Abstract:

Femoral artery Pseudoaneurysm (FAP) is one of the most troublesome complications after various invasive radiological procedures related to the femoral arterial access site. Iatrogenic pseudoaneurysms (IPA) form when an arterial puncture site fails to seal, allowing arterial blood to ooze into the surrounding tissues and form a pulsatile hematoma. This occurs in 0.8% to 2.2% after interventional procedures. This problem has become more significant due to the exponential growth of interventional radiology. The imaging of femoral artery pseudoaneurysm, indications, advantages & disadvantages of various treatment modalities are discussed in this review of literature.

Introduction:

The incidence of vascular complications is on the rise due to the higher number of radiological procedures now performed via the femoral artery. Femoral artery Pseudoaneurysm occur in 0.1% to 0.2% of diagnostic angiograms and 0.8% to 2.2% following interventional procedures[2]. The other arterial complications that occur are arterial thrombosis, hematoma formation and arteriovenous fistula. The longer duration of complex interventional procedures, usage of wide bore catheters and sheaths, and extensive anticoagulant therapy during the procedure are some of the risk factors responsible for the rising incidence of these pseudoaneurysms.

FAPs are usually caused by punctures of the femoral artery which are too distal, that is, at the level of bifurcation of the femoral artery or below [1]. 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 [3]. These lesions lack a fibrous wall and are contained by a surrounding shell of hematoma and the overlying soft tissues. It can present as a new thrill or bruit, pulsatile hematoma, or marked pain or tenderness. Complications of pseudoaneurysms include rupture, distal embolization, local pain, neuropathy and local skin ischemia [3].

Imaging:
Clinically a pseudoaneurysm presents as a pulsatile mass often with a bruit or palpable thrill and to-and-fro murmur. Ultrasound with Doppler plays a crucial role in the diagnosis of these iatrogenic vascular abnormalities. It demonstrates the cavity of the pseudoaneurysm, its size and communication with the femoral artery. A swirling pattern of blood flow may be seen in the pseudoaneurysm and the velocities can be measured in the pseudoaneurysm, its neck and the femoral artery. Documentation of the to-and-fro flow with spectral Doppler is essential to making the diagnosis. The size of the aneurysm may guide the physician as to whether a conservative approach or treatment is indicated. Kronzon, et al in his study reported that smaller aneurysms [\(< 2 \text{ cm}\)] may usually be followed up; however depending on the size of the pseudoaneurysm a number of treatment options can be offered.
Therapy:

Several therapeutic strategies have been developed to treat this complication. They include ultrasound-guided compression repair (UGCR), surgical repair, and minimally invasive percutaneous treatments (thrombin injection, coil embolization and insertion of covered stents)[4].

Ultrasound Guided Compression Repair:

UGCR has become the first-line treatment of pseudoaneurysms at many institutions. The introduction of this method in 1991 by Fellmeth et al [5] has significantly reduced the need for surgical repair of FAP. It has been shown to be a safe and cost-effective method for achieving pseudoaneurysm thrombosis [3]. However, UGCR has considerable drawbacks including long procedure time, discomfort to patients and a relatively high recurrence rate in patients receiving anticoagulant therapy (as high as 25% to 35%) [3]. UGCR has been shown to be less successful in patients with large FAP (i.e., larger than 3 cm to 4 cm in diameter) and those who cannot tolerate the associated discomfort [6]. The procedure carries an overall complication rate of 3.6% and risk of rupture of 1% [3]. Complications include acute pseudoaneurysmal enlargement, frank rupture, vasovagal reactions, deep vein thrombosis, atrial fibrillation and angina [3]. Moreover, UGCR requires the availability of an ultrasound device and the presence of skilled personnel during the procedure.

The technique involves applying compression on the pseudoaneurysm neck with the ultrasound transducer until the flow within the neck is obliterated. After obtaining written informed consent, the transducer is oriented to demonstrate the pseudoaneurysm neck to the best advantage. Manual compression is applied to the neck for 10–20-minute periods to completely arrest flow into the pseudoaneurysm. Compression is released as briefly as possible between cycles to assess pseudoaneurysm thrombosis, to reposition the transducer, or to switch operators.
Compression is continued until the pseudoaneurysm achieved thrombosis which is usually 45 to 60 minutes.

After compression, patient is instructed to lie in bed with the affected leg straight for 4–6 hours, with frequent groin checks. Follow-up color Doppler US examinations at 24–48 hours are not routinely performed in cases of successful thrombosis unless there is a compelling clinical indication such as a persistent pulsatile mass or bruit.

Contraindications to this technique include inaccessible site, limb ischemia, infection, large hematomas with overlying skin ischemia, compartment syndrome and prosthetic grafts [6].

**Ultrasound Guided Thrombin Injection:**

Reeder et al. introduced a new method of low-dose thrombin injection for the treatment of pseudoaneurysms [1]. An average dose of 192 U of thrombin was used (5-fold lower than previously reported). Time to coagulation ranged from 10 to 60 seconds. There were no complications. The investigators were able to successfully thrombose all pseudoaneurysms, even in the presence of anticoagulation. Their study demonstrated that a much smaller dose of a potentially dangerous medication can achieve the same efficacy as previously used higher doses.

Bovine Thrombin comes in strengths of 5000 or 20,000 units, in a powder form with 0.9% sodium chloride as diluent. It is reconstituted at a concentration of 1000 U/mL and then diluted to a concentration of 100 U/mL with sterile saline [11]. With sonographic guidance, a 22-to 25-gauge needle is introduced into the pseudoaneurysm. The needle tip is visualized and positioned at a site distant from the neck of the pseudoaneurysm. Increments of 0.5-1.0 mL (50-100 U) of thrombin were slowly injected at a rate of approximately 1 mL/10 sec [11]. A period of 5-10 sec is allowed to elapse before additional thrombin is injected. Results are monitored continuously with color-flow Doppler sonography. Injection is stopped when no further flow is identified in the pseudoaneurysm. When possible, the neck of the pseudoaneurysm must be occluded manually or with the sonographic probe during the injection procedure.

Compared with surgical repair, treatment of pseudoaneurysms with thrombin injection offers
many advantages. The success rate of thrombin injection reported in the literature has been consistently high, at an average of 97%, even with patients treated with therapeutic levels of anticoagulants. Treatment can usually be completed within several minutes. The results from studies conducted suggest that for most iatrogenic femoral arterial pseudoaneurysms, thrombin injection should replace compression repair as the first line of therapy [7].

Theoretically, a lower dose of a potentially dangerous medication should decrease the risks associated with its use. As more reports are published, it is possible more complications will come to light. In addition to distal limb ischemia caused by in situ thrombosis from thrombin leakage, there is a hypothetical risk of type I IgE-mediated allergic reaction to bovine thrombin. Topical bovine thrombin has been used extensively for hemostasis for more than 20 years. Recent descriptions of antibody responses show high titers against endogenous coagulation factors, with resulting bleeding complications. Prior exposure to bovine thrombin is considered a contraindication to treatment of pseudoaneurysms with thrombin by some investigators.

**USG guided Collagen injection:**

At the health center in Utrecht and Nieuwegein in the Netherlands, collagen injection as a method for FAP closure was developed as an alternative choice for either primary treatment of the iatrogenic pathology or treatment in the majority of cases where UGCR was unsuccessful [4]. The investigators studied the method in 110 patients with FAP following catheterization procedures (51% diagnostic catheterization, 42.8% interventional procedures, 6% other cardiac procedures). Purified bovine collagen in the form of a biodegradable adhesive paste was injected to promote hemostasis and accelerate the clotting process within the pseudoaneurysm. The success rate in this study was 98.2% (109 of 110 patients). The results of this study rank collagen injection among the most successful minimally invasive percutaneous FAP closure techniques.

Purified bovine collagen has been used in surgical procedures as an adjunct to hemostasis when control of bleeding by ligature or other conventional methods remains ineffective. When collagen comes in contact with blood, platelets aggregate on the collagen and release coagulation factors that, together with plasma factors, result in the formation of a fibrin matrix. Once implanted into tissues of an organism, collagen is ultimately degraded and progressively resorbed by granulocytes and macrophages. Contraindication to this procedure includes suspected underlying infection and known allergy to collagen or beef products [1].
Injection of collagen is easily accepted by the patients as there is no need for systemic analgesic medication during the procedure. Complete obliteration of the pseudoaneurysm is usually achieved within 10 seconds, which is comparable to that with thrombin. The coagulation status of the patient does not preclude its use.

The advantages of the collagen lie in its physicochemical properties. The fact that it consists of long paste fibers allows the collagen to remain within the FAP cavity, which putatively reduces the risk of migration through the neck of the FAP, or through a fistula. In conclusion, the technique of collagen injection is a fast, expeditious method, permitting early mobilization and discharge.

**Covered Stents and Coil Embolization:**

Other non-operative methods of treating pseudoaneurysms include placement of covered stents or endoluminal prostheses. Majority of the prostheses reported in the literature have been used for the exclusion of atherosclerotic aneurysms. A few reports have focused on the use of percutaneous coil placement (stents) to occlude the FAP [8]. In some cases the coil was placed in the neck, while in other patients the coil was placed inside the pseudoaneurysm in order to achieve closure and local thrombosis. Contraindications to the use of endovascular prosthesis in the management of IPA are injection, smaller arteries (<7 mm) and the essential parent artery, which needs to be saved.

**Percutaneous injection of fibrin adhesive:**

Loose et al. [9] describe a method of percutaneous injection of fibrin adhesive. This technique involves percutaneous injection of the adhesive components using ultrasound and screening control following successful occlusion of the aneurysm neck by angioplasty balloon [9]. The fibrin adhesive mimics the final stage of coagulation cascade. Thrombin is used to convert fibrinogen to fibrin, and the fibrin is then crosslinked by factor XIIIa in the presence of calcium to create a mechanically stable network filling the aneurysm. Tissue adhesives based on fibrinogen, thrombin, and factor XIII have been commercially available for many years. Fibrin has been extensively used in neurosurgery for repairing cerebrospinal leaks, sealing vascular anastomotic sites, reinforcing aneurysm clips and for hemostasis after tumor resection. The technique has several advantages—the balloon virtually eliminates the chance of distal embolization and decreases the likelihood of the tissue adhesive having any effects on the patient's coagulation status. The tissue adhesive does not rely on the patient's own clotting
factors. Therefore it is more likely to work in anticoagulated patients.

**Surgical treatment of femoral artery pseudoaneurysm:**

Indications for surgical repair include Rapid expansion of the IPA as there may not be time to wait for noninvasive treatments, Concomitant distal ischemia or neurological deficit due to local pressure from the IPA, or distal embolization from within it, Mycotic infection of IPA, Failure of percutaneous intervention and Compromised soft tissue viability.

**Conclusion:**

As vascular interventional radiological procedures are on a rise, there are more possibilities for occurrence of iatrogenic Pseudoaneurysms. Initially Ultrasound Guided Compression Repair was the preferred treatment as it was non invasive. But due to its failure in 25% of patients on studies conducted, increased pain experienced by the patient, long procedure time and recent development of other minimally invasive treatments which are more effective, UGCR is less preferred nowadays. Percutaneous injection of thrombin can be completed in several minutes, has the advantage of avoiding surgical intervention or the pain associated with ultrasound-guided compression, and can be performed effectively in patients who have received anticoagulation. Due to the procedural simplicity, cost effectiveness ultrasound-guided injection of thrombin remains a very appealing treatment to most physicians.

**References:**


10. A. F. Lennox, MSc, FRACS; M. B. Griffin, MSc; N. J. Cheshire, MD, FRCS; N. C. Peters, MD, MRCP; R. A. Foale, MD, MRCP; A. N. Nicolaides, MS, FRCS. Treatment of an Iatrogenic Femoral Artery Pseudoaneurysm With Percutaneous Duplex-Guided Injection of Thrombin. Circulation.1999; 100: e39-e41

11. Scott B. Reeder, David M. Widlus and Maxwell Lazinger; Low-Dose Thrombin Injection to Treat Iatrogenic Femoral Artery Pseudoaneurysms; AJR September 2001 vol. 177 no. 3 595-598