Endovascular retrieval of an entrapped balloon in a tibial artery

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ABSTRACT

Balloon entrapment is a rare complication of angioplasty in calcified or recalcitrant lesions. A 65-year-old man with chronic limb-threatening ischemia underwent balloon angioplasty of his heavily calcified tibial arteries with a low-profile, tapered, compliant balloon. The balloon became entrapped within the posterior tibial artery and required multiple endovascular maneuvers to deflate and separate the balloon from the calcified arterial wall. This case report describes several adjunctive techniques for retrieval of an entrapped balloon in small, calcified arteries before consideration of surgical removal. These techniques allow for minimally invasive retrieval and continuation of endovascular treatment thereafter. (J Vasc Surg Cases Innov Tech 2024;10:101459.)

Keywords: Arterial calcification; Balloon entrapment; Parallel ballooning; Snare; Tibial angioplasty

With the advancement of endovascular treatment modalities, more complex lesions are being treated percutaneously. Device entrapment is a serious endovascular complication and has been reported in coronary interventions and dialysis access procedures.[1-14] Although both surgical and endovascular treatments of such complications have been described in the literature, successful endovascular management of balloon entrapment in a tibial artery has been underreported. We describe a case of successful endovascular retrieval of an entrapped balloon in a heavily calcified tibial artery.

CASE REPORT

A 65-year-old man with diabetes, stage 3 chronic kidney disease, and hyperlipidemia presented with a wet gangrenous second toe, a superficial wound of his first toe, and erythema extending over the dorsum of the foot (Fig 1, *A and B*). The patient had a palpable posterior tibial artery (PTA) pulse, a triphasic PTA signal, a monophasic dorsalis pedis (DP) signal, an ankle brachial index of 0.83, a toe brachial index of 0.3, and toe pressures >30 mm Hg (Fig 1, *C*). He was admitted to the vascular surgery service, administered intravenous antibiotics, and underwent urgent debridement of the first toe wound and amputation of the second toe for infection source control. There was robust forward bleeding from the wound bed. The patient received intravenous antibiotics until resolution of the forefoot erythema on postoperative day 2. We offered the patient endovascular revascularization of his anterior tibial artery disease to optimize flow to the wound bed. However, after a full discussion of the risks and benefits, he chose to follow-up with weekly visits at the wound care center to see if the wound would heal without revascularization. The patient was discharged with oral antibiotics and ongoing care at the wound care center with his vascular surgeon. Our Advanced Wound Care Center is run by a multidisciplinary team of vascular and plastic surgeons. Patients with complex cases with substantial limb threat are reviewed by additional specialists, including orthopedic surgery, endocrinology, infectious disease, prosthetics and orthotics, radiology, palliative care, and social work.[15,16] During follow-up, the wound edges had ischemic changes (Fig 1, *D*) and required operative debridement on postoperative days 16 and 22. After the last debridement, the patient was admitted for prehydration, and a computed tomography angiogram was obtained, which showed heavily calcified and diseased tibial arteries. Based on these findings and the stalled wound healing, the patient agreed to undergo lower extremity angiography with possible intervention. The following day, a right lower extremity angiogram was performed, which showed a patent femoropopliteal segment, proximal occlusion of the anterior tibial artery with no distal reconstitution, occlusion of the mid-peroneal artery with distal reconstitution, and a diffusely diseased PTA with in-line flow into the medial plantar artery (Fig 2, *A and B*). The patient was heparinized and redosed appropriately to maintain an anticoagulation time >250 seconds throughout the procedure. At this point, the contralateral femoral access was upsized to a 6F by 90-cm sheath. No adjunctive maneuvers were needed to advance the sheath over the aortic bifurcation and into the superficial femoral artery.

The peroneal artery was selected while taking care not to catheterize the PTA. The peroneal artery lesion was crossed with an 0.014-in. Glide Advantage wire (Terumo Medical) and an 0.018-in. CXI catheter (Cook Medical), and angioplasty was performed with 1.5- to 2-mm and 2- to 2.5-mm Nanocross balloons (Medtronic; Fig 2, *C*). Care was taken to ensure the balloons were solely deployed in the peroneal artery and spared the

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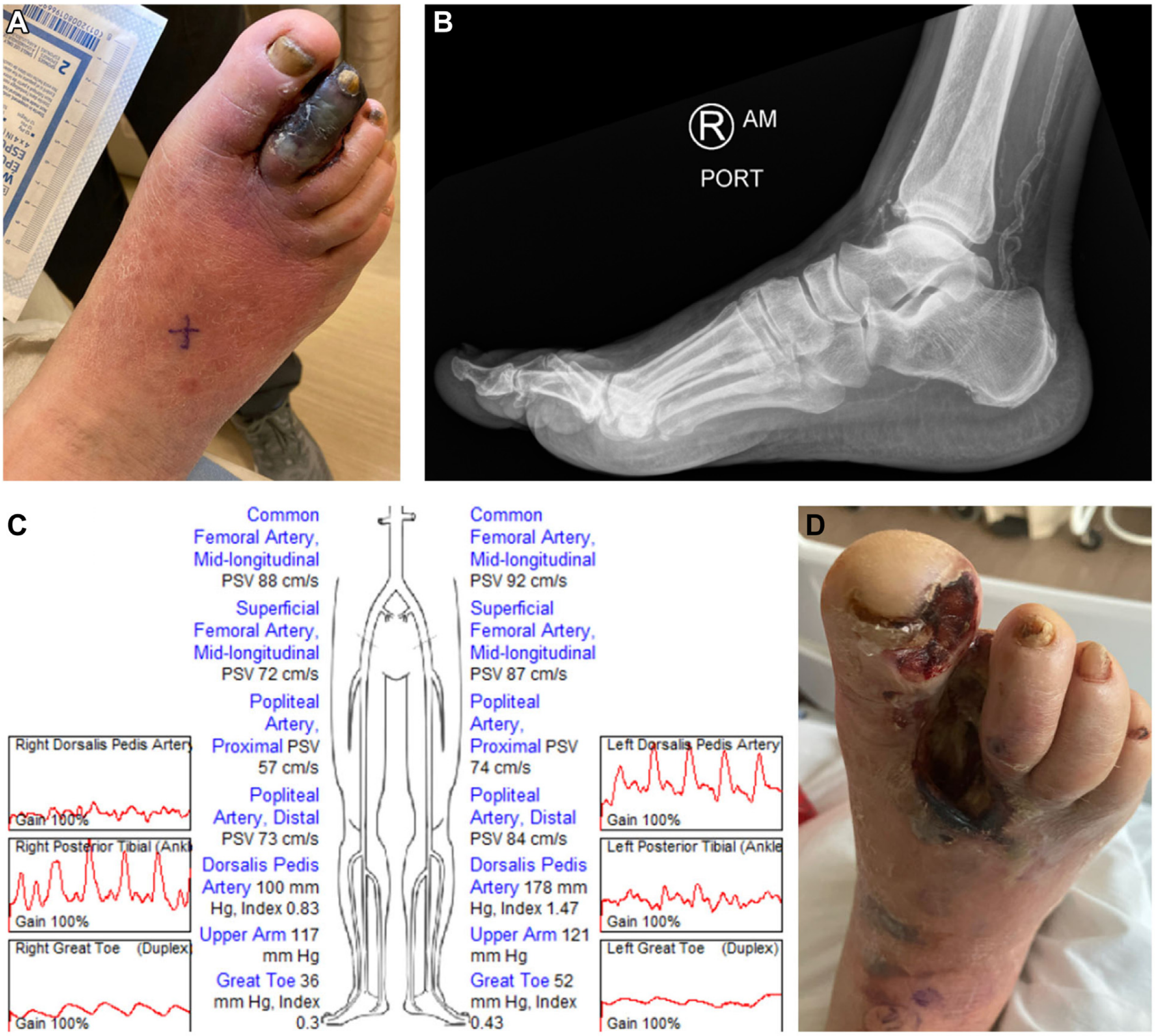

Fig 1. A, A 65-year-old man presented with a wet, infected diabetic ulcer of the second toe with erythema extending over the dorsum of the foot. **B,** Radiography revealed the patient had heavily calcified tibial and pedal arteries. **C,** The ankle brachial index was 0.83, and the toe brachial index was 0.3. **D,** The patient had poor healing of his amputation site and required further debridement and intervention. *PSV,* Peak systolic velocity.

nondiseased tibioperoneal trunk. A repeat angiogram showed in-line peroneal flow to the ankle with a collateral branch feeding into the DP (Fig 2, *D*). However, a new thrombus was noted in the distal PTA, with no reconstitution of the previously present medial plantar artery (Fig 2, *E*). An 0.014-in. Glide Advantage wire and 0.035-in. CXI catheter were used to select the proximal PTA—the larger 0.035-in. catheter was initially selected to deliver tissue plasminogen activator (tPA) more effectively using a Tuohy-Borst adaptor while maintaining the wire position. There was difficulty passing the 0.035-in. CXI catheter past a mid-PTA calcified lesion. A nested system of 0.018-in. and 0.035-in. CXI catheters were then used to traverse the tight lesion and through the fresh thrombus. Intravascular ultrasound (IVUS) showed a focal distal PTA thrombus, circumferential calcification, and diffusely diseased PTA. Angioplasty of the mid-PTA lesion was performed with a 1.5 × 20-mm Armada XT balloon (Abbot Vascular) to allow for passage of the nested 0.018-in. and 0.035-in. CXI catheters to the level of the thrombus. Through the larger catheter, 4 mg of tPA was slowly injected, but there was no resolution of the thrombus. The decision was made to perform angioplasty of the multifocal stenoses and distal thrombus with the 2- to 2.5-mm Nanocross balloon—this balloon had been previously used once in the peroneal artery.

After angioplasty, we were not able to deflate the balloon with negative pressure exerted from the inflation device. Prolonged aspiration with a 50-mL syringe was also unsuccessful in deflating the balloon. The balloon was then intentionally ruptured by overinflating it. However, the balloon stayed inflated and adhered to the heavily calcified artery. We then advanced a "buddy" 0.014-in. Glide Advantage wire between the vessel wall

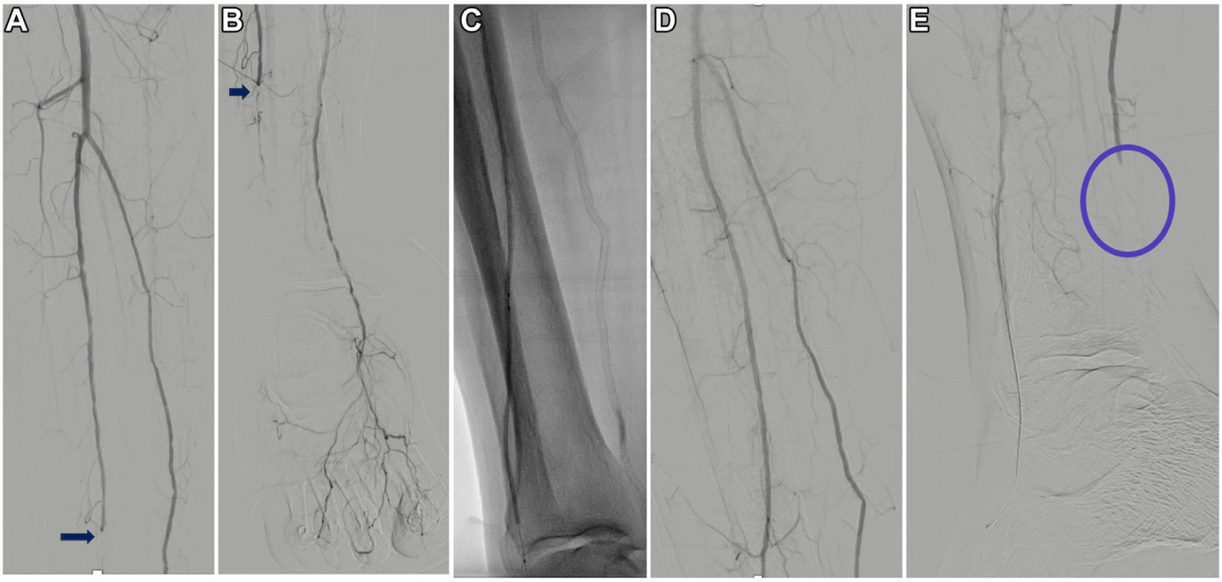

Fig 2. A,B, Right lower extremity angiogram showing proximal occlusion of the anterior tibial artery with no distal reconstitution, occlusion of the mid-peroneal artery with distal reconstitution, and a diffusely diseased posterior tibial artery (PTA) with in-line flow into the medial plantar artery (*arrows* indicate the proximal point of occlusion). **C,** Peroneal artery angioplasty was performed with 1.5- to 2-mm and 2- to 2.5-mm Nanocross balloons (Medtronic). **D,** A repeat angiogram showed in-line peroneal flow to the ankle with a collateral branch feeding into the dorsalis pedis (DP). **E,** However, a new thrombus was noted in the distal PTA with no reconstitution of the previously present medial plantar artery.

and the entrapped balloon through the existing 6F sheath. Over this wire, we performed serial dilations with a 1.5-mm × 8-mm coronary balloon along the length of the Nanocross balloon to separate the balloon from the calcified vessel wall in a piecemeal fashion. Despite this attempt, the balloon remained adherent to the vessel wall and could not be removed. The back of the balloon catheter shaft was then cut, over which a straight-tip 5F catheter was advanced to try to "swallow" and collapse the balloon into the catheter and extrude any remaining contrast material. We were not able to advance the 5F catheter beyond the proximal portion of the balloon, as it met resistance. We then performed "embolectomy" of the entrapped balloon by deploying a 1.2-mm Armada XT balloon (Abbot Vascular) on the 0.014-in. buddy wire distally in the ankle and pulling back, which was also unsuccessful. Next, over the buddy wire, we placed a 1.5- to 2-mm Nanocross balloon in parallel to the entrapped larger Nanocross balloon to separate the entrapped balloon from the calcified arterial wall. After this simultaneous full-length parallel ballooning, the entrapped system could be mobilized. The catheter shaft was retrieved out of the body; however, the balloon had separated from the catheter and was dislodged into the proximal popliteal artery (Fig 3, *A*). A 4-mm goose neck snare (Medtronic) and a 0.035-in. CXI catheter were used to capture and secure the distal part of the balloon, and the balloon was pulled into the 6F sheath and removed from the patient (Fig 3, *B and C*).

The proximal PTA was selected again, and 4 mg of tPA was injected, followed by 200 μg of nitroglycerin. The completion angiogram confirmed resolution of the PTA thrombus, with in-line flow to the medial plantar artery (Fig 3, *D*). On completion of the case, the patient had multiphasic posterior tibial and DP signals. The radiation dose (air kerma) was 189 mGy, the fluoroscopy time was 56.4 minutes, and 150 mL of contrast was used. He was placed in observation overnight for neurovascular monitoring and intravenous hydration and was then discharged home with instructions to take aspirin 81 mg daily and therapeutic anticoagulation with 20 mg rivaroxaban daily (Xarelto; Janssen Pharmaceuticals). The patient provided written informed consent for the report of his case details and imaging studies.

DISCUSSION

With the increasing prevalence and complexity of peripheral vascular interventions, rare complications such as balloon entrapment could occur more often. Retention of a balloon in a target tibial vessel is underreported, and several possible mechanisms have been described for balloon entrapment in calcified vessels.[17] For instance, the acute recoil of a highly calcified lesion with variable compression points along the lesion could lead to balloon entrapment. This was likely the case with the present patient, because IVUS before angioplasty showed calcified lesions with sharp edges. Another etiology could be strangulation of the proximal end of the balloon in the sheath by a mobile calcium remnant.[17] A kink in the balloon catheter or hypotube while traversing the lesion can also lead to air locking in the balloon, persistent inflation, and, subsequently, balloon

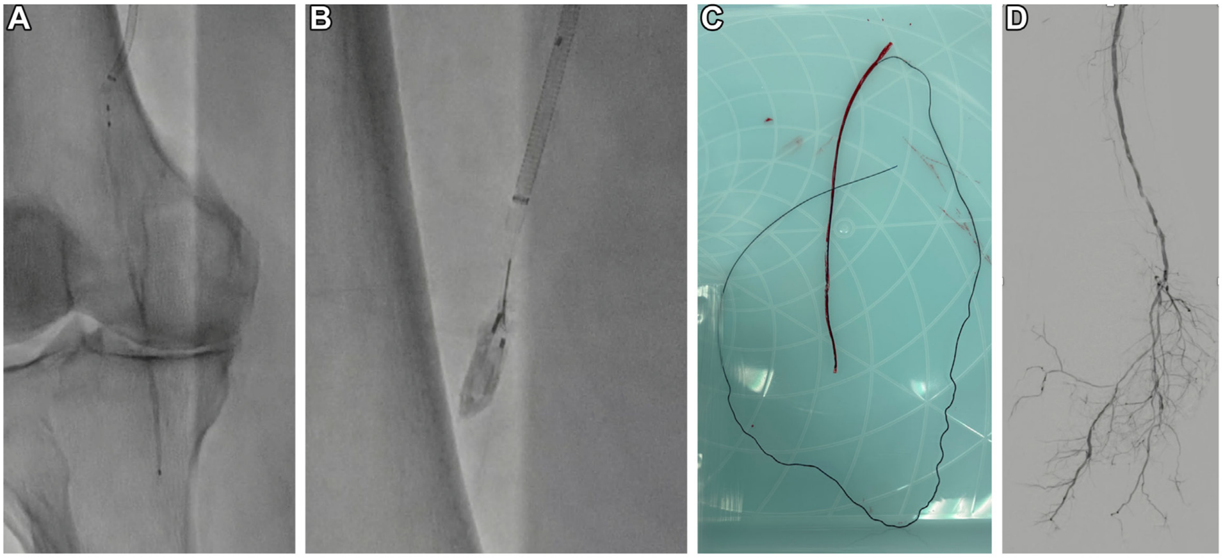

Fig 3. A, The catheter shaft was retrieved out of the body; however, the balloon was dislodged into the proximal popliteal artery. **B,C,** A 4-mm goose neck snare (Medtronic) was used to lock in the distal part of the balloon, pull it into the 6F sheath, and remove it from the body. **D,** After injection of tissue plasminogen activator (tPA) and nitroglycerin, the completion angiogram showed resolution of the posterior tibial artery (PTA) thrombus with in-line flow to the medial plantar artery.

entrapment.[17] The presence of a calcified, distal lesion could also prevent withdrawal of the balloon catheter.[17] The Nanocross balloon is a 0.014-in. over the wire balloon catheter that has a buckle-resistant shaft design that offers pushability along the length of the catheter. Proprietary ThermoFlex balloon material (ThermoFlex Corp) is used in the design to optimize the thin-wall strength. It also has a tapered tip that offers improved control to navigate turns and tortuosity. It is designed with tight pleat folds that reduces the profile and enables crossing of tandem lesions.[18] Two cases of Nanocross balloon malfunction have been listed in the Manufacturer and User Facility Device database. Both cases involved balloon rupture, tip detachment, and material retention.

In the present case, the embolus was likely dislodged from a proximal source when advancing the 6F × 90-cm sheath, and disruption of the in-line flow to the foot is what prompted intervention of the PTA. Ipsilateral antegrade access in patients with isolated tibial lesions provides more pushability, better tracking, and easier reach of devices. Additionally, in this patient, an antegrade access approach would have mitigated the risk of dislodging thrombus from the aortoiliac system. Because we were endeavoring to restore in-line flow, balloon entrapment could have possibly been avoided if a previously used balloon had not been reused in a severely calcified tibial artery. Alternatively, a shorter, nontapered balloon could have been used instead to serially treat the high-grade lesions. Furthermore, the use of IVUS to characterize complex lesions helps determine the need for vessel preparation before treatment and allows for appropriate device selection. In the present case, it would have been beneficial to pretreat the artery with serration angioplasty, atherectomy, or intravascular lithotripsy, given the extensive circumferential calcification.[19]

This case report describes several methods to endovascularly retrieve an entrapped balloon, including serial dilation of calcified track over a “buddy” wire, collapsing the balloon into a larger catheter, embolectomy using a distal balloon, and snaring. Another adjunct procedure would be to advance a second 0.014-in. guidewire distally, twist it with the distal part of the first guidewire to create a cage, inflate a second balloon over the buddy wire in parallel with the entrapped balloon, and then pull the whole system into a guide catheter.[8] If transcatheter attempts fail, surgical removal is necessary. For our patient, our surgical approach would have been to perform a below the knee open exposure of the tibioperoneal trunk and the origin of the PTA for proximal control and an above the ankle cutdown to control the distal PTA and then manually extract the balloon through an arteriotomy and perform thrombectomy of the PTA and medial and plantar arteries distally.

CONCLUSIONS

Interventionists should be aware of the possibility of balloon entrapment in small heavily calcified tibial arteries. Nonsurgical catheter-based methods for retrieval of entrapped balloons include “buddy” wire and parallel ballooning, "swallowing" with larger catheters, embolectomy with a distal balloon, and intraluminal snaring.

DISCLOSURES

V.C. is a consultant for Cook Medical, Medtronic, Shockwave Medical, Gore Medical, Alucent Medical, and Evident. A.F. and E.L.G. have no conflicts of interest.

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