Extra-anatomic temporary intravascular shunting to assist with replantation of an amputated hand with prolonged ischemic time

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ABSTRACT

Although temporary intravascular shunting has been reported to assist with hand revascularization and replantation after traumatic amputation, most reports have described using ipsilateral upper limb inflow. We present a case of a traumatic hand amputation in a patient who had presented with 4 to 5 hours of warm ischemic time. Because the replantation team believed that extra-anatomic revascularization would be necessary, we performed a novel type of temporary intravascular shunting by connecting two arterial sheaths placed in the ulnar and superficial femoral arteries. This permitted the hand to be successfully replanted away from the inflow source and resulted in a good long-term functional outcome. (J Vasc Surg Cases Innov Tech 2022;8:598-601.)

Keywords: Case report; Hand; Replantation; Temporary intravascular shunt; Traumatic amputation

Rapid revascularization of the amputated hand is essential for successful replantation.[1] Although temporary intravascular shunting (TIVS) can assist with replantation after traumatic hand or upper limb amputation, most reports have described using ipsilateral upper limb inflow.[2] To perform TIVS, a shunt is used to bridge a transected artery and/or vein.[3,4]

To the best of our knowledge, shunting from a lower to an upper extremity artery during hand replantation has been previously reported twice.[5] We present a case of a traumatic hand amputation in a patient who had presented with a prolonged warm ischemic time. We performed a novel type of extra-anatomic TIVS by connecting sheaths placed in the ulnar artery and superficial femoral artery (SFA). The patient provided written informed consent for the report of her case details and associated clinical and intraoperative images.

CASE REPORT

The case is reported in accordance with the CARE (case report) guidelines (the complete CARE checklist is provided in the Appendix).[6]

A 51-year-old, right-handed, nonsmoking woman with hypothyroidism experienced a left hand amputation by a circulating saw at her home. She lost consciousness and was discovered by her husband hours later who called emergency medical services. The patient received several minutes of cardiopulmonary resuscitation after emergency medical services arrived and then regained vital signs. The paramedics applied an arm tourniquet and transported her to a level 1 trauma center.

Upon arrival at the trauma center 4 to 5 hours after her injury, the patient was hemodynamically stable and had a nearly completely amputated left hand that was connected to the forearm by a skin bridge. The skin bridge was divided, the hand was placed in a protective bag and cooled on ice, and the hand replantation team was consulted (Fig 1). The tourniquet was released, and no bleeding occurred.

The replantation team consulted vascular and endovascular surgery because they believed that extra-anatomic hand revascularization was indicated. Although they considered placing a TIVS between the forearm and hand ulnar artery, they thought that a local shunt would interfere with dissection and replantation.

The patient was taken to the operating room and given a general anesthetic. An endotracheal tube was inserted. The ulnar and radial arteries of the amputated hand were thrombectomized with an embolectomy catheter. The radial and ulnar arteries were flushed with heparinized saline, and a 5F sheath was inserted into the ulnar artery and anchored in place with a silk tie (Fig 2). The contralateral right SFA was exposed through a vertical thigh incision, and the SFA was punctured with an

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Fig 1. Left hand and ipsilateral forearm upon presentation to hospital after a small skin bridge connecting them had been divided.

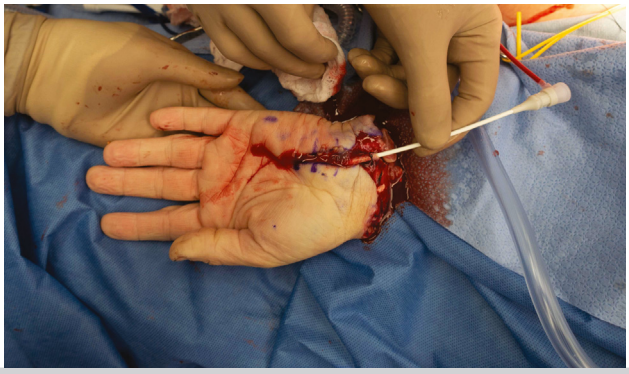

Fig 2. Left hand with a 10-cm-long 5F sheath inserted into the ulnar artery.

18-guage needle. We then exchanged the needle for a 5F sheath over a guidewire.

The ulnar 5F sheath was connected to the 5F sheath in the right SFA via arterial line tubing (Fig 3). Once the sheath valves were opened, the vessels of the amputated hand filled around the palmar arch and into each digital artery. The transected radial artery was clamped. Capillary refill occurred within 1 to 2 seconds of TIVS placement. A slow ooze of venous blood was present from the transected venous vessels of the amputated hand. Intravenous heparin was given to maintain an activated clotting time >300 seconds. The approximate time that the hand had been on ice until flow had been restored to the amputated hand was 2 to 3 hours.

With the shunt in situ providing continuous flow, the hand was replanted over an 11-hour period (Fig 4). The wrist was fused, and then the ulnar artery, dorsal ulnar vein, dorsal radial artery, dorsal radial vein, flexor tendons, nerves, and extensor tendons were anastomosed in sequence. Once the ulnar-to-ulnar artery anastomosis had begun, the ulnar end of the TIVS was removed. The sheath in the SFA was removed next, and the arteriotomy was repaired. Finally, the left thigh wound was closed.

The estimated blood loss was 4 to 5 L. The patient received 12 U of packed red blood cells, 6 U of fresh frozen plasma, and 3 U of cryoprecipitate. Her postoperative course was complicated by a replantation wound surgical site infection and dorsal wrist wound dehiscence. The patient returned to the operating

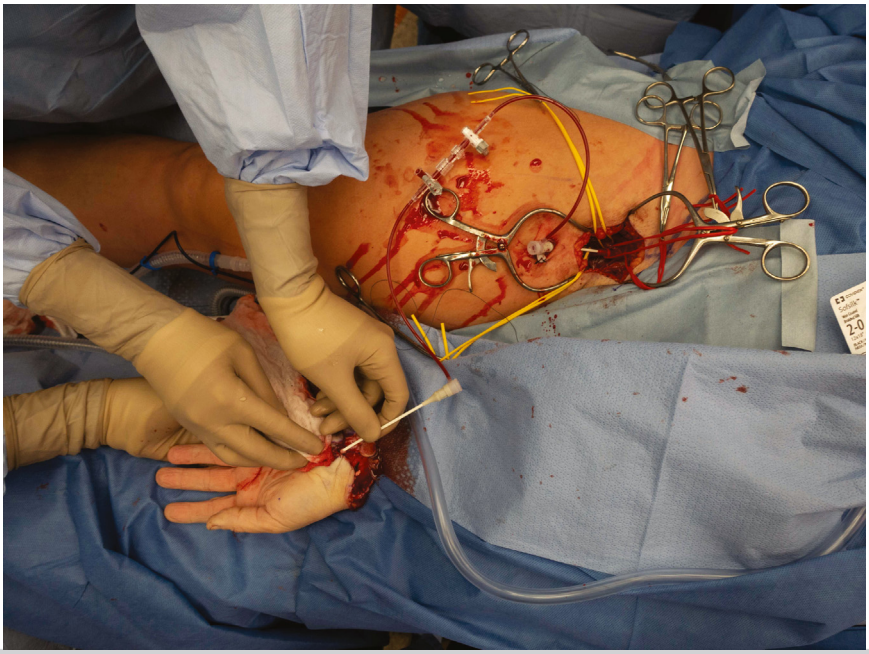

Fig 3. Left hand and right groin cutdown with the superficial femoral artery (SFA)-to-ulnar artery temporary intravascular shunt in situ.

room for irrigation and debridement of her dorsal hand wound and placement of a pedicled groin flap. The patient was discharged on postoperative day 25.

At 2 years after replantation, the patient was able to extend her left fingers with the exception of the fifth digit, which had a flexion contracture. She could flex her left fingers within 1 cm of her palm (Fig 5). Her main limitations were difficulty with fine motor skills, in particular, pinch and thumb opposition. She also had reduced sensation along the median, radial, and ulnar nerve distributions.

DISCUSSION

We have reported a novel type of extra-anatomic TIVS to assist with rapid revascularization during hand replantation. We chose to use the SFA instead of the common femoral artery (CFA) for inflow to avoid the patient's pannus (and the associated risk of a surgical site infection) and to allow unimpeded flow through the CFA and profunda femoris artery during TIVS. The TIVS facilitated replantation at a location away from the inflow source.

Replantation has generally been believed to have minimal success if warm ischemia time has been >6 hours or cold ischemia time has been >12 hours.[1] For our patient, upper limb inflow for TIVS was first considered but was less desirable because the shunt would have interfered with dissection and replantation. The ipsilateral brachial artery could also have been used as an arterial inflow source. However, the potential disadvantages include the relatively smaller size of the brachial artery, the risk of loss of inflow access during arm movement and manipulation, and flow disturbances or the risk of thromboembolic complications to the distal traumatized arm caused by an indwelling sheath during the course of replantation (11 hours for our patient).

In 2011, Lee et al[5] reported two cases of traumatic arm amputation successfully replanted after CFA-to-radial artery TIVS. For their patients, an 8F sheath in the femoral artery was connected to a 16F intravenous catheter in the ipsilateral radial artery. The cephalic vein of the amputated arm was also connected to the greater saphenous vein, and a tourniquet was applied to the open end of the amputated arm.[5] We used the ulnar artery for our TIVS, because it is the predominant arterial supply to the hand in nonsmokers.[7-9] In contrast, radial arterial dominance is more common in smokers because the ulnar artery is more often affected by smoking.[7-9]

Surgeons should consider the following if attempting our technique of TIVS in the future. If the palmar arch is suspected to not be complete, a Y-connector could be used to provide arterial outflow to both ulnar and radial arteries. Because the arterial line tubing connecting the two sheaths has the smallest diameter and likely provides the greatest resistance to flow, it should be kept as short as possible. The lack of a venous connection in our case resulted in an estimated blood loss of 4 to 5 L. In future cases, we would therefore suggest performing a second TIVS between one of the large branches of the deep venous system (eg, the dorsal radial or ulnar vein) and the saphenous or femoral vein to limit blood loss. Use of a cell salvage device would also allow for most of the intraoperative blood loss to be returned to

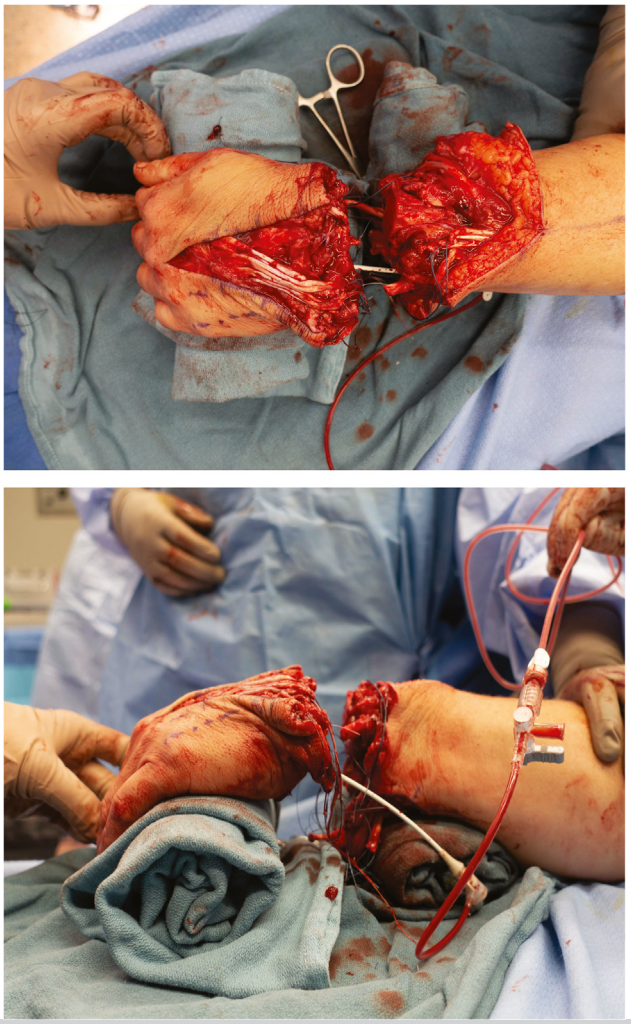

Fig 4. Hand replantation with the superficial femoral artery (SFA)-to-ulnar artery temporary intravascular shunt in situ.

Fig 5. Flexion and extension of the fingers of the replanted hand ~2 years after replantation.

the patient. Percutaneous CFA access should also be considered in future cases to decrease the time to achieving inflow arterial access. In retrospect, we believe it would be unlikely that a sheath placed 1 cm proximal to the CFA bifurcation would cause a disturbance in flow to the profunda femoris artery and might provide better flow through the SFA. Finally, a pulse oximeter could be used in future cases if uncertainty existed regarding the adequacy of hand tissue perfusion.

CONCLUSIONS

Extra-anatomic TIVS can be used to assist with replantation of an amputated limb. This technique can be particularly useful after complete limb amputations because the amount of surgery required for these cases is considerable.

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