneurysms which occurred in two hemodialysis patients [11]. We had not seen any patient with pseudoaneurysm in relation to venous structures, but blood access puncture site pseudoaneurysm was seen in two patients with arterialized cephalic vein after radio-cephalic AV fistula. Small (less than 2-cm) femoral pseudoaneurysms clot spontaneously and usually require no treatment. Larger femoral pseudoaneurysms may lead to complications including rupture and compression of the adjacent femoral vein (with resulting venous thrombosis) or of the femoral nerve. Treatment may be surgical. However, recently it has been shown that direct, noninvasive compression of the pseudoaneurysm stops the blood flow in the communication and leads to pseudoaneurysm clotting and obliteration [12]. We managed pseudoaneurysms up to 5-cm by compression dressings without surgical intervention, but patients with inherent risk factors and those patients who showed no response to conservative treatment needed surgical intervention. Venous pseudoaneurysm (common femoral vein) reported can be managed by compression therapy as it is for an arterial pseudoaneurysm [13], but we had not received any patient with venous pseudoaneurysm.

The cause of the pseudoaneurysm in our case was not cardiac catheterization but the placement of a commonly used catheter for hemodialysis [14]. We also observed that cannulation during hemodialysis in end stage renal disease is a major risk factor for pseudoaneurysm formation. Smaller aneurysms (<2cm) may usually be followed up; however depending on the size of the pseudoaneurysm a number of treatment options can be offered [12]. We observed that surgical evacuation or excision give comparative and optimal results, with slightly increased chances of adjacent injuries in case excision is performed. Pseudoaneurysms formed in 4.5% of patients undergoing traditional palpation-guided vessel cannulation and in 2.6% of patients after ultrasound-guided puncture of the femoral artery [15]. We observed that presence of different risk factors increase risk of pseudoaneurysm formation, but inadvertent cannulation of femoral artery is an inciting event. There is a case report of the patient with iliofemoral venous thrombosis related to external compression due to post-catheterization false arterial aneurysm [16]; we had one patient with compression neuropathy due to femoral pseudoaneurysm.

In conclusion, ESRD is a major risk factor for pseudoaneurysm formation. Coagulopathy, either therapeutic or pathological is also an important risk factor. Patients with these risk factors need cannulation of venous structures for hemodialysis under ultrasound guide to prevent inadvertent arterial injury. Patients with ESRD who sustain inadvertent arterial puncture during cannulation for hemodialysis should receive compression dressings for 5 to 7 days. Patients where abscess has been drained near any arterial site (more than medium in size) should be closely watched for early detection of pseudoaneurysm due to sloughing of vessel. Post-abscess drainage pseudoaneurysm needs early evacuation even if size of pseudoaneurysm is less than 5-cm. Evacuation of the pseudoaneurysm with suture closure of the arterial rent has good surgical results. Excision increases chances of vascular injury, bleeding and recurrence of pseudoaneurysm. Patients with deranged renal parameters have

significant soakage from the raw area, so these patients need suction drainage to prevent local collection and sepsis. Increased risk of formation of femoral pseudoaneurysm in chronic renal failure patients demands early formation of upper limb AV fistula and then cannulating arterialized vein.

Conflict of interest: None declared.

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