Axillary Approach for PAOD Intervention: An Alternative Method

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Abstract

Since the traditional surgical approach involves surgical incision and general anesthesia and is potentially complicated by infection, the percutaneous method might be of benefit in selected groups. Access by the trans-axillary route is typically chosen when femoral or other access sites are limited due to severe atherosclerosis, calcification or tortuosity.

Keywords: axillary artery, peripheral artery obstructive disease

Introduction

Inspired by the growing need for structural heart intervention, the axillary approach is a feasible alternative solution for patients without adequate vascular access. Conventionally, cardiac vascular surgeons need to establish axillary access for tissue incision and vessel exposure. In the following case, the axillary approach was selected due to the high level of obstruction due to peripheral artery obstructive disease (PAOD). While we successfully extended the working length of the device and completed the treatment for peripheral artery disease, we encountered unexpected complications including failure of closure and neurological injuries. Despite clinical data and experience still being quite limited, axillary access remains an indispensable solution for selected patients.

Case report

A 63-year old man with hypertension reported intermittent claudication of his right lower limb for 1-2 years, associated with numbness and cold limbs. He came to our outpatient department, where physical examination showed weak peripheral pulsation in the posterior tibial as well as dorsalis pedis arteries. The ankle-brachial index (ABI) was 0.11/0.43 bilaterally. Under the impression of peripheral artery disease, he was admitted for intervention.

Pre-intervention computer tomography showed severe stenosis or even total occlusion in the right common iliac artery, external iliac artery, internal iliac artery, and bilateral femoral arteries

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(Figure 1).

For the first intervention, we punctured the left brachial artery and switched to a 6 Fr. Destination long sheath. Angiography showed total occlusion in the right common iliac artery (Figure 2). We tried a Terumo 0.35 wire with the assistance of a Seeker microcatheter, which, luckily, could be advanced to the profunda femoris artery. After pre-dilatation of the iliac artery by Admiral balloon 6.0 x 80 mm, inflated to 10-12 atm, we tried to wire the superficial femoral artery (SFA), and were successful, replacing it with a Roadrunner guidewire. The SFA was subsequently pre-dilated using a Mustang 6.0-120 mm, inflated to 6-16 atm. Then the iliac artery was scaffolded using Visipro 5-57, 8-57 and 8-37 in sequence. Post-dilatation was done by Mustang 8.0 x 40 mm, inflated to 12-16 atm. The final flow showed TIMI 3 without complications (Figure 3).

After this iliac artery intervention, the patient still reported claudication of the right calf. In order to relieve the clinical symptoms, a second intervention was performed, for which we successfully punctured the left axillary artery under echo-guidance (Figure 4), and inserted a 6 Fr. Destination long sheath. With the assistance of a seeker catheter, a 0.35" Terumo wire successfully tracked the SFA (Figure 5), followed by sequential ballooning with Admiral 5 x 120mm and 6 x 80mm, with the final angiographic result showing good antegrade flow (Figure 6). After completing the procedure, we tried to close the axillary puncture wound using a vascular closure device,

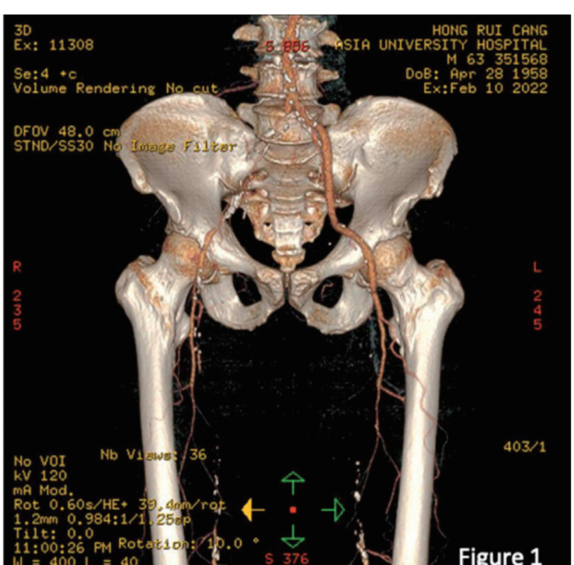


Figure 1. Computed tomography showing total occlusion in the right common iliac artery, external iliac artery, internal iliac artery, and bilateral femoral arteries.

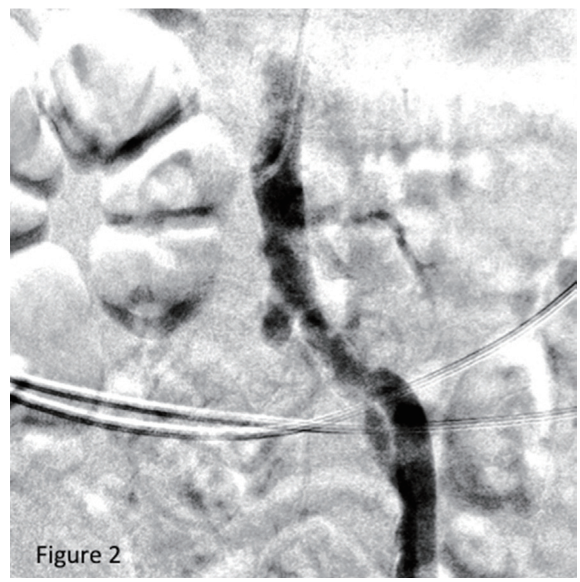


Figure 2. Total occlusion of the right iliac artery.

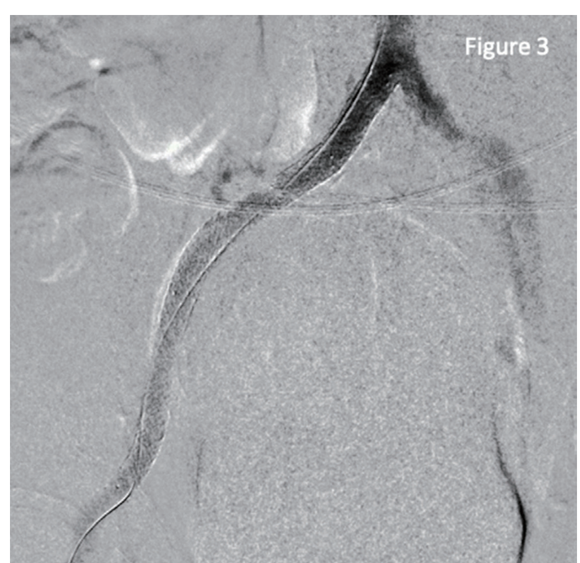


Figure 3. Final result of right iliac stenting.

but failed, leading to compromised hemodynamic status. Fluid supply and inotropic agent were administered immediately. We also delivered a Mustang 8 x 40 mm balloon to the puncture site of the axillary artery via the right femoral artery and inflated it to 10 atm for hemostasis (Figures 7 & 8). After repeated attempts at hemostasis through inflation of the balloon, no more vascular leakage was noted (Figure 9). A new blood exam revealed lowered hemoglobin (Hb) level, which was corrected after blood transfusion. The patient was transferred to a normal ward on the third day after his admission.

Unfortunately, he reported left arm numbness and weakness at the out-patient department, and physical examination revealed left shoulder muscle power grade 3 at the C4-5 dermatome, and brachial plexus injury was highly suspected. Left brachial plexopathy was diagnosed by a neurologist, and a rehabilitation program was arranged. Luckily, after the 6-month rehabilitation program, the left arm weakness subsided without limitation of movement.

Discussion

Conventionally, the common femoral artery is the most common access site, not only for cardiac intervention but also for endovascular procedures. The safety of femoral artery puncture has improved in recent years, due to the maturing of the technique and the development of modern closure devices. In addition, given the flourishing

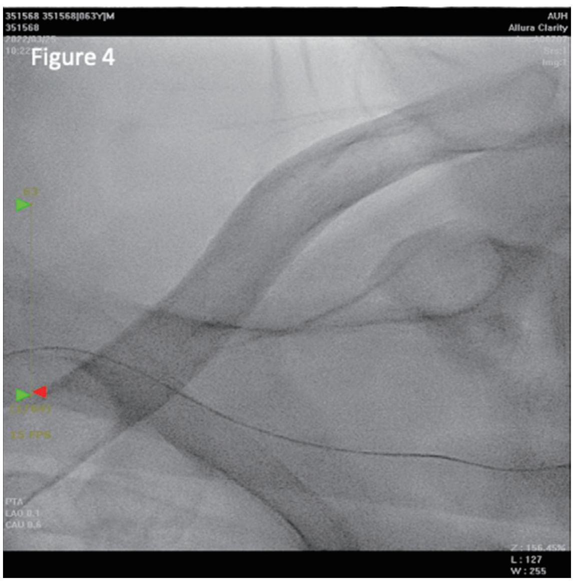


Figure 4. Left axillary artery puncture.

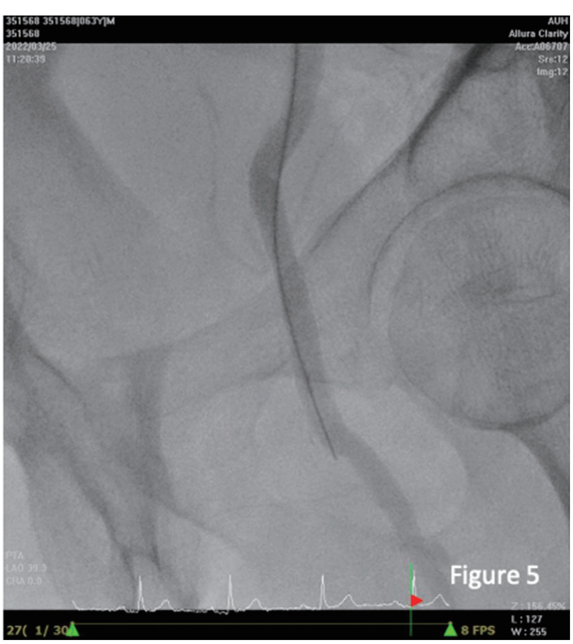
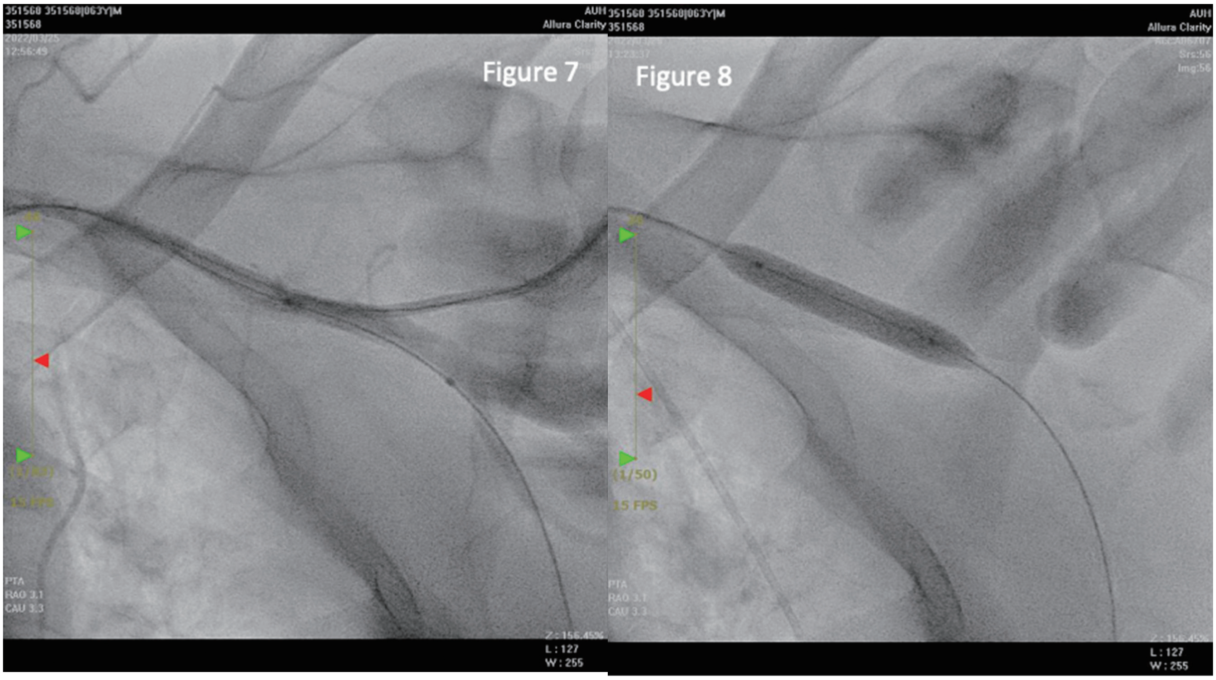
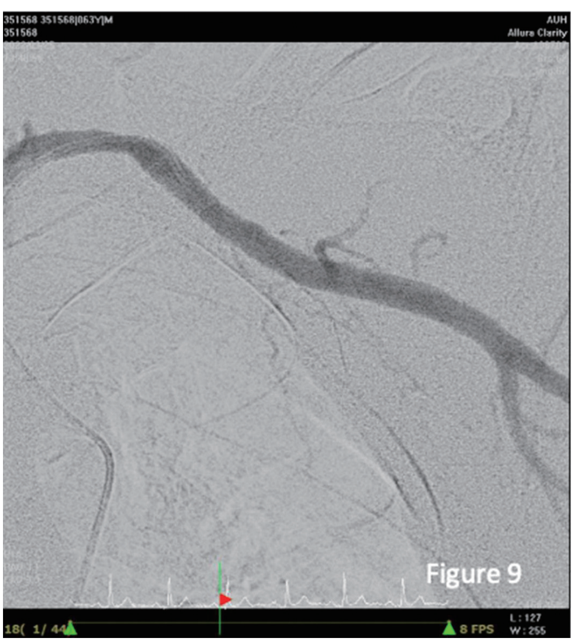


Figure 5. Total occlusion of the left femoral artery.

Figure 6. Final result of the SAF intervention.



Figures 7 & 8. Hemostasis of the puncture site by ballooning.



Figures 9. Angiogram after successful hemostasis.

of structural heart intervention (e.g. TAVI),[1,2] or mechanical circulatory support (e.g. Impella), the need for large-bore access is growing in the contemporary cath lab. However, the percentage of difficult femoral approaches is around 13-20%, which includes patients with prior surgical interventions, severe aortoiliac and/or iliofemoral atherosclerotic disease, vascular tortuosity or vascular calcification. In these circumstances, axillary artery access is a reasonable alternative.[3,4]

The diameter of the axillary artery ranges from 5 to 8 mm, but is typically around 6-7 mm.[5] This corresponds to a relative French size of 15 to 24. By contrast, the diameter of the common femoral artery is typically around 8-9 mm.[6] Compared to the femoral artery, the axillary artery is infrequently affected by atherosclerotic disease (2%) with unclear pathophysiology.[5]

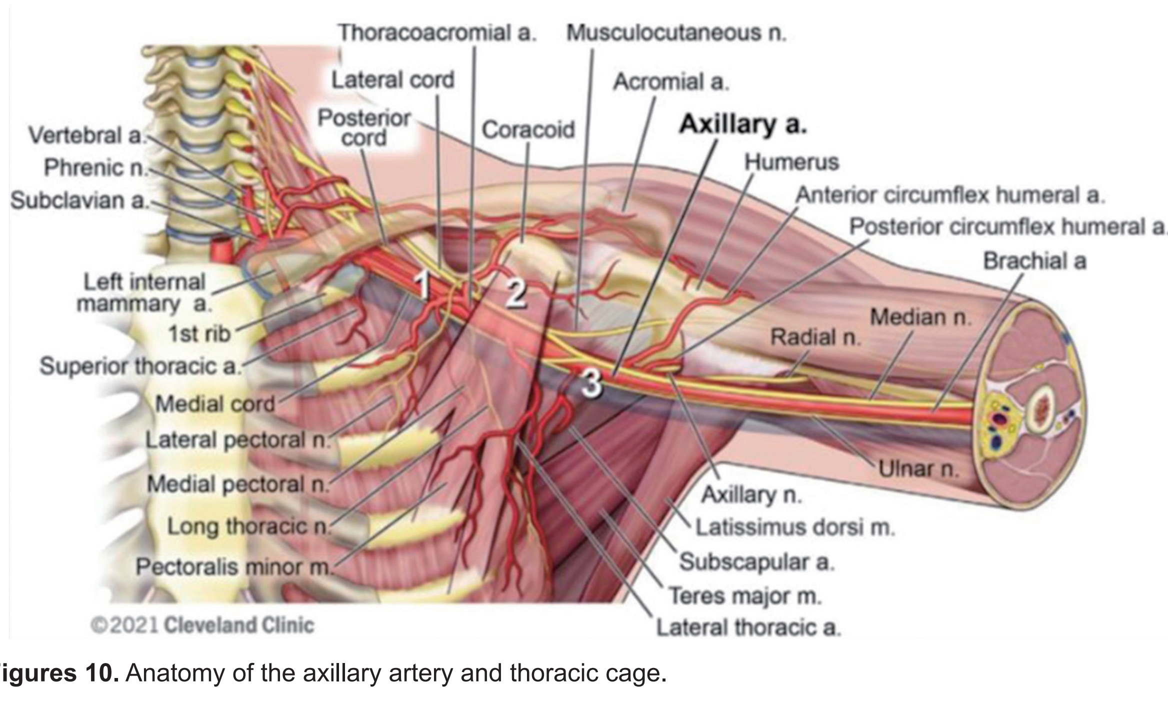
Traditionally, axillary arterial access is obtained by open surgical exposure, which allows for direct puncture, primary arterial repair/hemostasis, or placement of a sidearm conduit. Nevertheless, as the minimally invasive method, percutaneous axillary arterial access has become increasingly common, having evolved through lessons learned from experience with percutaneous access.[7] Advantages of percutaneous access include avoidance of a surgical incision, general anesthesia, and conduit graft infection.

In patients with cardiogenic shock, the axillary artery is also an ideal route for relatively long-term placement of mechanical circulatory support. Compared to femoral access, axillary access not only reduces the risk of infection but also allows patients to ambulate, thereby enhancing their quality of life and maximizing the benefits of rehabilitation.

To understand the axillary artery approach, we have to first grasp the anatomy: the axillary artery derives from the subclavian artery which is mostly within the intrathoracic space and supplies significant branches, including the vertebral artery, the internal mammary artery, the thyrocervical trunk, the costo-cervical trunk, and the dorsal scapular artery. The subclavian artery is intimately related to the brachial plexus, and given its anatomy, injury to the subclavian artery may result in intrathoracic bleeding or compressive neck hematoma.[8] After reviewing our case, we concluded that, owing to lack of experience, the puncture site may have been too close to the subclavian artery, resulting in nerve injury. In addition, improper puncture site location may have also contributed to the failure of the closure device.

Beyond the lateral chest wall border, the subclavian artery continues as the axillary artery, now in the extra-thoracic space (Figure 10). This distinction is important because the extra-thoracic location limits the risks of puncture-related pneumothorax and hemothorax. The axillary artery divides into 3 segments defined by the pectoralis minor muscle. The first segment is medial to the pectoralis minor and has a single branch, the superior thoracic artery. The second segment has 2 branches, the thoraco-acromial and lateral thoracic arteries. Lateral to the pectoralis minor, the third segment is the origin of 3 branches, the subscapular, posterior humeral circumflex, and anterior humeral circumflex arteries. The third segment ends at the head of the humerus and continues as the brachial artery.

Based on experts' consensus,[9] the second segment is ideally the preferred location for percutaneous puncture, due to its distance from the chest cavity (which reduces the risk of accidental intrathoracic puncture and allows for bailout if open surgical repair becomes necessary), absence



Figures 10. Anatomy of the axillary artery and thoracic cage.

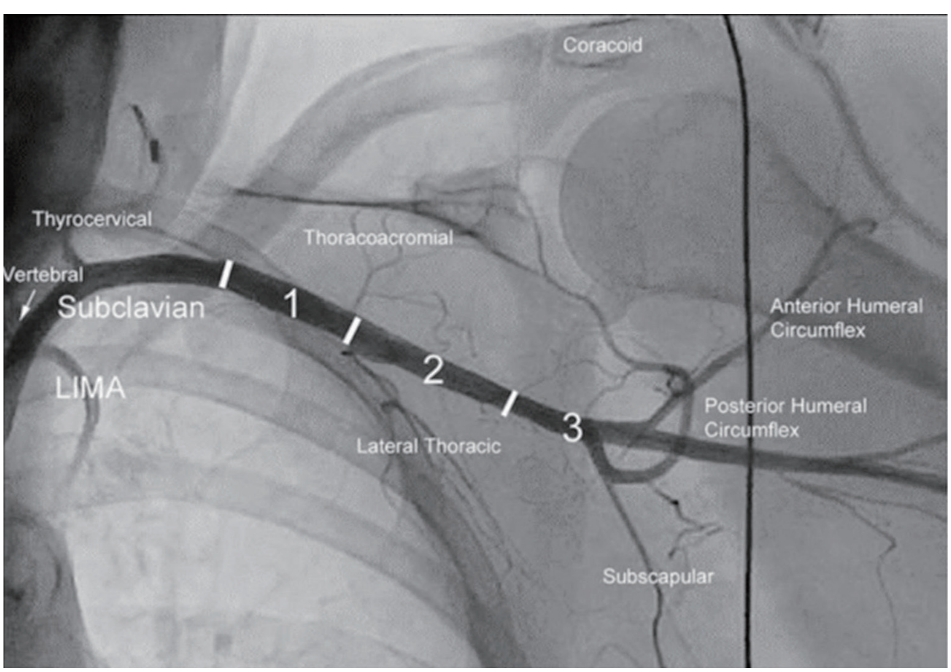
of critical branches, potential compressibility against the chest wall, and decreased risk of brachial plexus injuries. Covered stent placement and deployment of a closure device are similarly safer at this location. Patients with pacemaker/defibrillator at the anterior chest wall may need a more lateral puncture site.

Absolute contraindications to trans-axillary access include prior vascular procedures or surgical repairs, such as prior covered stent placement. Relative contraindications include vessel calcification, stenosis, tortuosity, aneurysmal dilatation, or prior dissection. Of course, the presence of a left sided pacemaker or defibrillator may confine access to the second segment of the axillary artery. Therefore, imaging study such as by computed tomography angiogram, axillary angiography (Figure 11) or peri-procedural ultrasound are very useful for decision making. Patients taking anticoagulants are definitely at increased risk of bleeding complications. The clavicle, second rib, and humeral head serve as useful bony fluoroscopic landmarks for the first, second and third segments.

While axillary access has the benefits mentioned above, the axillary artery is also overall more fragile in nature than the femoral artery, making it theoretically more prone to complications during instrumentation, although the relevant clinical data on this is quite limited.[3]

The potential complications include bleeding, pseudoaneurysm[7] and neurological injury. The Axillary Access Registry to Monitor Safety (ARMS), which included 102 consecutive patients who underwent trans-axillary access for mechanical hemodynamic support across 10 U.S. sites, reported a 15.7% (16/102) rate of procedural complications and 10% rate of access site bleeding/hematoma.[4] Similar to other intervention procedures, complications also include thrombus, vessel dissection, extremities ischemia, and stroke.

Therefore, the best practice involves a multidisciplinary team, multimodality imaging including CT and ultrasound, access at the second axillary segment, and expertise in large-bore dry-closure and hemostasis. As experience and knowledge accumulate, the procedures can be optimized.



Figures 11. Angiographic anatomy of the axillary artery.

Conclusion

With the increase in the elderly population, we may frequently face challenging scenarios where femoral access is limited. In such cases the axillary approach is a feasible alternative solution for large-bore TAVR, EVAR, and MCS procedures. Best practices for trans-axillary procedures include the involvement of a multidisciplinary team, multimodality imaging (including CT and ultrasound), access at the second axillary segment, and expertise in large-bore closure and hemostasis. Since the technique is not yet widely used, it will take time to mature, just like other interventional methods we have already become familiar with.

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