Section A-Research paper

Management of femoral artery pseudoaneurysm

Eslam Mohamed Mahmoud Romih, Abdelrahman Mohamed Gamil, Mohamed Ahmed Effat, Mahmoud Ahmed Elsabbagh

Vascular Surgery Department, Faculty of Medicine - Zagazig University, Egypt

Email: islamromih@gmail.com

Article History: Received 10th June, Accepted 5th July, published online 10th July 2023

Abstract

Background: A pseudoaneurysm, also known as a false aneurysm, is a local dilation or rupture of a blood vessel that is caused by a breach in the arterial wall not contained by layers of normal arterial wall. A true aneurysm, on the other hand, involves all the 3 layers including the intima, media, and adventitia. Clinically, it may present with pulsatile hematoma, pain, ecchymosis, or with active extravasation. In chronic scenarios, once a fibrous capsule has been formed, it may present with a persistent flow communicating with the arterial lumen. Pseudoaneurysm (PSA) clinical progression varies; its complications depend on the size, mechanism of injury, duration, patient comorbidities as well as neck diameter. Clinical examination should raise a high index of suspicion once a pulsatile mass can be felt, especially when a patient reports recent trauma or intervention. Vascular injury with formation of infected femoral artery pseudoaneurysms (IFAPs) is now frequently encountered by vascular surgeons. The management of IFAPS as opposed to standard pseudoaneurysms (PSA) has evolved owing to the inherent differences between them. A routine PSA encountered after vascular or an endovascular procedure is often amenable to percutaneous thrombin injection and, when required, direct repair or an interposition bypass graft can readily be performed. The cornerstone of treatment is arterial ligation, PSA excision, abscess drainage, and infected tissue debridement. Arterial reconstruction using great saphenous vein if available, femoral vein, internal iliac artery, prosthetic grafts, or CryoVein (CryoLife, Inc., Atlanta, Ga) has been described, as well as endovascular treatment with the placement of covered stents. Treatment of non-infected femoral PSA includes open surgical repair, ultrasound-guided compression, ultrasound-guided thrombin injection, coil embolization, covered stent placement. Surgical repair of PSA is an option when a concomitant arterio-venous fistula exists.

Keywords: femoral artery pseudoaneurysm, management

DOI: 10.53555/ecb/2023.12.Si12.303

A pseudoaneurysm, also known as a false aneurysm, is a local dilation or rupture of a blood vessel that is caused by a breach in the arterial wall not contained by layers of normal arterial wall. A true aneurysm, on the other hand, involves all the 3 layers including the intima, media, and adventitia. Clinically, it may present with pulsatile hematoma, pain, ecchymosis, or with active extravasation. In chronic scenarios, once a fibrous capsule has been formed, it may present with a persistent flow communicating with the arterial lumen. Pseudoaneurysm (PSA) clinical progression varies; its complications depend on the size, mechanism of injury, duration, patient comorbidities as well as neck diameter. Clinical examination should raise a high index of suspicion once a pulsatile mass can be felt, especially when a patient reports recent trauma or intervention **(1)**.

Etiology

The etiology of Femoral Artery Pseudoaneurysm includes the following: **(2)**.

Intravenous Drug Abuse (IVDA): involves injecting impermissible substances directly into the bloodstream. Repeated and improper injections can damage the walls of blood vessels, including the femoral artery located in the groin. The introduction of foreign materials and contaminants through contaminated needles can initiate an inflammatory response, weakening the arterial wall.

Intravenous Drug-Related Infection: In the context of intravenous drug abuse, the use of contaminated needles and substances significantly increases the risk of infection. An infected pseudoaneurysm occurs when bacteria enter the sac and cause an inflammatory response, which further weakens the arterial wall **(3)**.

Percutaneous interventions : as cardiac catheterization

Post surgical. (anastmotic aneurysm)

Post traumatic: blunt or penetrating trauma.

Epidemiology

As mentioned previously, PSAs are the most common complication that results after percutaneous procedures performed by a cardiologist, interventional radiologist, or vascular surgeon. Incidence has been reported from 0.5% to up to 9% in some series **(4).**

A meticulous physical examination is paramount for accurate diagnosis and effective management of femoral artery PSAs. The following aspects are key: **(5)**.

1. **Groin Examination:**
    - Focused examination of the groin area is essential.
    - Palpation for pulsatile masses, tenderness, and signs of infection guides diagnosis.
    - Detection of a bruit indicates turbulent flow characteristic of a PSA.
2. **Skin and Soft Tissue Examination:**
    - Skin over the mass for infection signs, redness, warmth, or wounds informs treatment considerations.
3. **Range of Motion and Pain Assessment:** The patient's ability to move the affected limb and any associated discomfort informs functional status.
4. **Differential Diagnosis Consideration:**
    - Distinguishing PSA from other conditions with similar presentations—such as inguinal hernias—relies on identifying a bruit and specific flow patterns.

Investigations:

Laboratory Tests:

Blood Tests: Depending on the clinical presentation, blood tests may be ordered to assess for signs of infection (elevated white blood cell count, C-reactive protein), renal function (especially if considering contrast agents for imaging), and coagulation profile.

Imaging Studies:

Imaging modalities for PSAs include a duplex ultrasound (DUS) which is usually the first test one should obtain if PSA is suspected. DUS carries a sensitivity of 92% to 96%. Findings on DUS which indicate PSA would consist of a flow called a “to-and-fro flow” between the aneurysm and femoral artery. Ideally, the DUS will include the dimensions, size of the sac and the neck as treatment will be based on those dimensions. Proximal and distal arteries should also be evaluated for thrombus extruding from the aneurysmal sac **(2)**.

Plain X- ray: for detection of any missed foreign body.

Duplex Ultrasound: Duplex ultrasound is often the initial imaging modality of choice. It provides real-time visualization of blood flow and can help determine the size, location, and characteristics of the pseudoaneurysm. It can also assess blood flow velocities and identify any thrombi or clots within the sac. Findings on DUS which indicate PSA would consist of a flow called a "to-and-fro flow" or "Yin-Yang sign" between the arterial lumen and femoral artery. Ideally, the DUS will include the dimensions, size of the sac and the neck as treatment will be based on those dimensions. Proximal and distal arteries should also be evaluated for thrombus extruding from the aneurysmal sac **(5)**.

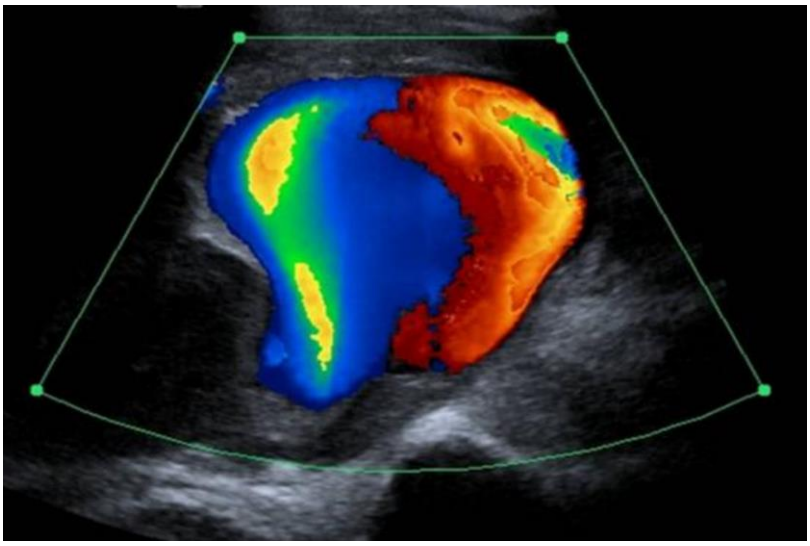
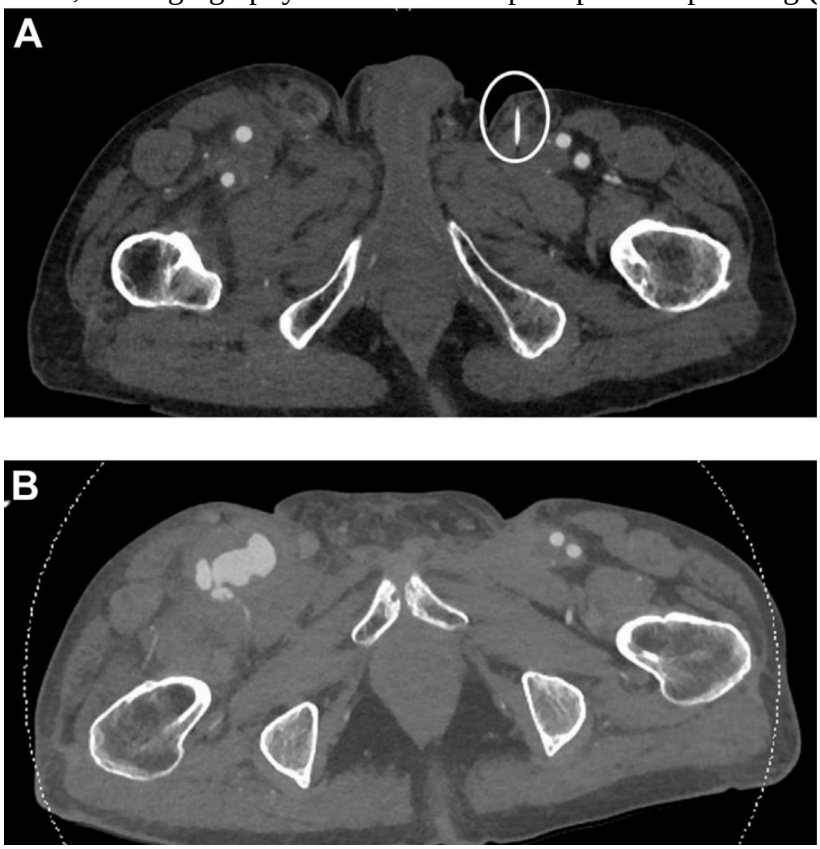


Fig. (1): Duplex US showing Yin-Yang sign **(6).**

CT Angiography (CTA): CTA provides detailed cross-sectional images of blood vessels. It can accurately assess the size, location, and relationship of the pseudoaneurysm to surrounding structures. Whenever a surgical intervention is planned, CT angiography can be used for pre-operative planning **(7)**.



- **Fig (2):** computed tomographic arteriogram showing **A,** Retained needle fragment in left groin subcutaneous tissue (white circle). **B,** Large femoral pseudoaneurysm (PSA) at the level of the right femoral bifurcation **(8).**

Fig. (3): Computed tomography (CT) angiogram showing the common femoral pseudoaneurysm surrounded by the abscess **(9)**.

- **Magnetic Resonance Angiography (MRA):** can provide high-resolution images without exposing the patient to ionizing radiation, making it a valuable option for some patients.

Angiography:

- **Digital Subtraction Angiography (DSA):** DSA is an invasive procedure that involves injecting contrast dye into the blood vessels and capturing X-ray images. It provides real-time images of blood flow and vessel morphology. DSA can help in cases where precise assessment of blood flow and anatomy is necessary, such as planning for endovascular interventions **(10)**.

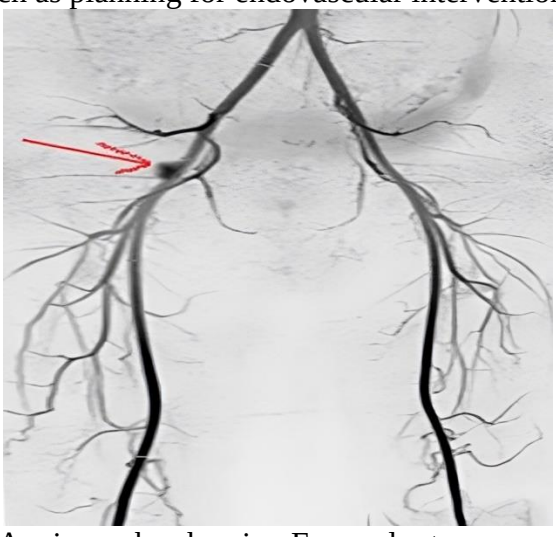


Fig (4): Angiography showing Femoral artery aneurysm **(2)**.

The evaluation process aims to determine the size, location, morphology, and potential complications of the femoral artery pseudoaneurysm. This information guides treatment decisions, which can range from conservative management (observation and monitoring) to more active interventions (surgical repair, endovascular procedures) **(7)**.

Management of femoral artery pseudoaneurysm

Vascular injury with formation of infected femoral artery pseudoaneurysms (IFAPs) is now frequently encountered by vascular surgeons. The management of IFAPS as opposed to standard pseudoaneurysms (PSA) has evolved owing to the inherent differences between them. A routine PSA encountered after vascular or an endovascular procedure is often amenable to percutaneous thrombin injection and, when required, direct repair or an interposition bypass graft can readily be performed **(8).**

With IFAPs the size of the PSA, the fact that it is infected, the potential for risk to the operative team with retained needles, as well as the risk of graft infection, makes the traditional vascular principles of management difficult. Even with a bypass routed around the area, the potential for infection from infected wound or repeat injection attempts exist **(8).**

The cornerstone of treatment is arterial ligation, PSA excision, abscess drainage, and infected tissue debridement. Arterial reconstruction using great saphenous vein if available, femoral vein, internal iliac artery, prosthetic grafts, or CryoVein (CryoLife, Inc., Atlanta, Ga) has been described, as well as endovascular treatment with the placement of covered stents **(7)**.

Revascularization is a challenge in the presence of an infected wound bed in the vicinity of the reconstruction. Some advocate reconstruction with an in-line biologic conduit, and coverage of the conduit with a well vascularized muscle flap, whereas other investigators recommend an extraanatomic bypass. Regardless, long-term follow-up has shown a high incidence of bypass graft infections, often related to repeated injection attempts **(11).**

. A CT arteriogram is performed to confirm the diagnosis and delineate the arterial anatomy (ie, distal iliac artery vs common femoral artery, relationship with the profundal bifurcation in femoral PSAs), as well as alert the surgical team about the presence of retained needle segments. Retained broken needle segments are reported very common in this patient population, with one study stating that up to 20% of patient who inject drugs reported breaking needles while injecting. Duplex examination can also provide useful information; however, probe pressure is rarely tolerated owing to pain and discomfort **(11).**

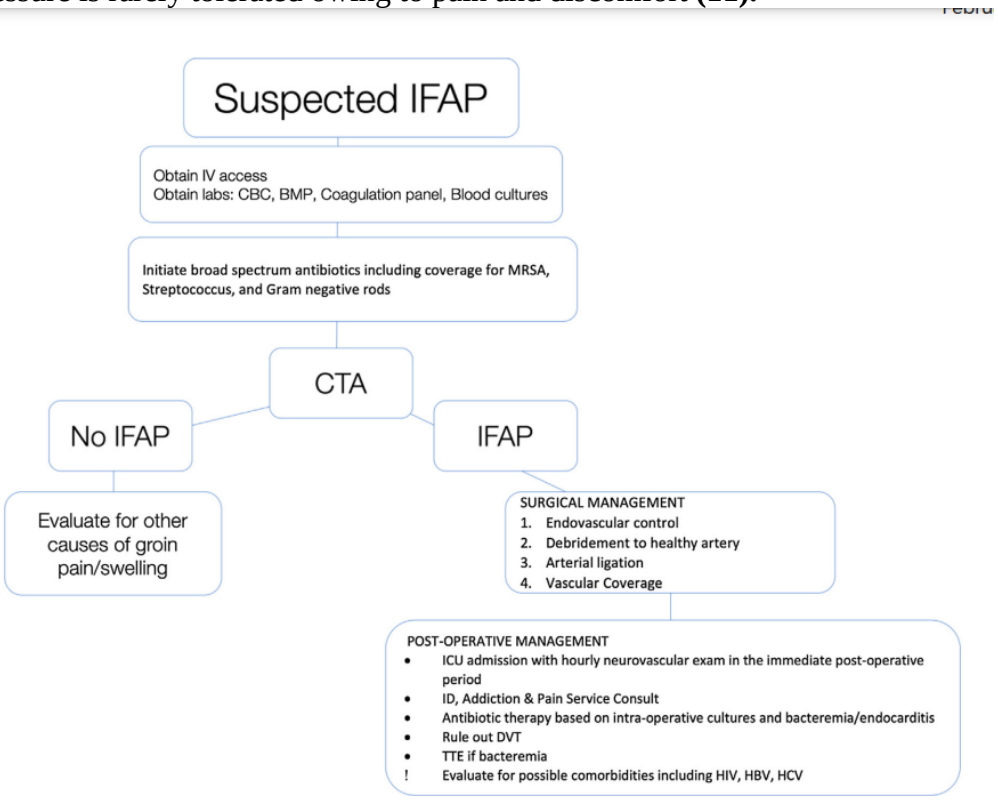


Fig.5 Management approach for patients presenting with suspected pseudoaneurysm (PSA) owing to intravenous drug use (IVDU) **(8).**

Treatment of non-infected femoral PSA includes open surgical repair, ultrasound-guided compression, ultrasound-guided thrombin injection, coil embolization, covered stent placement. Surgical repair of PSA is an option when a concomitant arterio-venous fistula exists. It should also be considered when there is ongoing hemodynamic instability, limb ischemia. Surgical principles consist of controlling the artery proximally and distally and primary repair of the arterial defect. When hemorrhagic shock ensues, digital compression of the bleeding site should be performed first followed by vascular control, and primary arteriography. Sometimes a retroperitoneal incision may be required for obtaining external iliac artery exposure in large PSA. If the primary repair cannot be successfully achieved, then a vein graft should be used to reconstruct the arterial system **(12)**.

Ultrasound compression is utilized to visualize the neck of the PSA and apply pressure until the sac is occluded. While performing compression if a PSA is present, care should be taken to avoid compression of the femoral artery. PSA is treated successfully with ultrasound when the sac is less than 3.5 cm. Technical failures with this method have been estimated up to 10% to 30%. If this occurs, then alternative treatment should be sought **(13)**.

Ultrasound thrombin injection is also a minimally invasive procedure that can be performed at the bedside under local anesthesia. To qualify for this treatment modality, the PSA should typically have a long neck that is narrow and easily seen on ultrasound. A spinal needle (22 gauges) is inserted into the sac and under continuous visualization thrombin is injected into the sac. The needle is visualized during the entire procedure to avoid accidental thrombin injection into the arterial system. Approximately 100 to 500 U/ml of thrombin is injected into the sac at about 0.1ml increments until thrombosis is achieved. A technical failure has been reported between 5% to 10% using this method providing neck anatomy is adequate **(13)**.

Another minimally invasive treatment includes endovascular treatment which could entail both coil embolization or covered stent deployment. Complications include failure of treatment as well as PSA formation since often the contralateral groin is used to gain access **(2)**.

With any treatment mentioned above, complications include thrombosis of both the venous and arterial systems. Embolization into the distal arterial tree can occur up to 2% to 4% of the cases; hence a thorough pulse examination should be carried prior and after the procedure. If distal embolization is suspected, a Fogarty catheter should be passed both proximally and distally. If the patient has a true aneurysm, then repair is not recommended. The aneurysm should be resected and a prosthetic graft should be inserted **(2)**.

Surgical procedure

The outcomes of surgical interventions for femoral artery pseudoaneurysms are of paramount importance in determining the success of treatment and the overall well-being of patients. Among the available options, ligation and excision of the pseudoaneurysm with local debridement is a therapeutic approach aimed at removing the pseudoaneurysm while addressing any localized infection. This method seeks to eliminate the risk of rupture and infection-associated complications. However, the decision to opt for this approach or the more intricate ligation and excision with revascularization depends on various factors including the patient's overall health, the extent of vascular compromise, and the potential for ischemic complications **(14)**.

The second treatment option, ligation and excision of the pseudoaneurysm with revascularization, represents a more comprehensive approach. In addition to eliminating the pseudoaneurysm, this method also involves restoring blood flow to the affected area through revascularization techniques. While the primary goal remains the prevention of complications like rupture and ischemia, the added emphasis on reestablishing blood supply aims to mitigate potential downstream consequences. Nevertheless, the decision-making process between these options is often complex and requires a careful assessment of the individual patient's condition **(15)**.

Procedure Steps includes the following: **(14; 15; 16)**

Patient Preparation:

- The patient is positioned on the operating table, and anesthesia (typically general or regional anesthesia) is administered to ensure comfort and pain control during the procedure.

Surgical Incision:

- A sterile surgical field is prepared, and an incision is made over the area of the pseudoaneurysm in the groin. The incision allows access to the femoral artery and the pseudoaneurysm.

Exposure and Isolation:

- The surrounding tissues and structures are carefully dissected to expose the damaged femoral artery and the pseudoaneurysm sac.

Ligation of the Pseudoaneurysm Neck:

- The surgeon identifies the neck of the pseudoaneurysm, which is the opening connecting the sac to the artery. The neck is carefully dissected and isolated.
- A non-absorbable suture (ligature) is placed around the neck of the pseudoaneurysm and securely tied. This ligature prevents further blood flow into the pseudoaneurysm.

Excision of the Pseudoaneurysm Sac:

- After the pseudoaneurysm is ligated, the sac is carefully dissected and excised from the surrounding tissues. The goal is to completely remove the sac to eliminate the risk of infection and other complications.

Revascularization:

- Following the excision of the pseudoaneurysm, the surgeon assesses the condition of the femoral artery proximal and distal to the pseudoaneurysm site.
- If the artery is healthy and free of significant disease, a decision is made to restore blood flow to the affected area. This can be achieved through various revascularization techniques, including bypass grafting or patch angioplasty.

Bypass Grafting (if needed):

- In cases where the femoral artery is damaged or compromised, a bypass graft may be used to redirect blood flow around the affected area. The graft is typically a synthetic tube (e.g., PTFE graft) or an autologous vein segment (such as the saphenous vein) harvested from the patient.

- **Closure and Hemostasis:**
  - After the revascularization procedure is completed, the surgeon ensures that there is proper hemostasis (control of bleeding) in the surgical field.
  - Layers of tissue are carefully closed with sutures, and the skin is closed using absorbable or non-absorbable sutures, staples, or adhesive strips.

Postoperative Care:

- The patient is monitored closely in the postoperative period for any signs of complications, such as bleeding, infection, or graft failure.
- Pain management, wound care, and appropriate medical therapies are provided as needed.

Currently, no specific guidelines dictate a preferred choice between these two treatment options for femoral artery pseudoaneurysms. The decision hinges on a thorough evaluation of the patient's medical history, anatomical considerations, risk factors, and potential complications. Clinical expertise, multidisciplinary collaboration, and a personalized approach are crucial in determining the most suitable intervention. As further research and clinical experience accumulate, a clearer understanding of the outcomes associated with each approach will aid in refining treatment recommendations and optimizing patient outcomes **(17)**.

Role of endovascular approach in management of femoral pseudoaneurysm:

Endovascular therapy has the advantage of avoiding surgical maneuvers in an already contaminated field and the risk of further bleeding in hemodynamically unstable patients. For all these reasons, the possibility to exclude IFAPs via stent-graft placement and simultaneously treat the infection (locally with open debridement/drainage and systematically with antibiotic therapy) is fascinating and provides bleeding control and distal perfusion at the same time **(18).**

Nevertheless, some aspects of endovascular therapy make it not ideal for the management of IFAPs. The need to obtain adequate proximal and distal landing zones may lead to coverage of the ostium of the PFA, which can result in limb ischemia. Moreover, it can be argued that the deployment of a stent-graft in an infected

area may lead to a catastrophic closed-space infection. It is hypothesized, as recently suggested by Moulakakis et al., that the bacterial load the endo-prosthesis was exposed to was low. This can probably be due to the fact that the minimal defect in the arterial wall, which leads to the development of the pseudoaneurysm, is not enough to provide a graft infection. In addition, the aggressive treatment of the infection can effectively control it by reducing the bacterial burden **(19).**

Stenting of the CFA historically represents a controversial issue essentially because its location against the hip joint flexion–extension point makes the stent vulnerable to fracture which in turn may cause in-stent restenosis. This notion might not be true with new generations of self-expandable covered stents (SECS), as reported by series in literature showing acceptable short and mid-term results after primary stenting of the CFA with these kind of endoprosthesis **(20).**

Endovascular Management of Infected Femoral artery Pseudoaneurysm exclude only the origin of the pseudoaneurysm leaving uncovered the distal CFA slightly above the PFA ostium. If longer sealing zone is not available, endovascular repair would not be appropriate and open surgical repair would represent a better choice. Traditionally, endovascular exclusion of IFAPs has been considered only as a bridging method toward a further definitive surgical reconstruction after slowdown of the infection **(18).**

In patients with symptomatic pseudoaneurysms who are fit for surgery at the time of presentation, it is prefered to execute an extra-anatomic bypass (running across healthy tissue planes) with autologous venous conduits, rather than primary endovascular repair. It is believed that, in patients at high surgical risk, the endovascular option could represent more than a bridging measure, leaving a major surgical procedure as a solution if relapse of infection/pseudoaneurysm or ischemic complications are noticed during follow-up. An open question remains about which factors need to be considered as prognostic factors in order to determine those cases in which endovascular treatment is most likely to have a poor outcome. In such cases, endovascular stent-graft placement can represent a temporizing measure, until definitive surgical treatment can be performed under more elective circumstances **(20).**

As for all endovascular procedures, ongoing surveillance is mandatory to achieve satisfactory outcomes. Of significant concern, remains the fact that most of these patients could continue their addictive behavior, and the risk of using the conduits for re-puncture calls for a prudent selection of patients **(18).**

References

1. Dwivedi K, Regi JM, Cleveland TJ, Turner D, Kusuma D, Thomas SM and Goode SD. (2019): Long-Term Evaluation of Percutaneous Groin Access for EVAR. Cardiovasc Intervent Radiol; 42(1): 28-33.

2. Tulla K, Kowalski A and Qaja E. (2022): Femoral Artery Pseudoaneurysm. In StatPearls [Internet]. StatPearls Publishing. pseudoaneurysms in intravenous drug addicts. The Egyptian Journal of Hospital Medicine; 72(5): 4539-42.

3. MacLeod CS, Radley A, Strachan D, Khan F, Nagy J and Suttie S. (2023): Management of the infected arterial pseudoaneurysm secondary to groin injecting drug use and outcomes: a systematic review protocol. BMJ open, 13(6): 706-15.

4. Mach M, Okutucu S, Kerbel T, Arjomand A, Fatihoglu SG, Werner P et al., (2021): Vascular complications in TAVR: incidence, clinical impact, and management. Journal of clinical medicine, 10(21), 504- 6.

5. Abou Diwan R, Kaadi L, Hachem S, Smayra T, Slaba S, Chalhoub B and Hachem K. (2023): Pseudoaneurysms: Different ultrasound patterns, aetiologies and locations. Australasian Journal of Ultrasound in Medicine.

6. Hemdan MAA, Ewida AM and Metwally YHH. (2018): Surgical management of the infected femoral pse

7. Bansal A, Gorsi U, Farook S, Savlania A and Sandhu MS. (2021): Interventional radiology management of extremity pseudoaneurysms: a pictorial essay. Emergency radiology; 28(5):1029-39.

8. Quiroga E, Shalhub S, Tran NT, Starnes BW and Singh N. (2021): Outcomes of femoral artery ligation for treatment of infected femoral pseudoaneurysms due to drug injection. Journal of vascular surgery; 73(2): 635-40.

9. Al Shakarchi J, Wall M, Garnham A, Hobbs S and Newman J. (2019): Artery ligation for infected femoral pseudoaneurysms does carry a high risk of major amputation. Annals of Vascular Surgery; (58): 326-30.

10. Campos LA and Schenning RC. (2020): Digital Subtraction Angiography. Imaging in Peripheral Arterial Disease: Clinical and Research Applications, 93-121.

11. Menard MT, Lotto CE, and Belkin, M. (2019): Reconstructive surgery for peripheral artery disease. Vascular Medicine: A Companion to Braunwald's Heart Disease E-Book, 281.

12. Mufty H, Daenens K, Houthoofd S and Fourneau I. (2018): Endovascular Treatment of Isolated Degenerative Superficial Femoral Artery Aneurysm. Ann Vasc Surg; (49): 311-14.

13. Fokin AA and Kireev KA. (2018): [Algorithm of treatment policy for a femoral artery false aneurysm]. Angiol Sosud Khir,]; 24(2): 195-200.

14. Jaiswal LS, Pandit N and Adhikary S. (2019): Outcome of Ligation without Revascularization in Pseudoaneurysms of Peripheral Arteries in Intravenous Drug Users. JNMA: Journal of the Nepal Medical Association; 57(217): 189.
15. Magar DT, Shrestha K, Chapagain D, Shrestha K and Thapa S. (2020): Outcome of ligation of peripheral arterial pseudo aneurysm with or without revascularization in intravenous drug abuser. Int J Surg; (4): 337-40.
16. Siddique S, Anwar MH, Khan TM and Zia N. (2022): Optimal management of infected femoral pseudo aneurysm in drug addicts presenting to Benazir Bhutto Hospital, Rawalpindi. The Professional Medical Journal; 29(11): 1625-9.
17. Shrestha KR, Gurung D, Khanal N and Shrestha UK. (2020): Femoral Pseudoaneurysm in IV Drug Abusers: Single-center Study Experience.
18. Antoniou GA, Papas TT, Tsagkos I, et al. (2014): Endovascular stentgraft repair of bleeding common femoral artery pseudoaneurysm in intravenous drug users: a bridge to surgical reconstruction. Vasa; 43(6): 473–6.
19. Moulakakis K, Sfyroeras GS, Alexiou VG, et al., (2016): Endovascular management of infected iliofemoral pseudoaneurysms: a case series. Vasc Endovasc Surg.
20. Azema L, Davaine JM, Guyomarch B, et al., (2011): Endovascular repair of common femoral artery and concomitant arterial lesions. Eur J Vasc Endovasc Surg; 41: 787–93.