Arterial Injury in the Upper Extremity

Evaluation, Strategies, and Anticoagulation Management

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KEYWORDS

• Upper extremity trauma • Arterial injury • Angiography • Graft • Patency • Anticoagulation

KEY POINTS

- Upper extremity trauma with an associated arterial injury typically occurs via a blunt or penetrating mechanism.
- Given the intricacy of the upper extremity arterial system, the diagnosis of an arterial injury can be challenging and requires a high index of suspicion.
- Appropriate treatment of the arterial injury is dependent on the mechanism and location of the injury.
- Although thrombosis is a common complication of arterial injuries, a standardized anticoagulation regimen has yet to be established.

EPIDEMIOLOGY

Vascular injuries to the extremities account for fewer than 1% of all traumatic injuries, and upper extremity arterial injuries comprise 30% to 40% of all extremity arterial trauma.[1,2] Typically, these injuries are a result of a penetrating or a blunt force mechanism. Although both mechanisms can involve any surrounding tissue, blunt mechanisms are associated with a higher morbidity and mortality due to the more generalized effect of the trauma.[2,3]

With either mechanism, various types of arterial injuries can occur, and these are grouped into 5 types: intimal injury (ie, flaps, disruptions, or subintimal/intramural hematomas), complete wall defect with hemorrhage or pseudoaneurysm, complete transection with hemorrhage or occlusion, arteriovenous fistula, and spasm.[4,5] Penetrating injuries typically cause wall defects. In contrast, blunt trauma usually causes intimal defects via a shearing contusion or crush injury. As a result, focal intimal damage may lead to the formation of an arterial dissection, thrombosis, or a pseudoaneurysm. Injury to a vessel can also be secondary to a stress lesion, such as a dissection or pseudoaneurysm caused by compression of the vessel. Joint dislocation can result in an occlusion or dissection injury. Spasm can occur after either blunt or penetrating trauma to an extremity and is more common in young patients.[5,6]

Upper extremity arterial injuries have the potential to have a substantial impact on the overall outcome for trauma patients. Given that these injuries most commonly affect men from 24 years

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old to 38 years old, it is understandable how these traumas present difficult medical and socioeconomic problems.[3,5,7] To properly manage these injuries, it is vital to make an appropriate assessment using all tools available.

EVALUATION

The arterial system of the upper extremity begins with the subclavian artery and continues distally as the axillary artery. In turn, this forms the brachial artery, which eventually divides into the radial and ulnar arteries in the forearm. Aside from this typical path, a rich collateral circulation exists (Fig. 1).[8] With such an intricate vascular network, the appropriate diagnosis of an arterial injury in an upper extremity trauma patient can be challenging. Specific algorithms can aid the process by providing various subjective and objective tools.

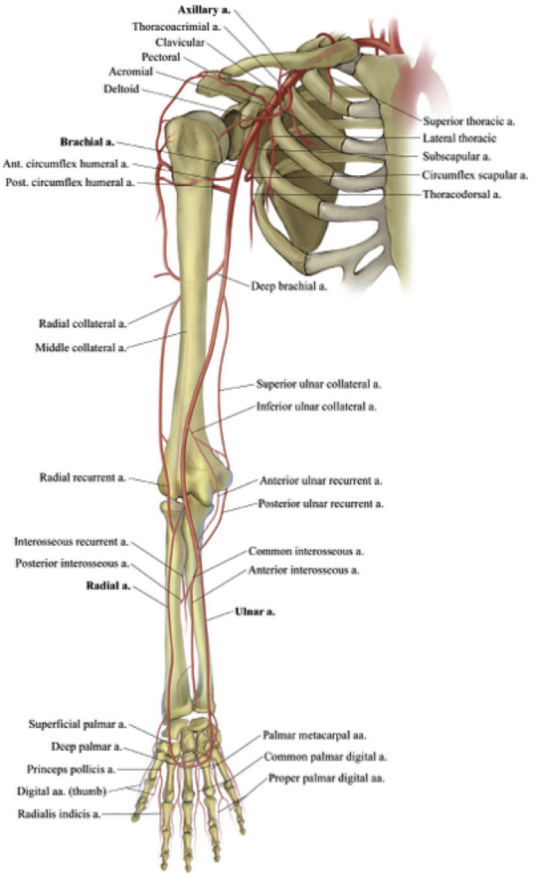

Fig. 1. An illustration demonstrating the arterial system of the upper extremity. a, artery; aa, arteriae. (*From* Daoutis N, Gerostathopoulos N, Bouchlis G, et al. Results after repair of traumatic arterial damage in the forearm. Microsurgery 1992;13(4):176; with permission.)

As with any trauma, the evaluation of a patient with an upper extremity injury begins with the primary survey (ABCDEs according to the Advanced Trauma Life Support protocol: Airway, Breathing, Circulation, Disability and Exposure/Environment).[9] If signs of bleeding are recognized, control by direct compression is advised. In the rare situation where direct compression is unable to provide adequate hemostasis, a tourniquet can be used.[9] Data collected from Operation Enduring Freedom (Afghanistan) and Operation Iraqi Freedom have demonstrated that the appropriate application of a tourniquet is effective in preventing loss of life and is safe, with an overall complication of rate of less than 5%.[9] If a patient's vital signs are unstable, however, immediate resuscitation with blood transfusion is indicated.[9]

Once a patient is hemodynamically stable, the secondary survey is initiated with a detailed history and physical examination focusing on the specific upper extremity injury. Occasionally, the physical examination can be misleading or unimpressive. In fact, 5% to 15% of patients with a vascular injury may present with a normal pulse examination.[5] Therefore, careful attention must be paid to any hard and/or soft signs of vascular trauma (Table 1). Hard signs are an absolute indication for vascular exploration, given that these patients have an incidence of vascular injury greater than 90%.[10,11] In contrast, patients with soft signs have an incidence of vascular injury ranging from 3% to 25%.[5]

If there is a high suspicion of vascular injury in the setting of soft signs, numerous noninvasive diagnostic methods have been found helpful (Fig. 2). One such diagnostic tool is the arterial pressure index (API), which is the ratio of the

Table 1
Hard and soft signs of vascular injury in orthopedic trauma

"Hard" Signs	"Soft" Signs
Pulselessness	History of bleeding in transit
Pallor	Proximity-related injury
Paresthesia	Neurologic findings from nerve adjacent to a named artery
Paralysis	Hematoma over a named artery
Pain	
Rapidly expanding hematoma	
Massive bleeding	
Palpable thrill or audible bruit	

Data from Doody O, Given M, Lyon S. Extremities—indications and techniques for treatment of extremity vascular injuries. Injury 2008;39(11):1295–303.