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Femoral Artery Pseudoaneurysm: Part 2—Treatment Approaches

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Introduction

Development of a femoral artery pseudoaneurysm (PSA) is estimated at 1% to 2% after percutaneous femoral artery access (Stone et al, 2014). The risk factors, clinical findings, and imaging diagnosis of femoral artery PSA were discussed in Part 1 of this column (Majdalany et al, 2018). Historically, surgical repair was the treatment of choice for PSA. Over time, PSA management has evolved toward less invasive approaches, decreasing the necessity for formal surgical repair. Herein, the evolution of femoral artery PSA treatment is reviewed from surgical repair to successive iterations of interventional radiologic approaches, which are increasingly used.

Surgical Repair

The necessity for open surgical repair has decreased since the 1990s given the multitude of image-guided procedures that are now possible. Although definitive surgical repair has decreased in frequency, it remains as a last resort (Horn et al, 2017). In particular, surgical repair is preferentially used for patients who present with PSA rupture, shock/cardiovascular collapse, associated skin necrosis, suspicion of an infected PSA, or nerve compression and intense pain caused by the PSA or patients for whom alternative treatments failed (Saad et al, 2005). There are no specific contraindications aside from those for any patient undergoing surgery including anesthesia. In preparation, the surgeon determines the incision site to properly expose the femoral artery, dissects the tissue around the artery to identify the arterial abnormality, and then primarily repairs the injured vessel with suture or performs graft reconstruction. Integrating the entire arterial wall is critical to achieve a durable result. Upon completion, blood flow is reassessed with Doppler ultrasound before layered tissue closure (Horn et al, 2017). Although surgical approaches are definitive when compared with image-guided procedures, they are more likely to be complicated by increased blood loss requiring a transfusion, higher infection rates, wound dehiscence, lymphocele formation, and death (Kapoor et al, 2009).

Ultrasound-Guided Compression

In 1991, ultrasound-guided compression (UGC) was developed as an alternative to surgical repair (Fellmeth et al., 1991). UGC allows for treatment with continuous visualization of the vessels. Direct pressure is applied to the skin, compressing the PSA neck for up to 90 min. If the initial 10 to 20 min of PSA neck compression is not successful, then the PSA itself can be directly compressed (Hendricks and Saad, 2012). The goal of UGC is to exclude flow into the PSA while maintaining arterial perfusion beyond it. Frequently, patients require sedation as compression may be painful. Long compression times can result in patient and/or operator discomfort, operator fatigue, and patient intolerance. Success, approaching 70%, is more common in thinner patients or in those with a more superficial PSA. Factors that determine the efficacy of UGC include coagulation status and PSA size, depth, complexity, chronicity, and the length and width of the PSA neck. Complications associated with this procedure are rare but include rupture of the PSA, venous thrombosis, and skin necrosis (Saad et al, 2005).

Direct Ultrasound-Guided Thrombin Injection

Direct ultrasound-guided thrombin injection (DUTI) has superseded surgical repair and UGC, becoming the first-line treatment for femoral artery PSA. This technique was initially reported in 1997 and allows for rapid treatment at the bedside, is relatively painless, and requires no sedation (Liau et al, 1997). Thrombin is supplied as a powder totaling 5,000 units and is reconstituted with 5 mL of normal saline to achieve a concentration of 1,000 units/mL (Figure 1). A 3-way stopcock is attached to the reservoir syringe containing the reconstituted thrombin, a delivery syringe, and tubing connected to a small-bore needle (Figure 2). After identifying the PSA, Color Doppler is used to highlight internal blood flow within the PSA and to delineate the length and size of the

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Figure 1. Thrombin powder (5,000 units) and 0.9% sodium chloride (5 mL) vials before mixing. The vials can be directly mixed with an adapter.

pseudoaneurysmal neck (Figure 3). Under ultrasound guidance, a small gauge (21–25) needle is positioned in the center of the pseudoaneurysmal sac (Figure 4). After confirming the needle-tip position, small aliquots (0.1–0.3 mL) of thrombin are injected. Thrombosis of the PSA occurs within seconds of injection (Figure 5). The ideal PSA is acute, simple, smaller than 3 cm, and has a definably narrow neck. Complications include nontarget arterial thromboembolism, allergic reaction to the thrombin, and venous thrombosis (Saad et al, 2005). DUTI success rates exceed 90%, irrespective of anticoagulation status.

Advanced Interventional Approaches

A PSA that has a wide neck, is complex or multilobular, has an arteriovenous fistula, or failed other therapies may warrant a more aggressive intervention. Innovative approaches such as coil embolization, balloon occlusion in combination with DUTI, or stent grafting with or without DUTI have been described. Of these, coil embolization is the least commonly performed because of technical difficulty, nontarget embolization, and palpability of the coils in the subcutaneous tissue. These procedures are performed in angiography suites with sedation. Access is obtained from the contralateral side or the radial artery. Arteriography delineates the relationship between the femoral artery and the PSA (Figures 6 and 7). Intraprocedural ultrasound is frequently used in combination. In the balloon-occlusion approach, a balloon is inflated across the PSA neck, and DUTI is performed simultaneously (Figure 8). The balloon isolates inflow into the PSA, promotes thrombosis, and minimizes the possibility of thrombin entering the peripheral circulation (Figure 9). In the stent graft technique, an angiogram is performed, and instead of a balloon, a stent graft is positioned across the PSA neck (Figures 10 and 11). After stent graft deployment, repeat arteriography is used to assess if there is residual flow into the PSA (Figures 12 and 13). If flow to the PSA persists, the balloon-occlusion method in combination with DUTI can eliminate any residual flow after stent graft deployment. Distal pulses should be evaluated before and after procedures to exclude nontarget thromboembolism. Endovascular treatment generally has lower complication rates than surgery, which can include PSA rupture, PSA recanalization, and thromboembolism (Saad et al, 2005).

Figure 2. The thrombin delivery setup comprising a thrombin reservoir syringe and a delivery syringe connected to a 3-way stopcock and a T-connector tubing. In this example, a 25-gauge needle is used.

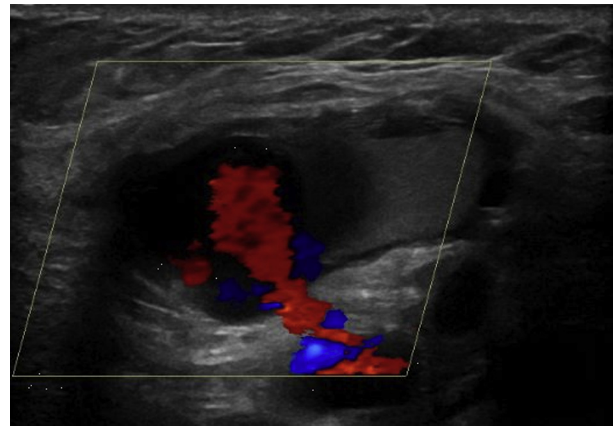

Figure 3. A Color Doppler image of the right groin revealing an active pseudoaneurysm (PSA) extending from the common femoral artery with a thin neck and a central area with blue and red colors representing active flow or the "ying-yang" sign. This PSA is partially thrombosed, which is seen to the right of the "ying-yang" sign and is represented by gray. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

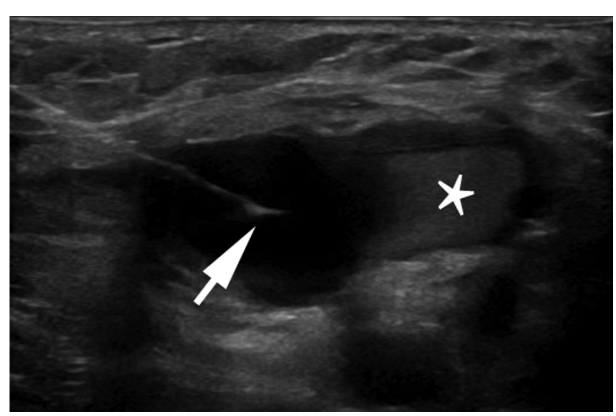

Figure 4. A grayscale ultrasound image with the needle (white arrow) positioned in the center of the active pseudoaneurysm (PSA). Once the needle is inserted, blood flow is confirmed with gentle aspiration before injection of thrombin. The "asterisk" demarcates the partially thrombosed portion of the PSA as seen in Figure 3.

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