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Case Report *Vascular and Interventional Radiology*

Peripheral stent-graft for the management of an ulnar artery pseudoaneurysm

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ABSTRACT

Penetrating injury can cause pseudoaneurysm which can then affect nerve compression. Although rare, penetrating injuries leading to ulnar artery pseudoaneurysm (UAP) are implicated slightly more frequently than other upper extremity arterial segments. Manual compression, thrombin injections, and surgical reconstruction are typically chosen to effect repair. Conversely, peripheral stent-graft implantation has rarely been reported as an option to exclude upper extremity pseudoaneurysm. We describe a case of a 25-year-old male who was stabbed, presented with signs of ulnar nerve compression, and in whom UAP was instead discovered and treated by stent-graft deployment.

Keywords: Ulnar artery, Pseudoaneurysm, Stent-graft, Interventional radiology

INTRODUCTION

Pseudoaneurysm, or false aneurysm, is focal vascular tears contained by adventitia or an extraluminal fibrin-platelet wall. A tear in an arterial wall constitutes an extra-arterial hematoma, contained, and sometimes organized within a fibrous capsule around the damaged segment.[1] A true aneurysm is an outpouching of all three layers of the vessel wall.[2] True aneurysms typically result from hypertension and progressive atherosclerotic disease in the elderly, while pseudoaneurysms typically arise from infections, congenital artery defects, and trauma.[3] Trauma may be due to penetrating injuries including gunshots, stabbings, and iatrogenic etiologies (e.g., cardiac catheterization).[1]

Clinical presentations vary. Painful/pulsatile mass may be observed and not always immediately. Occasionally pulsatile mass presents after complete wound healing. Atypical Raynaud's syndrome has been reported.[1] Diagnosis is usually confirmed with color-flow duplex ultrasonography, or alternatively, the use of computed tomography angiography or magnetic resonance angiography.[1,4] Doppler signs include the whirling blood flow within the sac, also known as a "yin-yang sign" and a communicating neck between the sac and native artery with a "to and fro" waveform.[2,5]

Pseudoaneurysms most commonly arise from the aorta, femoral, and visceral arteries.[2] Upper extremity pseudoaneurysms, particularly involving the ulnar artery, comprise about 1% of cases.[2] Initial clinical suspicion is usually nerve injury and/or nerve compression. Ulnar artery

rupture may result in the upper extremity necrosis and loss of hand function.[6] We describe a case of ulnar artery pseudoaneurysm (UAP) which occurred secondary to a stab wound, and in which partial ulnar nerve transection was initially suspected. A stent-graft was deployed beyond his elbow. We are aware of only two other reported cases describing treatment of this injury by peripheral stent-grafting.

CASE REPORT

A 25-year-old male without pertinent medical history was brought to the emergency department (ED) due to a stab wound to the medial right forearm. Accompanying symptoms included a pins and needles sensation in his right finger and pinky. The wound was cleansed, the laceration was sewn, and a follow-up appointment was arranged at the hand surgery clinic.

He returned to the ED several days later and before his clinic appointment. At this time, he complained of progressive paresthesias with loss of sensation. A partial ulnar nerve tear was suspected. As a result, hand and vascular surgery consultations were obtained. The patient was scheduled to undergo wound exploration and nerve repair the following morning, but these providers requested arteriography before they embarked on the operation. Interventional radiology obliged by performing arteriography several hours before the scheduled operating room procedure.

Once on the angiography table, the patient stated that he preferred to leave his right arm abducted with his forearm crossing above his head. In fact, this facilitated the case because we did not need to rotate the angiography table. The right femoral puncture was utilized. A coaxial system was advanced to the ascending aorta, followed by the selection of the right subclavian, axillary, and brachial arteries, in that order. Arteriography revealed the pseudoaneurysm [Figures 1 and 2].

Following exchanges, the angle tipped catheter and stiff angled glide wire were utilized to cross beyond the pseudoaneurysm and enter the normal ulnar artery in the distal forearm. The wire was removed, and contrast was administered to confirm that our coaxial system remained intraluminal. Subsequently, a 100 μg bolus of nitroglycerine was promptly administered through the catheter, and the wire was readvanced. At this time, the attending plastic/hand and vascular surgeons were consulted and concurred that stent-grafting was a viable option.

The pseudoaneurysm existed more than three centimeters beyond the brachial artery bifurcation. Palmar arch, metacarpal, and digital arterial runoffs were supplied by both radial and ulnar arteries, and it was deemed, therefore, that the ulnar artery was expendable if it became occluded.

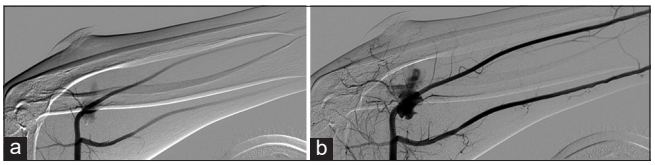

Figure 1: A 25-year-old male who presented with signs of ulnar nerve compression and in whom ulnar artery pseudoaneurysm (UAP) was instead discovered and treated by stent-graft deployment (a) Angiogram of traumatic UAP. (b) Simultaneous opacifications ulnar and radial arteries before ulnar artery selection and interventions.

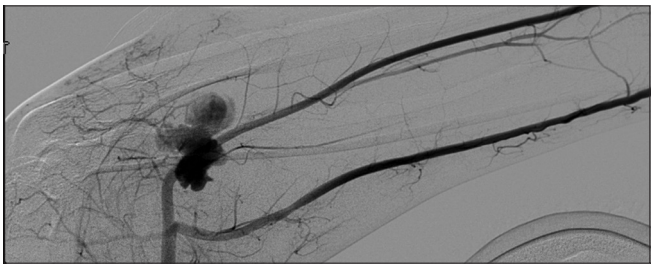

Figure 2: A 25-year-old male who presented with signs of ulnar nerve compression and in whom ulnar artery pseudoaneurysm was instead discovered and treated by stent-graft deployment. Angiogram showing simultaneous opacifications of ulnar and radial arteries before ulnar artery selection and interventions.

Furthermore, the vascular surgeon indicated that his treatment would likely involve purposeful ligation proximal to and beyond the UAP anyway.

An Amplatz wire was advanced, and the angle-tipped catheter was removed. An 8 mm self-expanding stent-graft (Gore -Viabahn) was deployed. A 6 mm balloon catheter was advanced, the wire was removed, and another 100 μg of nitroglycerine was administered. The wire was then readvanced. The balloon was then expanded and decompressed from peripheral to central to complete apposition of the stent-graft [Figure 3]. At this time, we chose not to heparinize the patient.

The balloon was then deflated, the balloon catheter was removed, and the diagnostic catheter was returned to the brachial artery in the peripheral right arm above elbow. Afterward, the wire was removed, another 100 μg of nitroglycerine bolus was given, and arteriography was repeated [Figure 4a and b].

The pseudoaneurysm was no longer demonstrated, and ulnar artery flow was maintained. Spasm was encountered however due to instrumentation. The radial artery flow remained rapid and the ulnar artery also remained patent in the right wrist. Opacification was seen through retrograde flow [Figure 5a-c].

Since stent-grafting for the UAP was deemed successful, surgery was canceled. The patient was discharged home

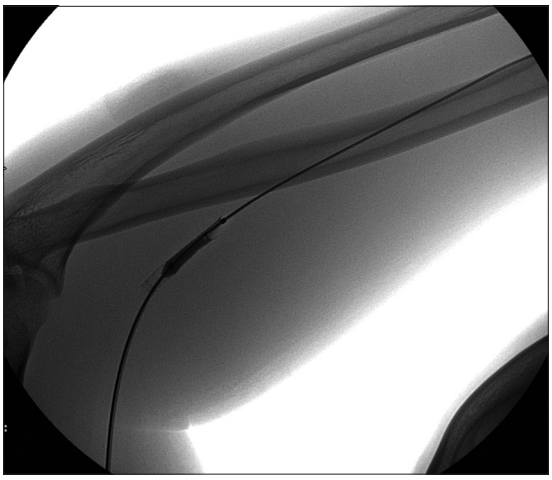

Figure 3: A 25-year-old male who presented with signs of ulnar nerve compression and in whom ulnar artery pseudoaneurysm was instead discovered and treated by stent-graft deployment. Stent-graft tacked down.

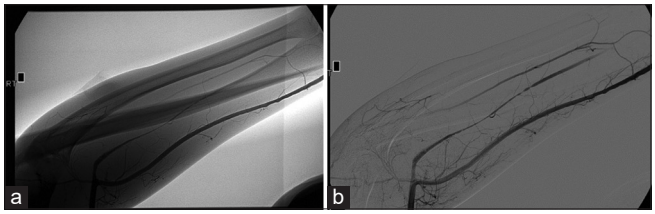

Figure 4: A 25-year-old male who presented with signs of ulnar nerve compression and in whom ulnar artery pseudoaneurysm was instead discovered and treated by stent-graft deployment. (a) Pseudoaneurysm excluded (b). UInar arterial patency maintained but with significant spasm.

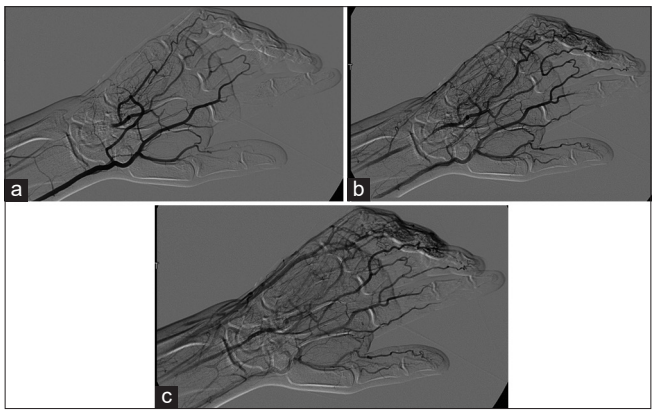

Figure 5: A 25-year-old male who presented with signs of ulnar nerve compression and in whom ulnar artery pseudoaneurysm was instead discovered and treated by stent-graft deployment. (a) Radial artery flow is rapid and entirely antegrade. (b and c) Retrograde flow into the ulnar artery at levels of the right wrist.

several days later. He was seen in the surgery clinic 1 week following discharge. Ulnar and radial artery pulses were palpable, although the ulnar pulse was weaker than radial. Antegrade ulnar artery flow was noted based on purposeful proximal and distal pressure application testing. Most importantly, the patient described complete relief of symptoms specifically the absence of paresthesias and complete return of sensation. He was lost to further follow-up which would have included a Doppler/duplex ultrasound.

DISCUSSION

The mainstay treatment for UAP is most often open surgical repair. Options vary depending on location, size, anatomy, and acuity. Authors advise against stent-grafting if UAP is too close to brachial artery bifurcation. In this case, the pseudoaneurysm was 4 cm beyond the brachial bifurcation, and the patient's right-hand segments were richly supplied by both radial and ulnar arteries. As a result, the ulnar artery was therefore expendable. His stab wound was relatively clean, which, further, supported stent-grafting as a feasible option.

Although several case reports have been reported discussing the presence of an UAP, to the best of our knowledge, only two other case reports exist in which a UAP was treated with a peripheral stent-graft. Moriarty *et al*. describe a case in which a 36-year-old office worker underwent routine blood testing from the proximal volar aspect of the left upper forearm and developed a UAP nearly 4 weeks later.[7] After a multidisciplinary discussion, a staged approach was favored: Stent-grafting followed by purposeful intraoperative ligation. In contrast to this case in which only a peripheral stent-graft was performed, a hybrid approach was chosen to ensure that the surgical field would be free of active bleeding.[7] Nough *et al*. report yet another case in which a 35-year-old man with a right forearm gunshot developed an ulnar and radial artery pseudoaneurysm and underwent endovascular stent-graftings.[3] A 6-month follow-up confirmed patency to both radial and ulnar arteries, exclusion of pseudoaneurysm, and no signs of ischemia.[3]

Open repair, ultrasound-guided thrombin injection (UGTI), and endovascular stent-graft have all been described. No algorithm exists describing the best treatment for UAP. Surgical repair with revascularization is the conventional approach, with high success rates and minimal morbidity.[1] Open surgery is particularly urgent and/or indicated in cases of significant contamination, significant erosion of the overlying skin, or signs and symptoms of compartment syndrome.[2] Surgical procedures for visceral pseudoaneurysms include arterial ligation with or without revascularization and/or removal of the more distal organ.[2] Open repair for UAP is associated with post-operative complications, ranging from 16% to 71%.[5] Such post-operative complications include bleeding, wound infections, wound dehiscence, seroma, neuropraxia, venous thrombosis, and arterial embolization.

Furthermore, open repair can lead to longer lengths of stay and delayed mobility.[5]

In 2004, Komorowska-Timek *et al*. described the successful use of thrombin in the treatment of a radial artery pseudoaneurysm and of ulnar artery aneurysm resulting from local trauma during attempted catheterization.[8] The main mechanism behind such treatment is the injection of thrombin into the chamber under ultrasound guidance resulting in thrombosis of the pseudoaneurysm within seconds.[4] Major advantages of UGTI include quick and easy intervention, and anticoagulation may continue.[4,5] Complications occur in about 1.3–2.2% of cases and include arterial embolization or thrombosis (<1%) and risk of anaphylaxis.[4,5]

Finally, endovascular stent-grafts, though infrequently performed, have been reported as a possible treatment for UAP. It is minimally invasive and allows access to the lesion without disruption of the neurovascular bundle.[7] Stent-grafts are ideally used if a pseudoaneurysm originates from an otherwise expendable arterial side branch.[9] When aneurysms are situated in larger or more vital segments such as the brachial artery, resection and bypass are commonly performed.[9] Compared with a stent-graft, open surgery involves dissection and clamping at greater distances proximal and distal to the pseudoaneurysm.[10] Although stent-graft is an ideal choice in certain scenarios, it is associated with a high infection rate, up to 17.1% in one case series.[10] Other drawbacks of covered stents are the risk of contrast-induced nephrotoxicity and radiation exposure.[5] Deployment across joints may kink the metal stent or occlusion to occur from bending the joint.[5]

Acute traumatic arterial injuries to peripheral arteries near the joint level are relatively infrequent. In a study conducted by Li *et al*., 16 patients were identified who presented with peripheral arterial injuries at the joint level, primarily attributed to pseudoaneurysm.[11] The study revealed that when coated stents are employed at the joint levels, there is a potential risk of acute ischemia due to the potential coverage of the origin of the branch artery. Utilizing bare-metal stents carries the possibility that these stents might act as passive barriers, thereby diminishing blood flow in the proximity of the injury site and offering an opportunity to avoid covering these origins.[11] Nonetheless, this approach is rarely employed due to the inherent risk of stent fracture resulting from the mechanical stresses imposed by the joint.[11] Despite the limited available data, the deployment of bare-metal stents at the joint could potentially be both safe and effective.

CONCLUSION

Ulnar artery pseudoaneurysm is a rare phenomenon that may present with signs of ulnar nerve compression or injury. No current algorithm exists. Location, size anatomy, and acuity must be considered. We advocate for the use of endovascular stent-grafting when pseudoaneurysm can be excluded in a relatively clean wound, and when distal perfusion is likely even if the stented segment becomes occluded.

Data availability

All information found in the St. Barnabas electronic medical records.

Ethical approval/clinical trial registration

Waived as per hospital policy.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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