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Iatrogenic pseudoaneurysm as a complication of hemodialysis vascular access: a descriptive study

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ABSTRACT

Introduction: Iatrogenic pseudoaneurysm (PSA) in hemodialysis vascular access puncture site is the most common complication in a patient with ERSD, which needs urgent surgical intervention. This research explained the patients' characteristics with pseudoaneurysm in vascular access that underwent surgical intervention immediately.
Methods: Retrospectively, it reported cases of pseudoaneurysm that underwent immediate surgical intervention in an operating theatre in the emergency department of RS Dr. Soetomo Surabaya.
Result: Twenty-one patients, whose age range from 26-to 64 years old (mean 46.57 + 12.14 years), have undergone immediate surgical and vascular intervention in an operating theater in the emergency department of RS Dr. Soetomo from 2017 until March 2021. The site of pseudoaneurysm varies from cubiti (90.4%), with signs and symptoms of impending rupture (57.1%), rupture (28.6%), and infected pseudoaneurysm (14.3%). Surgical management such as arterial repair was conducted in 90.4% of cases, and two patients (9.6%) unfortunately underwent takedown AVF. It was found from all 21 cases that nine cases didn't have vascular access as recommended, leading to repetitive puncture in the same puncture site.
Conclusion: Iatrogenic Pseudoaneurysm in ESRD patients on regular hemodialysis is the most common complication that has been treated. The medical staff's knowledge about recognition and prevention is a crucial factor in controlling this complication.

Keywords: pseudoaneurysm, arteriovenous fistula, hemodialysis, surgical intervention.
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INTRODUCTION

Arteriovenous fistula (AVF) is the first choice in vascular access for end-stage renal disease (ESRD) patients who need renal replacement therapy. Because the AVF needs time before it can be used, the Central venous catheter (CVC) is the alternative hemodialysis access as recommended.[1] However, in some cases, hemodialysis access with a direct puncture in peripheral vascular usually is preferred by medical staff and patients during waiting for AVF maturation. Direct puncture and inadequacy therapy after direct puncture usually leads to a higher risk of pseudoaneurysm. The reported rate of PSA formation is about 2%–10%. Pseudoaneurysm occurs when the puncture site in an artery fails to heal completely, leading to the leak of blood to surrounding tissue, which manifests in pulsating mass.[2]

The symptoms, such as pulsating mass, pain, and skin eruption with or without infection, decrease the patient's quality of life. Hemodynamic deterioration is often found in a patient with ruptured pseudoaneurysm, so surgical and vascular intervention must be conducted. Surgical intervention should also be done in infected pseudoaneurysms with definite infection signs or impending rupture.[3] This research aimed to explain the patients' characteristics with a pseudoaneurysm in vascular access that immediately underwent surgical intervention.

METHODS

This study is done retrospectively with 21 patients who were collected from 2017 until March 2021. Retrospective data is collected from the database in Thorax, cardiac and vascular surgical department in RS DR. Soetomo/Universitas Airlangga Surabaya. All ESRD patient that diagnosed with pseudoaneurysm related to hemodialysis vascular access and have been conducted an immediate surgical intervention in an operating theater in the emergency department of RS Dr. Soetomo are considered as subjects in this study. The retrospective data about characteristics of pseudoaneurysm, surgical technique, and result of the procedure were collected from the electronic medical data records. The pseudoaneurysm not related with hemodialysis vascular access, for example, post trauma, artery puncture not for hemodialysis purpose were excluded.

Some clinical features and pictures during the operation that we could collect are presented in Figure 1. Demographic data and clinical findings have been concluded in tables. Data analysis is done by using SPSS 25 application and explained in standard deviation and proportion descriptively.

Figure 1. Clinical features in a patient with active bleeding from pseudoaneurysm in the right cubital fossa.

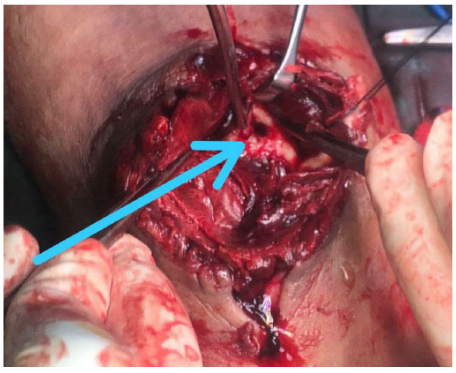

Figure 2. The same patient in Figure 1 during operation has undergone clot evacuation of about 50 ml, and the capsule was extracted. The fistula is located in the brachial artery (blue arrow).

Surgical Method

The surgical procedure is done by using a local anesthetic. Two longitudinal incisions in proximal to the mass and superiorly to the mass. The proximal incision was made to put the surgical loop for bleeding control. Pseudoaneurysm exploration is started by incising the skin, then dissecting bluntly until the pseudoaneurysm is identified. The procedure is proceeded by clot evacuation and capsule excision. Vascular intervention is done due to locating the fistula (Figure 2). Fistula repair in the noninfected case is done with direct closure using a nonabsorbable monofilament surgical suture 6.0 or 7.0. In infected cases, debridement and wound closure should be secondarily done (Figure 3).

Figure 3. It is one of the infected pseudoaneurysm cases that has already undergone surgical debridement in the operating theatre. The healing process was expected to happen secondary. Because the infected skin was fragile, we decided to modify our suture technique to keep them intact.

RESULT

We reported 21 ESRD patients with pseudoaneurysm. The average age of patients in this study was 46.57 + 12.14 years old, with the youngest patient aged 16 years old and the eldest aged 64 years old. The total patients comprised 11 (52.4%) men and 10 (47.5%) women.

The characteristics of pseudoaneurysm patients are described in Table 1. The cubital fossa was the most common site of pseudoaneurysm found in 19 (90.4%) patients. There was one case of pseudoaneurysm found on the femoral whose patient had a history of CVC insertion in the femoral vein but pulled out accidentally when the patient took off clothes. One patient with pseudoaneurysm concerning radial artery at radiocephalic arteriovenous (AV) fistula site for hemodialysis was already used for three weeks.

From all pseudoaneurysms in the cubital fossa, 8 (42%) patients did not previously have proper vascular access, either AVF or CVC (Table 2). Six (28.6%) patients came with chief complaints of active bleeding at the site of pseudoaneurysm, and the other came with local pain, progressive expanding mass, skin eruption over the mass, or infected pseudoaneurysm. For the surgical intervention, two cases (9.6%) were decided for AVF takedown, and the rest were primary artery repair.

DISCUSSION

Pseudoaneurysm happens due to arterial wall disruption, which can be caused by inflammation or iatrogenic. Due to the high arterial pressure, blood flows through this tear and fills the space between the arterial wall and its surrounding tissue, forming a blood sac and keeping its communication with its feeding artery through the fistula. This blood sac or pseudoaneurysm capsule can consist of tunica media, adventitia, or simply from the soft tissue surrounding the artery.[4] In this study, we report pseudoaneurysm cases of ESRD patients our department consulted in the last four years. ESRD became the most common risk factor for developing pseudoaneurysm, not only because of the repeated puncture for hemodialysis access, but the pathology of the disease itself also became the contributing factor.[3] Prasad (2020) reported rate of PSA formation is about 2%–10% on dialysis access.[5] These ESRD patients who plan to have regular hemodialysis must have proper vascular access, either by CVC or arteriovenous fistula. Vascular access was obtained by blind vein puncture, which often accidentally punctures nearby arterial structures. The previous study reported the incidence of pseudoaneurysms in the femoral artery in 4.5% of cases post-venous puncture with palpation (blind) method and in 2.6% of cases post-ultrasound-guided puncture.[6,7]

The formation of pseudoaneurysm

Table 1. The demographic and clinical characteristic of 21 patients with pseudoaneurysm.

Variables	Value (%)
Age (years, mean±SD)	46.57 ± 12.14
Sex	
Men	11 (52.4%)
Women	10 (47.6%)
Site of pseudoaneurysm	
Brachial artery	19 (90.4%)
Femoral artery	1 (4.8%)
Radial artery	1 (4.8%)
Clinical manifestation	
Ruptured	6 (28.6%)
Impending rupture	12 (57.1%)
Infection	3 (14.3%)
Surgical Procedure	
Repair fistula	19 (90.4%)
Take down AV shunt	2 (9.6%)

Table 2. The cross-tabulation between the site of pseudoaneurysm and previous hemodialysis access.

Variables		Previous vascular access		
		Yes	None	Total
Site of pseudoaneurysm	Cubital fossa	11	8	19
	Wrist	1	0	1
	Femoral	0	1	1
Total		12	9	21

in the vascular access of patients whose hemodialysis occurs due to the contribution of several factors, including the high flow of AVF, repeated punctures at the same location, and the presence of stenosis or thrombus, which results in further increased AVF pressure.[8] The complication of AVFs can consist of thrombosis, stenosis, aneurysm (true or false), and infection.[9] However, aneurysms become the most potential complication that causes patients and the paramedics to be concerned about the risk of rupture due to the thinning skin over the aneurysm. Although the occurrence of rupture is relatively rare, it can be fatal if it occurs due to the rapid hemodynamic deterioration.[3]

A pseudoaneurysm can appear asymptomatic (found accidentally) and symptomatic. It can be manifest as local or systemic signs and symptoms. Local signs can be found as a palpable thrill, audible bruit, pulsating mass, ischemia, and neurologic sign if the mass compresses the vascular or neurological structure. Compression to the vein structure will manifest as upper limb edema and deep vein thrombosis. Skin thinning above the pseudoaneurysm can be ruptured at any time. Ruptured pseudoaneurysm will cause a catastrophe that needs immediate intervention to prevent hemorrhagic shock.[4] In this study, the most common clinical findings were impending rupture (51.7%) with expanding hematoma, history of active bleeding just before getting to the hospital, skin eruption with infection, and signs of inadequate perfusion to the distal. We report six (28.6%) cases of ruptured pseudoaneurysm and locally infected pseudoaneurysm in three (14.3%) cases.

The strategy management can be primary surgical repair, ultrasound (US)-guided compression, and percutaneous intervention (thrombin injection, coil embolization, and stent insertion). In this study, we report 71.4% of cases of impending pseudoaneurysm ruptured and undergoing immediate surgical repair in the OR. We did not perform US-guided compression or percutaneous intervention in all cases because of the limitation of our intervention devices in the Emergency ward, and also based on the previous study reported that both still have a high recurrence rate, about 20-30% dan failure rate 15-38%.[4]

Surgical procedure is indicated in the ruptured aneurysm (true or false), progressive hematoma expansion or mass size accompanied with local pain, vein hypertension, skin eruption, infection, limited puncture site, and poor flow. Aggressive surgical intervention in cases of aneurysms has been reported to be useful for maintaining functional AVF; in certain cases, AVF has to be taken down due to difficulty in controlling bleeding or accompanied by infectious complications requiring aggressive debridement.[3] Determining the surgical technique depends on the presence or absence of infection. In pseudoaneurysm without infection, primary correction of the arteries should always be attempted. In cases with infection, control of the source of infection is the priority (administration of antibiotics, pus drainage, or debridement).[4] In this study, we had clinical pseudoaneurysm with infection in 3 cases (14.3%), and 2 cases ended in take-up down AV shunt.

Due to the high risk of pseudoaneurysms in ESRD patients, all medical staff and patients need to know and understand the conditions and initial management needed to prevent the formation of pseudoaneurysms. In cases where the artery is accidentally displaced during the hemodialysis cannulation, a compression band should be applied for 5 to 7 days. A skin infection or abscess near AVF needs to be reported for observation because inferior tissue or slough around blood vessels will potentially form pseudoaneurysm fistulas.[3] In this study, we obtained pseudoaneurysms in ESRD patients who had never even had access to standard hemodialysis. From Table 2, we found that nine forms of 21 cases convinced that they had never used CVC or AVF since starting hemodialysis. Thus, every time these patients come for dialysis, hemodialysis access is obtained

by direct puncture of the vein with the palpation method. Webber (2007), in his study, reported that hemodialysis, poor post-vascular compression, hypertension, repeated punctures at the same location, and false puncture are some of the factors associated with the formation of pseudoaneurysms.[8]

CONCLUSION

Iatrogenic pseudoaneurysm in ESRD patients becomes the most common complication consulted to our department as its high morbidity and mortality rate. Surgical intervention is the therapy of choice in our cases, whereas the timing of intervention is decided based on the patient clinical manifestation. However, prevention is crucial and needs to be known and understood by both paramedic and patient. Thorough information was meant to make them understand the importance of proper vascular access for regular hemodialysis access, as it seems both still lack it in our cases.

SOURCE OF FUNDING

None.

CONFLICT OF INTEREST

All of the authors declare that there were no conflicts of interest in this study.

ETHICAL CLEARANCE

Not applicable.

AUTHORS CONTRIBUTION

All authors contributed equally in the writing of this article.

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