Achieving Hemostasis After Tibiopedal Access

The most effective closure methods after utilizing tibiopedal access in endovascular procedures.

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Utilizing the tibiopedal (TP) area for alternative access during endovascular procedures has recently become more common. Achieving hemostasis at the TP junction is usually straightforward, but difficult situations may arise, depending on the exact location of the access. Our approach to access and close the TP area that has proven to be the most successful is an algorithmic method: always attempt access first with the easiest and safest vessel to enter and exit; only use the most complex and least safe access site as a last resort.

TIBIAL ANATOMY

Figure 1 shows the normal anatomy of the TP arterial runoff. On angiography, it seems that gaining access and achieving closure in these arteries would be reasonably feasible. However, there are multiple neighboring structures in the surrounding anatomy, including the tibial veins and nerves. The combination of the vessels and the tissue that holds them together is referred to as the *tibial bundle.*

Figure 2 shows the tibial bundle. Note the proximity of the tibial vein to the tibial artery. This is a feature that is very important during the two major steps of access and closure.

Figure 3 shows the tibial arteries and tibial veins in situ; this image demonstrates why caution is necessary when entering and exiting the arteries, due to their close proximity to the veins. This proximity is a contributing factor to the development of one of the most common and silent complications of TP access: an arteriovenous (AV) fistula. Per the authors' experience, AV fistulas are more common when access is achieved using fluoroscopy or a "blind" stick. Fortunately, most are not clinically significant. With this in mind, the need for an algorithmic approach to tibial access and closure becomes more evident.

TIBIAL ACCESS ZONES

Figure 4 demonstrates the different tibial access zones. The first step is to break down the access sites into zones

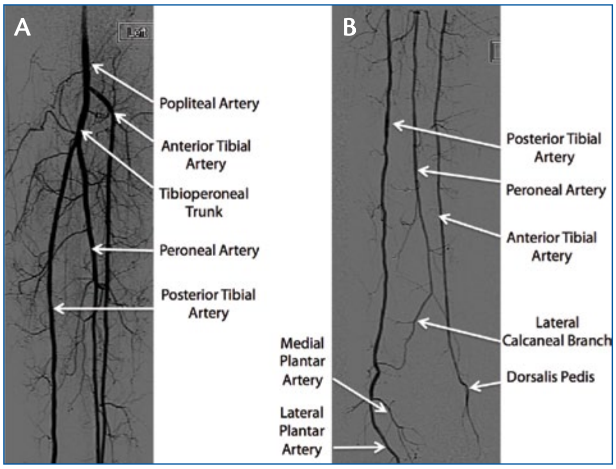

Figure 1. Normal anatomy of the proximal to midtibial arterial runoff (A). Normal anatomy of the mid-to-distal tibial arterial runoff (B).

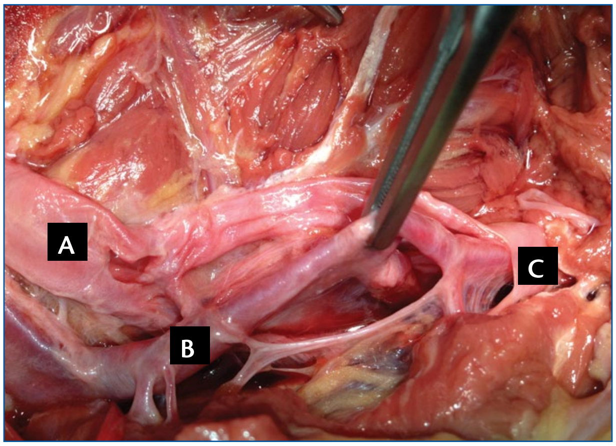

Figure 2. The tibial bundle. The tibial vein after it was dissected away from the connecting tissue that held it close to the artery (A). The tibial artery after it was dissected away from the vein (B). The tissue that bundles the tibial veins and artery (C).

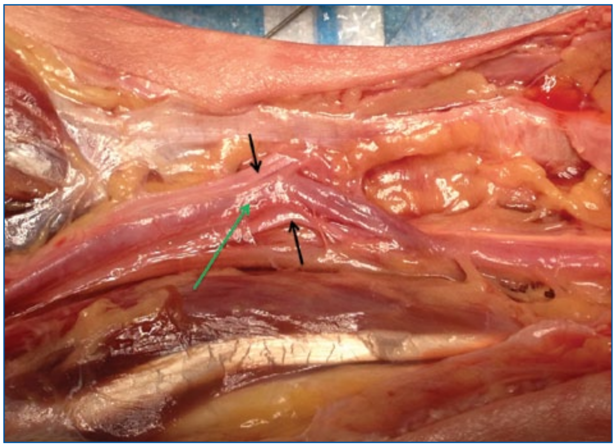

Figure 3. The tibial veins surrounding the tibial arteries. The black arrows identify the tibial veins; the green arrow identifies the tibial artery.

one, two, and three. Zone one is the safest and easiest zone in which to achieve access. Zone three is the least commonly used and least safe; it should only be used as a last resort. In zone one, the tibial and pedal arteries are superficial, so one can easily enter and exit with a very low chance of complication. There are no major compartments in zone one, and therefore, the likelihood of developing compartment syndrome is low. As access attempts move toward the distal foot, there is a higher chance of compartment syndrome, and more attention should be given in this area. Periarterial TP veins are less problematic if extravascular ultrasound (EVUS) is used because operators can clearly see and differentiate the artery from the veins (Figure 5).

Figure 6 shows common alternative access points in patients with advanced lower extremity peripheral arterial disease (PAD) and/or critical limb ischemia (CLI). Figure 7 shows a cadaveric model of target tibial arteries available for potential access: anterior tibial artery, tibioperoneal trunk, peroneal artery, and posterior tibial artery.

TYPES OF TP ACCESS AND DIFFERENT APPROACHES TO HEMOSTASIS

Historically, hemostasis after arterial access has been achieved by the following methods:

1. Manual compression, which should continue to be an important part of our daily practice.
2. External compression with tibial hemostasis closure devices or blood pressure cuffs, which can be used in conjunction with manual compression.
3. Intra-arterial hemostasis via balloon inflation at the access site.

Tibial arteries may require different types of compression to achieve hemostasis than other arteries.

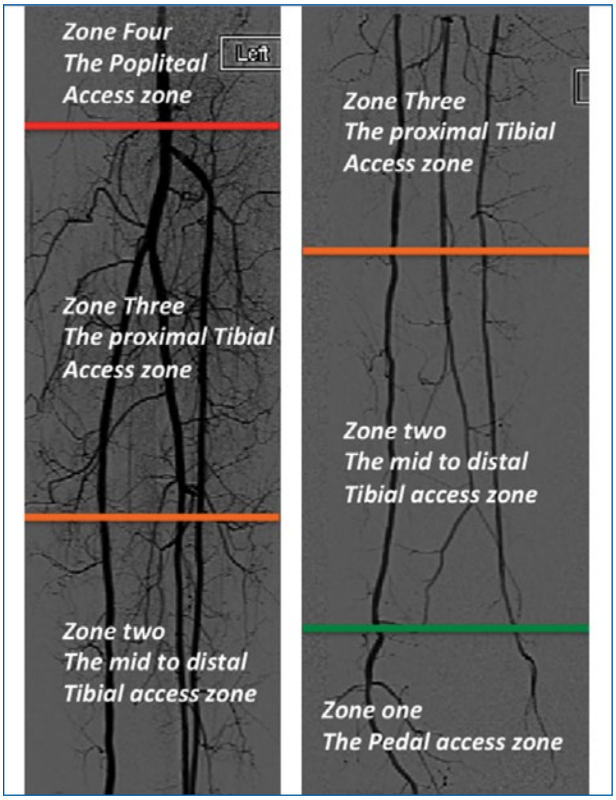

Figure 4. The different tibial access zones.

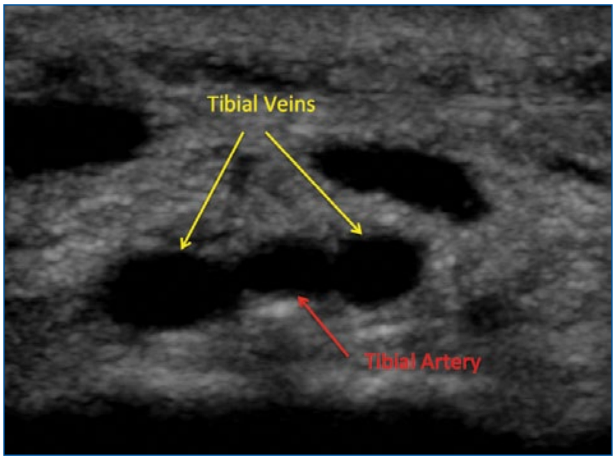

Figure 5. An example of the value of EVUS for imaging the posterior tibial artery (PTA) and its surrounding posterior tibial veins. EVUS aids the operator in directing the access needle into the artery and away from the veins and other neighboring structures.

Manual and External Compression

Manual compression in the infrapopliteal arteries should be used in a differentiated fashion, depending on the location of the arteriotomy after sheath removal.

Sheath removal and manual compression for hemostasis

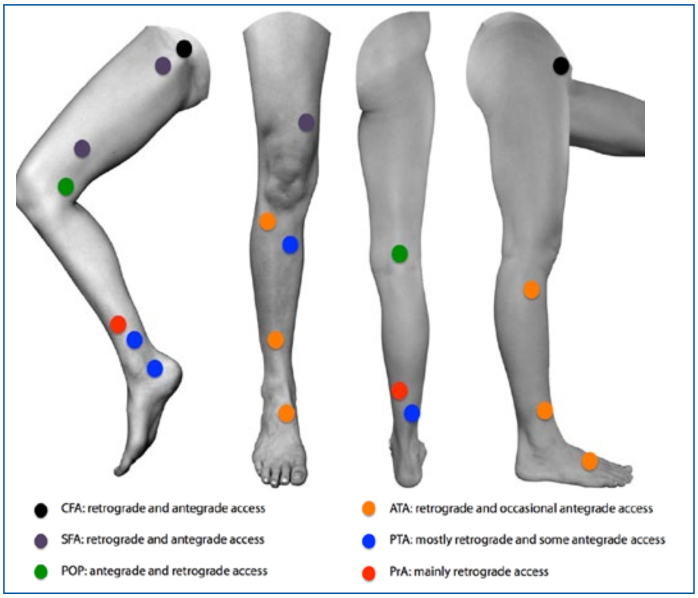

Figure 6. Common alternative access points in patients with advanced lower extremity PAD and/or CLI.

is difficult in the proximal tibial arteries due to the location of the tibial arteries deep in the calf muscles, as shown in Figure 8. Hemostasis in this location is better achieved by either mechanical external compression with devices such as blood pressure cuffs or use of the Boa hemostasis device (Lakeshore Medical, Grand Rapids, MI). The time to achieve hemostasis varies with the sheath size removed and the patient's activated clotting time.

Sheath removal in the midtibial arteries is better managed with manual compression because of the more superficial location of the tibial arteries. External and internal hemostasis methods, as previously described, are also very effective.

In the distal tibial arteries, all tibial hemostasis methods are equally effective due to the proximity of the tibial arteries to the skin, as shown in Figure 9.

The most effective method is focal compression force. The Boa tibial compression device is specifically built for tibial hemostasis. It achieves hemostasis by applying focal compression force against the target tibial artery without affecting the rest of the tibial arterial flow. If such a device is not available, consider using 4- X 4-inch gauze with any radial hemostasis device. The folded gauze helps direct and control the compression force to the target artery.

Figure 10 demonstrates the unique features of the Boa tibial hemostasis closure device and various stages of its function after a retrograde tibial access for peripheral intervention. The focal force ridges, which make this device unique and effective, allow the operator to apply selective and directional focal force compression. The ability to target a tibial artery without affecting the neighboring arteries is advantageous.

Key Points and Pitfalls for External Compression

A closer look at calcified tibial arteries with macropathology, as shown in Figure 11, gives great insight on their complexity. These arteries not only collect calcium but also start to create ridges and layers of calcium that line the arterial wall. It is important to understand this pathology as preparations are made for access and closure. In severely calcified tibial arteries, external tibial compression poses a challenge due to the lower compressibility of the calcified tibial arterial wall. Figure 12 shows common tibial arterial calcification in patients with CLI and end-stage renal disease. These types of arteries are known to have severe deep arterial wall calcification. These calcified vessels are more prone to "fracture," as also

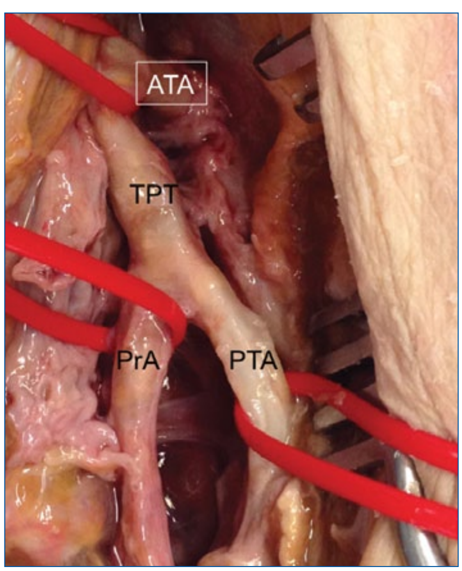

Figure 7. Possible target tibial arteries available for access: anterior tibial artery (ATA), tibioperoneal trunk (TPT), peroneal artery (PrA), and PTA.

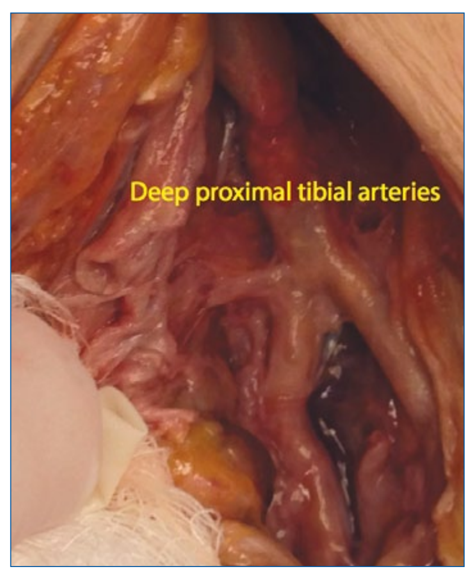

Figure 8. The depth of the deep proximal tibial arteries in situ.

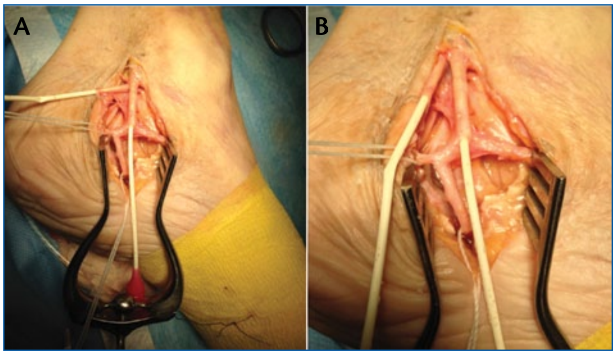

Figure 9. The arterial sheath in the PTA (A). Magnified view of the sheath in the PTA (B). Note the close proximity between the artery and the skin.

Figure 10. Angiographic image of the Boa tibial device causing indentation in the skin as it maintains hemostasis in the PTA access site and balloon angioplasty of the peroneal artery demonstrating focal force compression of the target posterior tibial artery without affecting the flow in the peroneal artery (A). Example of one Boa tibial device in use at the peroneal access site and one Boa tibial device released after hemostasis of the target tibial artery is achieved (B). Close-up of the Boa tibial device with the arrow identifying the unique focal force ridges (C).

shown in Figure 12. This pathology causes these vessels to become difficult to compress externally.

The obese patient will also benefit from intra-arterial tibial hemostasis due to the distance between the entry access

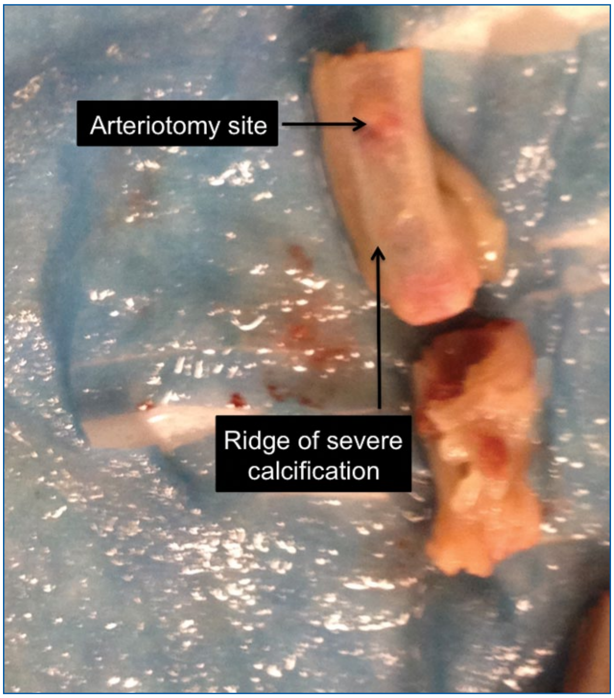

Figure 11. Dissected tibial artery from a patient with end-stage renal disease, demonstrating ridges of severe calcification in the wall of the vessel. Note the arteriotomy site of a 4-F sheath.

point and the tibial artery. As illustrated in Figure 13, notice the white arrow showing this distance. There are multiple structures between the skin and the artery that absorb the majority of the external compression force. External compression can still be successfully performed but will require much higher pressure. Intra-arterial balloon hemostasis is an excellent option for this type of patient.

Intra-Arterial Tibial Hemostasis

Another method for hemostasis in the proximal tibial arteries is internal hemostasis performed by inflating a balloon at the site of the sheath removed. Intra-arterial hemostasis is a valuable technique because it can be used in difficult cases including proximal tibial access, obese patients, and severely calcified tibial arteries. Intra-arterial hemostasis requires a secondary access and is usually performed by reversal to an antegrade common femoral artery (CFA) access or contralateral retrograde CFA access (Figure 14A). A wire is advanced across and distal to the tibial access point. Next, a low-profile balloon is advanced, preferably one that is 0.5 mm smaller than the arterial lumen. Once the balloon is across the access site, the retrograde tibial sheath is removed, and the antegrade balloon is inflated (Figure 14B). This requires 2 to 5 minutes of inflation depending on sheath size and the level of anticoagulation.

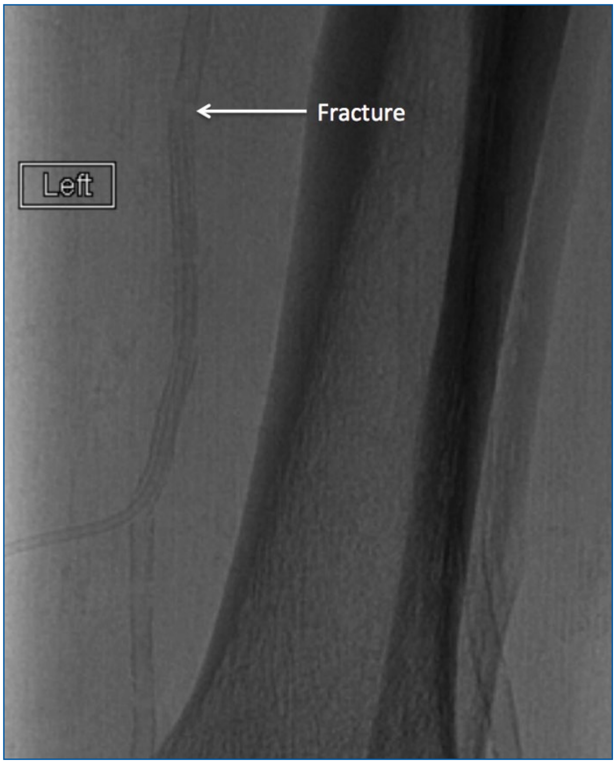

Figure 12. Example of a fracture in a calcified tibial artery.

Figure 13. The white arrow reflects the distance between the needle access point in the skin and the tibial artery.

To evaluate the success of hemostasis, the balloon is retracted back to the popliteal artery while the guidewire is left across the access site. Angiography is performed, and late phase fluoroscopy is performed until the tibial artery completely deopacifies to observe for any delayed extravasation.

CONCLUSION

Tibial arterial access and closure is being increasingly used for lower extremity interventions. Currently, the three most common methods to achieve hemostasis in the tibial arteries are external manual compression, external mechanical compression, and intra-arterial balloon-assisted hemostasis. Tibial arterial access and closure is a feasible and viable option for patients with CLI and should be mastered by those who are delivering endovascular CLI therapy. ■

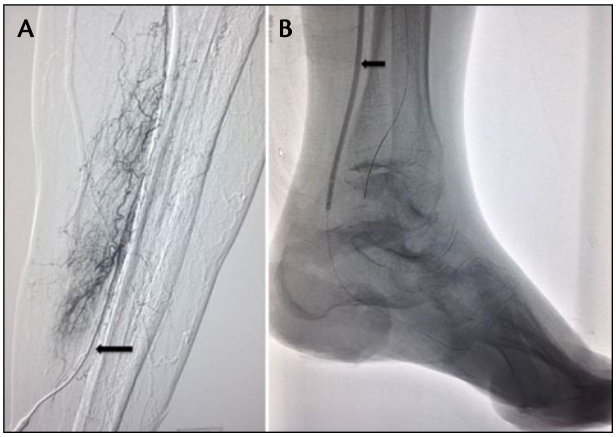

Figure 14. Retrograde PTA tibial access (A). PTA access site being treated with intra-arterial balloon hemostasis (B).

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