Dilemmas in the Management of Pseudoaneurysms, Treatment Approaches, and Clinical Outcomes

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Abstract

A review was conducted of all patients who were investigated for pseudoaneurysms, including those who were treated with ultrasound guided percutaneous thrombin injection(s) – (UGTI) in the medical imaging department since 2014. Our institute’s electronic database was searched and data was extracted using the keywords “thrombin” and “pseudoaneurysm”. A total of 87 cases were identified. Out of these, we present a series of six interesting pseudoaneurysms cases, its associated management dilemmas, treatment approaches, and clinical outcomes. Key learning point for each case is discussed.

Keywords

Pseudoaneurysm, Ultrasound guided compression, Thrombin injection, Endovascular balloon occlusion, Related complications, Interventional radiology

Introduction

Pseudoaneurysms occur following a defect in the arterial vessel wall leading to leakage of blood into the surrounding soft tissue, bounded only by the tunica adventitia. The extra-vascular haematoma freely communicates with the intravascular space [1].

 Whilst iatrogenic-related pseudoaneurysms occur more commonly, other aetiologies include trauma, infection, malignancy, and vasculitis/inflammation [2]. We present six-interesting and note-worthy pseudoaneurysms cases that were treated in our department, the associated management predicaments, and discuss the key learning points for each.

Case 1

A 67-year-old male, clinically septic at day nine post-reversal of an end ileostomy. The procedure was complicated by the development of intra-abdominal collections, each measuring 31 x 152 x 158 mm, and 26 x 65 x 43 mm respectively which were identified on the subsequently performed CT abdomen (Figure 1). The patient had an intra-abdominal drainage catheter placed in the right upper quadrant to drain the collections. The drainage catheter was removed two weeks later.

Case 2

A 57-year-old female, sustained a traumatic left knee injury with a crowbar. The patient developed a tender swelling around the left knee which was...
Dilemmas in the Management of Pseudoaneurysms, Treatment Approaches, and Clinical Outcomes

Dulku and Vander Wal.

subsequently interrogated with ultrasound, CT angiogram, and MRI of the knee (Figure 2).

Case 3

A 62-year-old female, sustained a traumatic injury to the inflow brachial artery of her above elbow left brachio-basilic arterio-venous fistula (Figure 3) whilst being needled at haemodialysis.

Case 4

A 66-year-old female with a background of non-alcoholic steatohepatitis cirrhosis presented with large volume ascites. Given that the patient was symptomatic, she underwent an abdominal paracentesis (Figure 4) to drain the ascitic fluid. The patient developed intractable pain at the drainage site post-procedure.

Case 5

A 25-year-old male, sustained a traumatic glass injury to both upper limbs. The patient developed a painful and throbbing right axillary swelling following self-removal of a glass shard in the same location (Figure 5).

Case 6

A 61-year-old male who developed central chest pain, underwent percutaneous coronary intervention via right common femoral artery access which was complicated by the development of a painful right groin swelling (Figure 6).

Discussion

Pseudoaneurysms or false aneurysms occur as a result of arterial wall injury resulting in extravasation of blood into the surrounding soft tissue which is contained only by the tunica adventitia [1].

Pseudoaneurysm characterisation, localisation, and treatment approaches

All symptomatic pseudoaneurysms require treatment due to the high risk of rupture with incidences ranging from 2-80%, and mortality rates approaching 100%. There is a paradigm shift in the treatment of pseudoaneurysms moving...
Dilemmas in the Management of Pseudoaneurysms, Treatment Approaches, and Clinical Outcomes

Dulku and Vander Wal.

from surgical repair to minimally invasive procedures which include ultrasound-guided compression and/or -thrombin injection (UGTI), and endovascular management, due to its reduced rates in overall mortality and morbidity. Surgical repair is reserved for selected cases.

Pseudoaneurysm characterisation not only include the sac and neck sizes, but also the complexity (multi-lobulated/multi-compartmental), parent arterial supply, and location. Superficial...
A CT angiogram of the abdomen demonstrates a pseudoaneurysm which measures 13 x 10 x 13 mm with a narrow and long neck, approximately 7 mm in length, arising from the right CFA (Images A (axial), B (coronal), C (sagittal). The pseudoaneurysm communicates with a cluster of blood-filled sacs and was complicated by fistulisation to the right inferior epigastric vein (Images A and D – arrow). Contrast drainage is also identified in the right common femoral vein (Images A – arrow head). Manual compression of the pseudoaneurysm was performed and the follow-up ultrasound the following-day demonstrates complete thrombosis of the pseudoaneurysm (Image E).

The common femoral artery and is often iatrogenic-related, as this is the most common vascular access site for diagnostic and therapeutic interventional procedures [2]. The most frequently treated pseudoaneurysms via the percutaneous method, it is not only post-catheterisation pseudoaneurysms should be treated with UGTT [1]. For the treatment of all other pseudoaneurysms, it is then important to determine endoluminal accessibility. An algorithmic approach (Figure 7) towards direct percutaneous management can be considered as seen with case 1, when the pseudoaneurysm is deemed inaccessible via the preferred and widely used endovascular approach [1, 3].

When the decision is made to treat visceral pseudoaneurysms via the percutaneous method, it is not only crucial to determine the pseudoaneurysm characteristics, but also prudent to determine the anatomical blood supply of the parent vessel, the presence of anatomical variants, location of the pseudoaneurysm in relation to collateral vascular network particularly when involving the splenic artery (60%), hepatic arteries (20%), superior mesenteric artery (5.5%), coeliac trunk (4%), gastric and gastroepiploic arteries (4%), pancreaticoduodenal arteries (2%), gastroduodenal (1.5%), and inferior mesenteric arteries (1%). This can simply be determined with CT angiography. Absence of collateral pathways would be favourable for percutaneous approach [3, 4].

Peripheral pseudoaneurysms most frequently involve the common femoral artery and is often iatrogenic-related, as this is the most common vascular access site for diagnostic and therapeutic interventional procedures [2].

In contrary, pseudoaneurysms around the knee are often trauma-related as seen with case 2, but also known to occur as a complication of orthopaedics intervention [5], with <1% occurring following knee arthroscopy, and between 0.3-1.6% of total knee replacements [6]. The most frequently treated culprit vessel around the knee is the superior lateral genicular artery [7]. Endovascular approach remains the treatment of choice [5, 6], although percutaneous thrombin injection has also been reported [8].

**Thrombin injection, technique, contraindications, complications, and dosing protocols**

Thrombin injection consist of either bovine or human formulations. These usually come as dehydrated powder which is then reconstituted with sterile saline to form preparations in concentrations of 100 to 1,000 International Units (IU) per mL [9].

The technique is performed under sterile conditions, and following local anaesthesia, a 22- or 25-gauge needle is utilized to puncture the pseudoaneurysm sac, with its tip directed clear from the pseudoaneurysm neck [10]. When injecting a complex multi-lobular pseudoaneurysm, the lobe furthest from the neck is treated first [11].

Additional thrombin injection is ceased once no flow is identified in the pseudoaneurysm. Manual or ultrasound-guided compression of the pseudoaneurysm neck can also be applied to further aid thrombosis and also prevent reflux of thrombin. These maneuvers are aimed to avoid non-target embolization [11, 12].

Contraindications for thrombin injection include history of allergic reaction to thrombin, local infection, distal limb ischemia, large pseudoaneurysm (>5cm), wide (>1cm) and short or indefinable neck, direct adjacency of the pseudoaneurysm to vessels, and presence of concomitant arteriovenous fistula [11, 13, 14].

Complication rates of thrombin injection is recorded at 1-4% which comprise of thromboembolic phenomena including clot propagation, venous thrombosis, allergic reactions, pseudoaneurysm rupture, and recurrence [1, 3, 11].

Till date, there is no established optimal dosing protocol for thrombin injection. Successful thrombosis of pseudoaneurysms utilising low dose protocols, as low as 40 IU [12, 15] have been described. Slow-injection techniques have also shown equivocal success for pseudoaneurysm thrombosis when compared to bolus administration [16].
complications associated with the low dose protocol [12] and slow-injection techniques are also lower, with the incidence of silent microembolization phenomena appearing marginally higher with the bolus-technique [16].

We found the use of a small-syringe 1 ml enabled controlled-delivery of smaller aliquots of thrombin, and when injected intermittently over longer intervals, commencement of thrombosis can be clearly visualized without excess thrombin needing to be delivered, which in turn reduces the risk for clot propagation. Distal clot propagation can be managed with intravenous administration of heparin, thrombolysis with recombinant tissue plasminogen activator (r-tPA), and surgical thrombectomy as seen with case 2 [17].

**Haemodialysis-related pseudoaneurysms and treatment options**

The management of pseudoaneurysms arising from haemodialysis arterio-venous fistulas can be difficult and complex. Repeated punctures and adjuvant heparinization increase the risk of developing pseudoaneurysms in these patients. Although applying manual compression directly on either the pseudoaneurysm neck [18] or sac [19] can result in thrombosis of the pseudoaneurysms, these may not always be feasible, especially when the neck is short or indefinable, tortuosity of the AVF limbs, peculiar location of the pseudoaneurysm in relation to the anastomosis, and mass effect exerted by the pseudoaneurysm onto the adjacent AVF, all of which were seen with case 3. In this case, manual compression with view to preserve shunt flow would not be possible. In these high-risk pseudoaneurysms, balloon catheter-assisted UGTT technique is an invaluable treatment option offering protection to the AVF by occluding the pseudoaneurysm neck. This prevents reflux of the injected thrombin into the native parent artery [20–22]. Additionally, the transvenous approach also enabled us to treat stenotic segments of the draining venous limb and improve angiographic appearance post-thrombin injection in the same setting. Alternatively, if thrombin is contraindicated, prolonged balloon-occlusion can be attempted to achieve thrombosis of the pseudoaneurysm.

**Abdominal paracentesis-related pseudoaneurysms and current guidelines in the management of peri-procedural bleeding risks**

Even common and low risk procedures such as abdominal paracentesis can result in pseudoaneurysm formation. Two-thirds of pseudoaneurysms arise from the inferior epigastric artery which is more prone to injury when the procedure is performed without imaging guidance. Performing abdominal paracentesis under ultrasound guidance may reduce the likelihood of this complication from occurring. The most common procedure-related complication is ascitic fluid leakage. Although haemorrhage, infection, and bowel perforation are less common, these complications confer more serious implications with mortality rates approaching 50%. Haemorrhagic complications can be stratified into abdominal wall hematomas (52%), hemoperitoneum (41%), and pseudoaneurysms (7%), which are often associated with coagulopathy and/or thrombocytopenia, and a higher Child-Pugh score [23].

The current guidelines suggests that a pre-procedural laboratory threshold of a platelet count of >20 x 10^9/L and fibrinogen >100 mg/dL are required to perform low risk procedures such as abdominal paracentesis in patients with chronic liver disease, whilst transfusion can be considered if laboratory results are below the threshold values. International Normalized Ratio (INR) is not routinely performed unless there are other clinical indications to do so, and slow intravenous infusion of vitamin K, 10 mg is recommended if the INR >2.5 [24].

**Extremity pseudoaneurysms and combined treatment approaches**

Traumatic pseudoaneurysms involving the upper and lower limbs most commonly arise from the axillary-brachial (22%) and femoral-popliteal (16%) arteries [25]. Endovascular intervention with bare-metal stent or stent-graft placement can be utilized as first-line management options in the treatment of upper-limb arterial injuries involving the subclavian and axillary arteries [26]. Open surgical exploration and repair is often required in the setting of penetrating, or extensive blunt-traumatic injuries [25]. A combined surgical and endovascular intervention is an alternative approach to treatment as seen in case 5.

**Pseudoaneurysms and concomitant arterio-venous fistula**

The incidence of femoral puncture site-related pseudoaneurysms account for 1% following diagnostic, and up to 8% of therapeutic interventional procedures. The presence of a concomitant arterio-venous fistula is a contraindication for thrombin injection due to the concerns for venous thromboembolism [14]. However, the cautious use of UGTT has been reported in selected cases, with favourable outcomes identified in patients who were on oral anticoagulation, and with small AVFs which is determined by end-diastolic arterial-flow-velocities ≤25 cm/second. Combined treatment with manual compression can aid partially thrombosed complex multicompartmental pseudoaneurysms [27]. Given the benign natural course and outcome of small pseudoaneurysms and AVFs which often resolves spontaneously, a trial of watchful management [28], or prolonged compression either manually or under ultrasound-guidance can be offered as alternative treatment to UGTT or surgery. As with case 6, manual compression was sufficient to result in complete thrombosis of the pseudoaneurysm. When contemplating manual compression, it would be prudent to determine the patient’s anticoagulation status, complexity of the pseudoaneurysm including neck width and length, and the age of the pseudoaneurysm. Failure rates of this technique approaches 40% with 30% recurrence rates when patients have received
anti-coagulation. Therefore, to improve the procedural success, temporary discontinuation of anti-coagulation therapy prior to manual compression is critical [1].

Conclusion

In the management of pseudoaneurysms, apart from determining if endoluminal accessibility is possible, pseudoaneurysm characteristics, anatomical blood supply, and pseudoaneurysm location are crucial. Complications related to thrombin injection needs to be actively watched for and it is critical to recognise silent microembolisation phenomena which can have devastating outcomes. Balloon catheter-assisted UGTT technique is an invaluable treatment option that can be readily utilised concurrently particularly in the management of haemodialysis fistula-related pseudoaneurysms. Although the presence of a concomitant AVF is a contraindication for thrombin injection, combined manual compression with watchful management can aid thrombosis and should be considered in these cases.

References


