Acute Ischemia of the Upper Extremity

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KEYWORDS

• Vascular • Ischemia • Hand • Trauma • Thrombosis

KEY POINTS

- Open vascular injury should be managed with exploration.
- Ulnar and radial artery thrombosis in the hand may be managed conservatively in some patients.
- Subclavian artery and vein thrombosis in high-level athletes often requires surgery, but the patient can usually return to sports.

Acute ischemia in the upper extremity is an uncommon occurrence in orthopedic trauma but can pose significant problems if it occurs. An ischemic hand is most common after open trauma, and is often the result of cutting injuries or firearms; however, it can present after a closed injury. A review of a large series of civilian traumatic vascular injuries revealed that 18% occurred in the upper extremity.[1] Significant arterial injury with ischemia of the hand presents a surgical emergency, and restoring flow to the injured limb usually takes precedence over the management of other injuries. In the large series of civilian vascular injuries mentioned previously, however, with appropriate vascular intervention major and minor amputation rates remain less than 5%.[2]

OPEN TRAUMA

Open injuries to the upper extremity may cause injury to a major arterial structure, which can lead to ischemia of the distal limb. This more commonly occurs in the upper arm with injury to the brachial artery, because injury to either the radial or ulnar artery in the forearm should not lead to ischemia in the hand. Injury to both vessels in the forearm can lead to an ischemic hand, but these injuries are usually amputations or near-amputations. In any event, the vascular injury needs to be addressed in terms of reestablishing flow to the hand before undertaking management of the bony and soft tissue injuries. Muscle only tolerates 4 to 6 hours of warm ischemia,[3] and thus restoring arterial flow quickly to the ischemic limb is paramount.

In general, a patient with an open injury to the upper limb and an ischemic hand requires urgent exploration in the operating room. Physical examination with Doppler examination of pulses in the emergency department, along with appropriate radiographs to evaluate bony trauma is probably all that is necessary in these patients. Although other imaging studies might be helpful, the delay required for performing vascular studies is generally not warranted. The wounds need to be managed regardless, and thus expeditious exploration in the operating room after hemodynamic stabilization of the patient is the proper course of action.

Once the patient is stabilized and is taken to the operating room, flow can be restored temporarily with an arterial shunt. This technique has been proven to be reliable and was used in several patients during recent military conflicts.[4,5] Published studies have shown that shunts can be used to control hemorrhage from vascular injuries and to reperfuse distal tissue. They can also be placed as a temporizing measure until surgeons with expertise in the

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area of vascular repair are available, or even left in place to allow perfusion of the limb while the patient is transferred. Studies have shown that the results of placing a shunt temporarily (hours up to a day or more) are the same as performing a vascular repair at the initial exploration.[6] An arterial shunt can be placed while bony fixation is performed, and a definitive repair done once bony stabilization has been achieved.

A Javid-type shunt of the appropriate size is chosen and flushed with heparinized saline. The shunt is place in the vessel ends and held in place with either a special clamp designed for this purpose or an umbilical tape placed around the vessel and clamped down via a piece of red rubber catheter (Fig. 1). In most instances, this shunt is left in place only long enough to allow for bony stabilization, at which time definitive repair of the vascular injury is performed. It has been shown feasible to leave the shunt in for 6 hours or longer[7] if the patient is unstable or needs transfer.

Definitive repair of major arterial injury in the upper extremity can sometimes be performed primarily if the injury is a sharp laceration. In these cases the injured vessel end is trimmed back and the vessel is freed up for a few centimeters by taking down small local side branches (Fig. 2). In most instances of significant trauma with open fracture, however, resection of the injured portion of the vessel and reversed vein grafting is required (Fig. 3). This is done with either the cephalic or basilic veins from the arm or saphenous from the leg. Whichever vein is chosen, it should be reversed to prevent the venous valves from obstructing distal flow.

The basic principle of vascular surgery is proximal and distal control of the injured vessels. In the upper extremity this is usually fairly straightforward because surgery can often start with a tourniquet applied. Regardless, wide exposure of the vessel is necessary to gain appropriate control and place vascular clamps, and thus incisions should be made or extended as necessary to allow for proper visualization. Blind clamping of a bleeding vessel is to be condemned, because it can lead to further trauma and potentially damage uninjured nerves, which increases the morbidity of the injury. If necessary, finger pressure is held on a bleeding vessel while an incision is made proximal to the site of injury over the injured vessel where this can be exposed and controlled. If exposure is very difficult (for example in the axilla), the end of the vessel is identified and a Fogarty balloon catheter of the appropriate size placed in the lumen of the damaged vessel and the balloon inflated. This can occlude flow until better exposure is obtained. Once the vessels are clamped, one should irrigate proximally and distally with heparinized saline to decrease the risk of thrombosis while the clamps are in place. If flow from the proximal vessel is not good one may need to consider using a balloon catheter to remove thrombus before attempting repair. This technique is beyond the scope of this article but is reviewed in standard textbooks on vascular surgery.[8]

Once proximal and distal control is secured, the ends of the vessel should be trimmed back to an uninjured area and the defect between the ends measured. An appropriate length of graft is marked out over the selected vein and this vein is then harvested. The vein is marked so that it can be reversed and brought up to the site of arterial injury. I prefer to perform the proximal anastomosis first, in arteries the size of the brachial artery generally using a 6–0 or 7–0 polypropylene suture, with either an interrupted or continuous suture technique. For the smaller vessels in the forearm I use an 8–0 nylon for repair and generally use an interrupted suturing technique (see Fig. 2D). In the case of severe degloving injuries, repair of

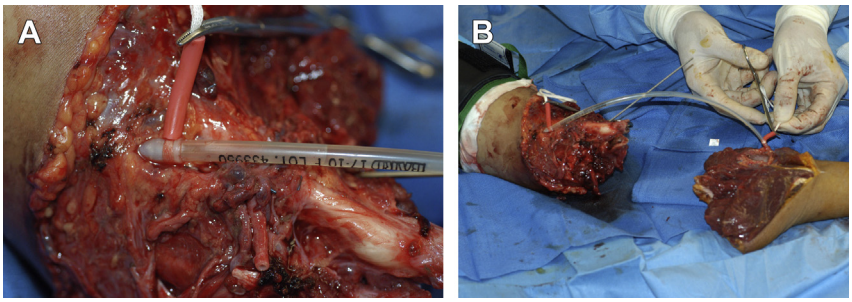

Fig. 1. (*A*) View of Javid shunt placed on proximal vessel after being flushed with heparinized saline. Note umbilical tape pulled around vessel and held in place with portion of red rubber catheter and clamp. Tourniquet is currently up so there is no flow through the shunt. (*B*) Shunt connected proximally and distally before tourniquet deflation.