Revascularization of radial artery for ischemic hand with history of hand reimplantation

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ABSTRACT

Limb reimplantation is widely described, but there are sparse reports of limb ischemia complications. We present the case of a patient with hand reimplantation who developed limb-threatening ischemia 20 years later. The patient is a 37-year-old man with a history of traumatic wrist amputation and reimplantation who presented with fingertip ulcerations. Testing demonstrated ischemic digit pressures and no flow in the palmar arch. The initial angiogram demonstrated radial artery occlusion. Balloon angioplasty had initial success; however, the loss of primary patency prompted repeat angiography with the use of intravascular ultrasound and laser atherectomy. His symptoms and wounds resolved, with normalized digit pressures. His radial artery remains patent after 2 years. (J Vasc Surg Cases Innov Tech 2024;10:101492.)

Keywords: Laser atherectomy; Limb reimplantation; Radial artery occlusion; Upper extremity angiography; Upper extremity limb ischemia

Limb reimplantation after traumatic injury has been reported since the 1960s.[1] The long-term outcomes of limb reimplantation are dependent on multiple factors, including the mechanism of injury, level of amputation, and ischemia time.[2] The current literature, however, focuses on nerve dysfunction and cold intolerance as the most common long-term complications in limb reimplantation.[3,4] Thrombosis of the arteries and veins in reimplanted limbs has been most commonly described as occurring during the immediate postoperative period, with most occurring during the first 3 days and arterial in origin.[3,5] Progressive neointimal thickening and atherosclerotic changes have been observed as long-term outcomes in a case series with the use of vein graft bypass for arterial injuries in urgent limb reimplantation,[6] similar to the long-term changes seen in vein grafts used for lower extremity atherosclerotic disease.[7] However, there is sparse literature reporting on arterial disease outcomes and interventions in patients with primary anastomosis during limb reimplantation. We present the case of a patient with hand reimplantation who developed ischemia 20 years after his initial operation and underwent successful endovascular intervention for his symptoms. The patient provided written informed consent for the report of his case details and imaging studies.

CASE REPORT

The patient is a 37-year-old man who presented with a 2-month history of intermittent left hand pain, pallor, and paresthesia. His history was significant for a traumatic left-hand amputation 20 years prior due to sharp, work-related trauma; however, he had been able to return to work and successfully perform his activities of daily living following successful reimplantation. He also had fingertip ulcerations that had been worsening. During this initial visit, he was diagnosed with vasospasm, for which he received a trial of verapamil 40 mg three times daily and continued with aspirin 325 mg daily that he had been compliant with since his initial surgery. He was also an active smoker and was counseled on cessation, which he was able to accomplish. However, within a 2-month period, he returned with worsened symptoms and progression of ulcerations of his fingertips, at which point our team was consulted for evaluation. Noninvasive studies were obtained, including an upper extremity arterial duplex ultrasound examination and upper extremity segmental limb pressures. Duplex ultrasound imaging demonstrated normal velocities and waveforms through the brachial and ulnar arteries but no flow in the palmar arch (Fig 1, *a*) and apparent triphasic waveforms of the radial artery, albeit with spectral broadening, but an inability to follow the vessel beyond the distal forearm (Fig 1, *b*). Comparison studies are shown in Fig 1, *c and d*. Upper extremity limb pressures showed digit pressures of 10 to 12 mm Hg (Fig 2, *a*). Comparison studies are shown in Fig 2, *b*. A multidisciplinary discussion with the hand surgery team concluded that they would be unwilling to offer the patient a palm-level bypass until 6 months after he had stopped smoking. Based on the rapid progression of his symptoms, worsening of the wounds, and incongruence of the findings between the noninvasive studies, we discussed consideration for angiography to better characterize the anatomy and potentially intervene.

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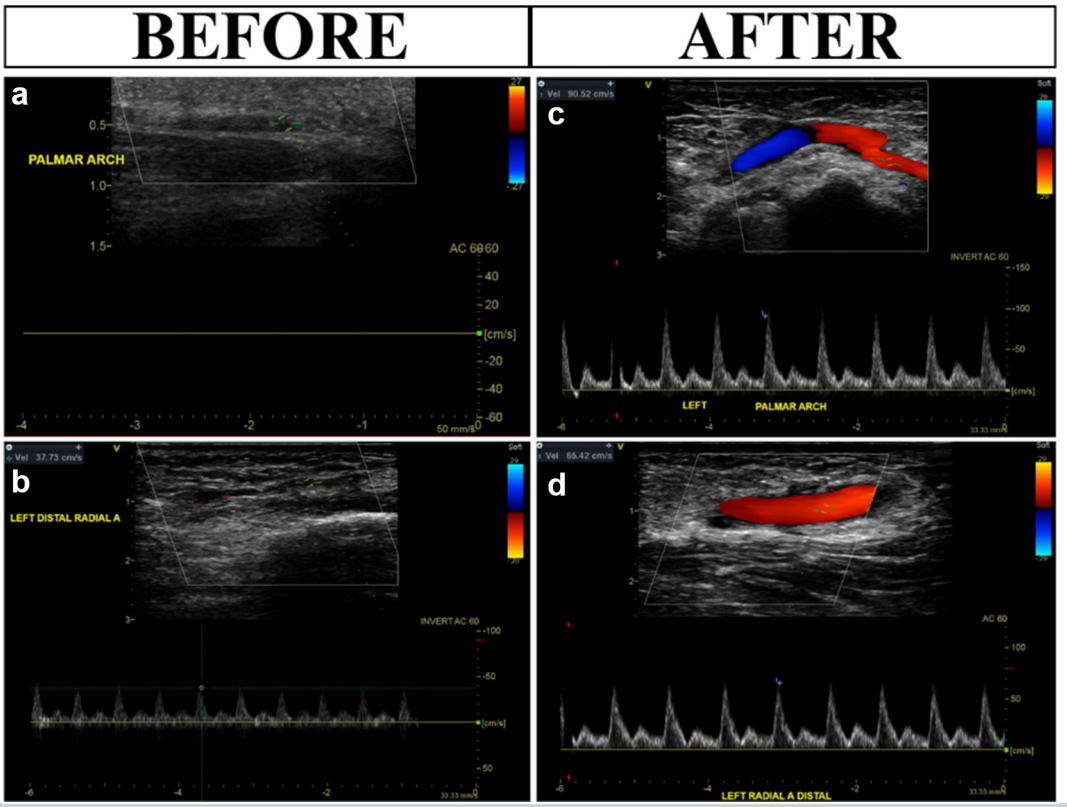

Fig 1. Duplex ultrasound waveforms before intervention of the palmar arch (**a**) and radial artery (**b**) compared with waveforms after intervention for the palmar arch (**c**) and radial artery (**d**).

An initial angiogram through right femoral artery access demonstrated a radial artery occlusion near what appeared to be an end-to-end anastomosis with reconstitution at the level of the wrist (Fig 3, *a*). Comparison studies are shown in Fig 3, *b*. Prolonged balloon inflation with a 3-mm balloon was performed with a return of brisk flow into the palmar arch. He was discharged with daily clopidogrel 75 mg, in addition to his aspirin therapy. At 1 month of follow-up, he had improvement in coloration and active healing of the wounds of his hand. However, he continued to complain of pain at his fingertips with recumbency that improved with sitting up, which we interpreted as equivalent to rest pain symptoms. Noninvasive studies showed digit pressures in the 30s, and duplex ultrasound imaging demonstrated occlusion of the distal radial artery. Notably, he had quit smoking at this time. We, therefore, offered him repeat left upper extremity angiography.

We obtained access through the right femoral artery and selectively cannulated the left subclavian to advance a 7F sheath to the level of the left brachial artery. Angiography confirmed reocclusion of the radial artery with reconstitution at the level of the wrist. We were able to then selectively cannulate the radial artery and cross the occlusion into the palmar arch. At this point, we performed intravascular ultrasound (IVUS) and found soft-appearing atheroma at the occlusion and at what appeared to be the spatulated anastomosis (Fig 4). Given the rapid loss of patency after balloon angioplasty alone, we chose to preemptively perform laser atherectomy, using the Spectranetics 1.4-mm by 150-cm shaft catheter (Philips). We then performed prolonged balloon dilation with 3- and 4-mm balloons, using our IVUS measurements. The technical result was excellent with brisk angiographic flow to the palmar arch (Fig 3, *b*) and multiphasic signals throughout his palmar arch on intraoperative continuous wave Doppler ultrasound examination.

At the 1-month follow-up, his symptoms had completely resolved, and his wounds had almost completely healed. Studies showed his digit pressures had improved to >100 mm Hg (Fig 2, *b*) and duplex ultrasound showed significantly improved flow through his palmar arch (Fig 1, *c*) and radial artery (Fig 1, *d*). He was found to be nonresponsive to clopidogrel on laboratory work and this medication was removed and he maintained daily high-dose aspirin. Two years after his endovascular interventions, the patient's radial artery remains patent on duplex ultrasound imaging, his wounds have fully healed, and he has returned to his baseline function.

DISCUSSION

The reported incidence of arterial occlusion after limb reimplantation is low. There is sparse data and guidelines

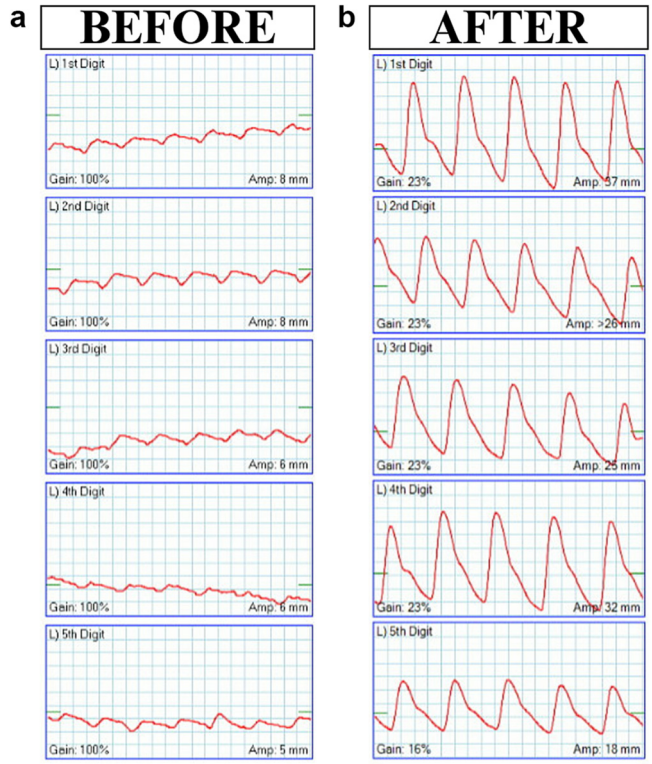

Fig 2. Finger pressures before any intervention (**a**) compared with after the second angiographic intervention (**b**).

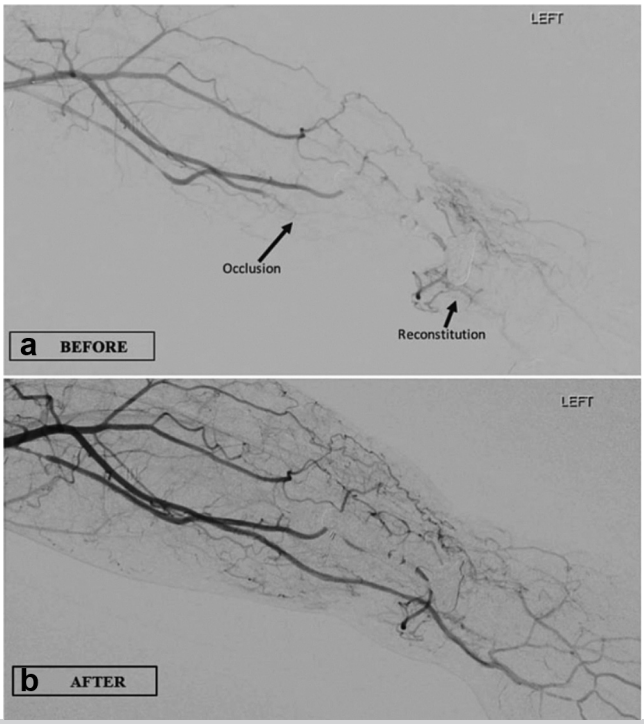

Fig 3. Angiographic images before (**a**) and after (**b**) intervention. **a,** Occlusion and reconstitution of the radial artery during the index angiogram. **b,** Return of blood flow after intervention during the second angiographic procedure.

on the management of ischemia in this setting. Also, although open microvascular surgical techniques will likely remain the gold standard, they are not always available. Endovascular techniques used in other small vessel beds, such as the coronary and tibial arteries, have proven effective and acceptable therapeutic options,[8] prompting our willingness to attempt this in our patient who was otherwise at high risk for limb loss and already debilitated to the point of the nonuse of his hand.

Given the limited expectation of prolonged patency and our goal of simply having this patient achieve 6 months of smoking cessation to allow him to undergo surgical bypass, our initial therapy used prolonged balloon angioplasty alone. Although there are coronary stents suitable for the vessel size, we did not believe their off-label use was supported for our patient, and we had concerns about the risk of a balloon expandable stent being crushed, given the mobility of the radial artery. With such early loss of patency, on the second attempt, we took advantage of more advanced imaging using IVUS, which has been associated with improved outcomes.[9] In this case, IVUS guided the balloon sizing, which we learned had been undersized at the index procedure, and selection of an appropriate vessel preparation device (ie, laser atherectomy, given the soft atheroma vs thrombus or calcium). Previous studies have shown that laser atherectomy plus plain balloon angioplasty used to treat lower extremity in-stent restenosis has improved efficacy and safety outcomes compared with plain balloon angioplasty alone.[10] Laser atherectomy has also been shown in other studies to have a low risk of distal embolization.[11]

CONCLUSIONS

Although intended as bridging therapy, endovascular intervention in our patient has resulted in ongoing primary patency at 2 years of follow-up. This case demonstrates that endovascular interventions are a viable treatment option for select patients with upper extremity critical limb-threatening ischemia.

DISCLOSURES

None.

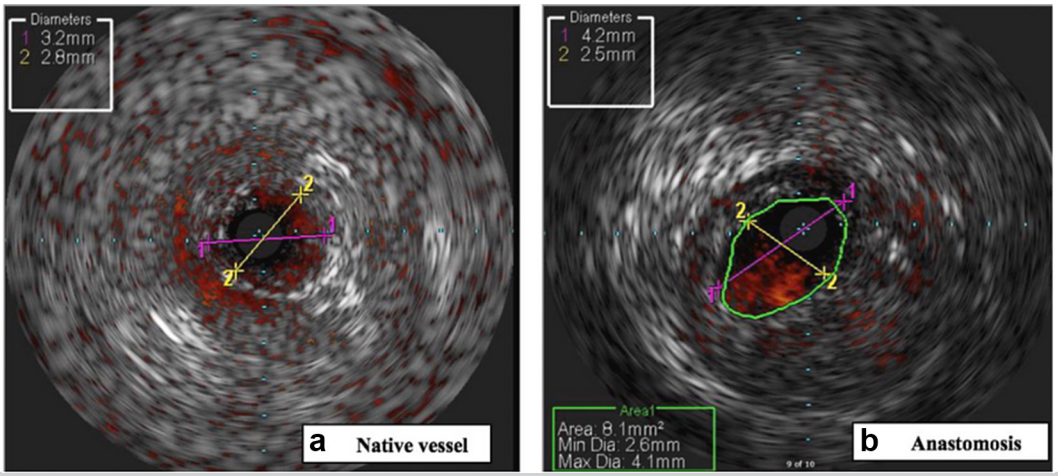

Fig 4. Intravascular ultrasound (IVUS) images demonstrating the native vessel (**a**) and the anastomosis from prior reimplantation surgery (**b**).

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