

# Vascular emergencies in the emergency department

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**Vascular injuries of the extremity may be the result of penetrating trauma (gunshot or stab wounds) or, occasionally, blunt trauma. The nature of the injury may be transection, laceration, contusion, compression, fistula, spasm, or trivial injury in a chronically ischemic limb. The emergency department physician has an important role in determining the extent of injuries and establishing priorities in treatment. Evidence of vascular injury is divided into "hard" and "soft" signs. The indications for immediate surgical exploration and emergency arteriography are explored, and case reports are presented for illustration.**

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Vascular injuries to the abdomen and more particularly to the chest are associated with a high prehospital mortality. In the emergency department, therefore, the majority of vascular injuries seen are of the extremities. Because the vessels of the extremities are longer and more superficially placed, they are more vulnerable to injury. Many of these injuries occur in victims of assault, because such persons frequently attempt to defend themselves with either their arms or their legs.<sup>1</sup>

The vessels of the upper extremity that are most frequently injured with significant consequences are the subclavian, axillary, and brachial arteries. In the lower extremity, the femoral or popliteal artery is the usual site of injury.

Many vascular injuries of the extremities are the consequence of gunshot wounds, but a considerable number are the result of stab wounds. Blunt trauma, as will be discussed later, is occasionally the cause of vascular injury.<sup>2</sup>

Vascular injuries may be complicated by the fact that high velocity missiles often cause extensive destruction of neurovascular structures and surrounding soft tissue. Shotgun wounds frequently

produce widespread, serious damage because of dispersal of a large number of pellets. Gunshot wounds often drive foreign bodies such as dirt, wadding, or fillers and pieces of clothing into the wound.

Extensive damage to neurovascular structures and to soft tissue also results when blunt trauma produces a fracture. There may be laceration of the vessel by bony fragments or the tremendous force released by the bending and sudden break of a large bone. Dislocation of the shoulder may injure the axillary artery. Medial angulation of fragments of the humeral neck can lacerate the axillary or brachial artery. Fractures of the distal tibia and fibula may cause injury to the anterior and posterior tibial arteries. Pelvic fractures may injure the iliac arteries. Fracture dislocations of the knee are particularly likely to produce serious vascular injury,<sup>3</sup> because the popliteal artery is relatively fixed and hence vulnerable and because the collateral circulation about the knee is composed of small vessels that are easily torn. An unstable knee may be easily missed in a multiple trauma patient with a dramatic injury, and the contused artery may clot when hypotension persists or when treatment is delayed.

Injury to a vessel may be one of the following kinds: (1) transection; (2) laceration; (3) contusion with intimal tear and subsequent thrombosis; (4) compression by bone or hematoma; (5) arteriovenous fistula; (6) arterial spasm; or (7) trivial trauma in a chronically ischemic limb, resulting in obstruction. The most common vascular injury associated with blunt trauma to the extremities is a contusion spasm and subsequent thrombosis rather than a frank laceration or transection. Compression resulting from bone or hematoma is rare.

Gradual vascular occlusion encourages the development of an increasing collateral circulation capable of maintaining the limb; however, acute total occlusion is less well tolerated, particularly in the hypovolemic patient. A significant number of older patients, who often have pre-existing arterial disease, are seen with vascular injury. The presence of arteriosclerosis complicates the pattern of trauma because it may precipitate thrombosis.

A relatively high rate of mortality results from

arterial injuries to the base of the neck because of uncontrollable hemorrhage. Permanently crippling neurologic injuries can result from cerebral ischemia in such cases.<sup>4</sup>

### Emergency department priorities

The initial examination of the traumatized patient in the emergency room must be carried out with the understanding that vascular injuries require early recognition and rapid repair and a minimal interval between, because irreversible muscle necrosis occurs some 6 to 8 hours following injury. The extent of circulatory impairment is dependent upon the size of the artery injured, the adequacy of the collateral circulation, and the degree and duration of shock, as well as the pre-existing vascular status. The external temperature may also play a role, because a chilled extremity can tolerate ischemia longer.

The emergency department physician who first examines the trauma patient must determine the extent of injuries sustained and establish priorities of treatment. Injuries affecting vital physiologic functions constitute an immediate threat to life, and, therefore, they must take precedence in management, which may include immediate surgical intervention.<sup>5</sup> Many injuries do not pose an immediate threat to life, and although surgery may be required within a few hours of arrival, in these cases time should be allowed for commencement of resuscitative steps and diagnostic studies. However, delay in the surgical control of exsanguinating hemorrhage is to be condemned because it greatly reduces the chances of survival; therefore, unnecessary diagnostic and laboratory evaluations in the emergency room must be avoided. Prompt vascular control represents the only hope for survival in many patients. Bright red blood pulsating from an open wound is readily recognized as representing arterial injury; however, one should also consider that a wound in the vicinity of a major artery, a large hematoma over the course of an artery, the absence of distal pulses, or the presence of a cool, pale, numb extremity may suggest vascular injury. It must further be borne in mind that palpable pulses may not rule out proximal arterial injury.<sup>3</sup>

Active bleeding should be controlled by pressure rather than tourniquets; certainly, clamping of bleeding vessels should not be carried out, because this might increase vascular injury or injure nerves accompanying vascular structures. All peripheral pulses should be examined and recorded as either present, absent, or diminished. The "six p's"—pulselessness, paresthesia, pallor, paralysis, poikilothermia, and pain—should all be checked for.<sup>3</sup> The examiner must bear in mind that a pulse may be present with a tangential injury of an artery.<sup>6</sup>

Evidence of vascular injury can be divided into the following "hard" and "soft" signs. The hard signs<sup>7</sup> are as follows: (1) massive external hemorrhage; (2) an enlarging hematoma; (3) a thrill over a hematoma; (4) a continuous murmur; and (5) the six p's. Soft signs of vascular injury<sup>8</sup> include the following: (1) a wound near an artery; (2) a small, nonpulsating hematoma; (3) a questionable history of arterial bleeding with shock; and (4) neurologic deficit.

The patient with obvious arterial injury, significant hypotension, or a hard sign of vascular injury must undergo immediate surgery. If time permits, arteriography should be performed to provide a "road map" for the surgeon.<sup>3</sup> Patients with soft signs of vascular injury should undergo arteriography. The arteriogram is to be used as an adjunct to the history and physical examination. Of course, the triage officer must remember that both false positive and false negative results are possible.

Emergency arteriography,<sup>9</sup> therefore, is indicated in the following circumstances: (1) absent or diminished pulses; (2) a wound near a major vessel; (3) a significant or enlarging hematoma; (4) neurologic deficit, either motor or sensory; (5) fracture/dislocation (particularly in posterior dislocations of the knee, major fractures of the humerus, femur, hip, and thoracolumbar spine); or (6) hypotension.

Arteriography is more likely to be positive when combinations of the above findings are present.

Other diagnostic modalities found in modern vascular laboratories (including plethysmography) are time consuming. For this reason, they will not be discussed in the acute trauma situation.

It is imperative that the emergency room physician realize that trauma to an extremity may cause swelling of the contents of the muscular compartment, which, in turn, will produce a pressure rise sufficient to impair the local blood supply. This muscle ischemia, unless recognized and treated promptly, can result in serious neuromuscular damage.

This syndrome has also been caused by improper application of medical antishock trousers<sup>10</sup> as well as improper sequential deflation of the leg segment without prior deflation of the abdominal portion.<sup>11</sup> Problems have also been reported with more than 2 hours of deflation of such trousers with the abdominal portion inflated. Cellular damage is likely to occur when compartmental pressure exceeds 45 mm. Hg.<sup>9</sup> Several methods of measuring compartmental pressure are presently available. Even in an extremity with intact blood vessels, compartment syndrome can result in severe tissue loss and may even necessitate amputation.

The proper treatment for compartmental syn-

drome is fasciotomy and its need should be recognized by the emergency department physician at the earliest possible time. Fasciotomy should be considered with the following conditions: (1) combined arterial and venous injury; (2) massive soft tissue damage; (3) prolonged hypotension; and (4) swelling of the extremity. The longer fasciotomy is delayed, the less is the benefit and the greater the likelihood of long term disability.

### Report of cases

The following cases are examples of some of the kinds of decisions with which the emergency department physician will be faced. They are especially illustrative of the respective roles of surgical exploration and of emergency arteriography.

#### Case 1

A 33-year-old woman was admitted from the emergency department with a gunshot wound of the right thigh. The entry wound was in the upper medial part of the thigh; no exit wound was noted. The history was that of "accidental pistol discharging." Copious, bright red bleeding was noted immediately after the accident. The emergency department examiner detected only minimal bleeding.

On examination the patient's condition was stable. The entry wound was noted in the upper medial part of the thigh. A hematoma was detected. The right foot was pale, with a decreased temperature. Both dorsalis pedis and posterior tibial pulses were very diminished on the right. Motor and sensory functions were normal.

Because this patient had soft evidence of vascular injury, an arteriogram was obtained immediately. It revealed obstruction of the right superficial femoral artery in the upper part of the thigh with increased collateral circulation (Fig. 1).

Immediate exploration revealed a full-thickness defect of the posterior wall of the superficial femoral artery 10 cm. distal to its takeoff. A Dacron graft was placed and circulation was restored.

This case is representative of penetrating trauma (gunshot wound) with a history of arterial bleeding, the presence of a hematoma, and a pale, cool, almost pulseless limb. Firm indications for arteriography were present.

#### Case 2

This patient, a 26-year-old man, was seen in the emergency department with a stab wound of the lateral aspect of the left arm about 5 cm. above the elbow. There was a history of profuse bleeding at the scene which had abated during the initial examination in the emergency department.

Examination revealed that the patient's condition was stable. The left arm was cool to the touch, and both radial and ulnar pulses were absent. A hematoma was noted on the medial aspect of the upper part of the left arm. Motor and sensory functions were intact.

The patient was taken immediately to the operating room, where exploration confirmed arterial injury. The left brachial artery was found to be completely transected, as was the vein; the nerve remained intact. Reanas-

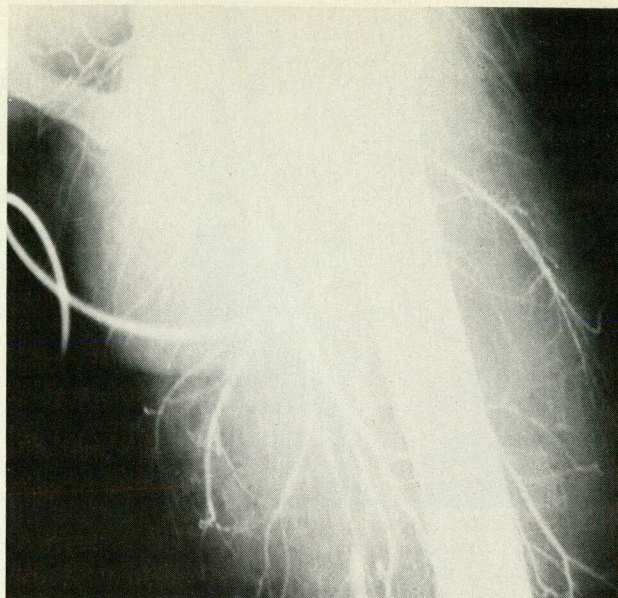


Fig. 1. X-ray demonstrates obstruction of the right superficial femoral artery in the upper portion of the thigh.

tomosis was carried out after débridement.

This case represents penetrating trauma (stab wound) with a history of profuse bleeding at the scene of the accident but with little bleeding in the emergency department. The absence of pulses in the affected extremity and the presence of a hematoma overlying the course of the artery dictated that exploration of the injury was obligatory. Arteriography was not indicated in this case.

#### Case 3

A 19-year-old man was seen in the emergency department after a motorcycle accident. X-ray films demonstrated a left clavicular fracture with considerable displacement. Physical examination revealed swelling of the left upper extremity. The left arm was cool and pale compared to the opposite arm, and all pulses were faint. A hematoma was palpated in the upper anterior portion of the right side of the chest. The neurologic examination of the left upper extremity showed no motor and very little sensory activity. The patient's condition was stable at the time of examination.

Arteriography demonstrated an intimal flap (Fig. 2).

Neurologic consultation revealed complete avulsion of the brachial plexus on the left, with complete paralysis of the left upper extremity. For this reason, no attempts at surgical correction of the intimal tear were carried out; however, if the limb had been salvageable, such a procedure would have been indicated.

The degree of displacement of the clavicular fragments suggests the force of the trauma. The cool, pale upper extremity with faint pulses and a hematoma overlying the course of the subclavian and axillary artery dictated the need for arteriography, which was diagnostic in this case.

#### Case 4

The patient was a 26-year-old woman seen in the emergency department with a gunshot wound of the neck. The entry wound was found in the region of the left max-

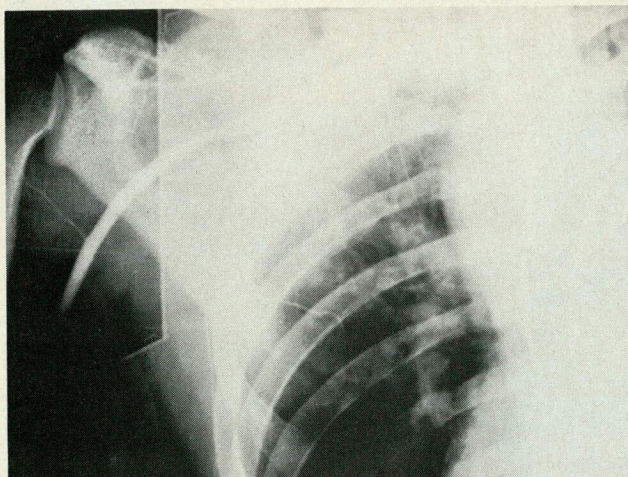


Fig. 2. X-ray demonstrates severe multiple fractures of the left clavicle with displacement and with an intimal flap demonstrated in the distal subclavian artery.

illa, and the exit wound was in the posterior part of the left side of the neck near the base of the skull. Profuse hemorrhage was present, and resuscitative efforts were begun. The patient was taken to the operating room immediately, and exploration revealed intact left internal jugular vein and common carotid arteries and bleeding from a transected left vertebral artery. Ligation was performed with eventual success in controlling the hemorrhage, but not before approximately 1,500 ml. of additional blood were lost during the procedure.

Profuse hemorrhage requires immediate exploration. Arteriography should not be performed, because the patient would be at risk for exsanguination in the x-ray department.

### Case 5

An 18-year-old man was seen in the emergency department shortly after he had received a gunshot wound of the right side of the neck. Examination revealed that the patient's condition was stable. An entry wound was noted in the midportion of the anterior sternocleidomastoid muscle on the right side with an underlying, expanding mass. Very little external bleeding was noted. The bullet could be palpated in the posterior part of the right side of the neck overlying the transverse process of C6. No crepitus was elicited in the neck. Chest and cervical x-ray views yielded negative results.

The patient was taken immediately to the operating room, where exploration revealed a hematoma with a small laceration of both the internal jugular vein and the common carotid artery. Both were repaired without incident.

It must be borne in mind that the dense cervical fascia may act to tamponade a wound and that opening of that fascia may be followed by exsanguinating hemorrhage and permanent signs of cerebral ischemia. Arteriography would have been valuable in this case, because it would have revealed the extent of the injury. The high density of critical structures in penetrating wounds to the neck requires that arteriography must be performed immediately if surgery is not mandated.

## Summary

The initial management of the trauma patient in the emergency room setting is crucial not only to the ultimate survival of that patient but often to the quality of that survival. This is certainly true of vascular injuries which, if unrecognized during the so-called *golden period*, may rapidly lead to the death of the patient or the death of the limb.

As soon as resuscitative measures are underway and overt, active bleeding is controlled, all extremities, and especially the injured limb, must be carefully examined. The history must be reviewed to ascertain if arterial bleeding had been present. Life-threatening hemorrhage or the other "hard signs" of vascular injury—enlarging hematoma, a thrill over a hematoma, a continuous murmur, or the "six p's" (pulselessness, paresthesia, pallor, paralysis, poikilothermia, and pain)—may require immediate surgery. Patients with "soft signs" of vascular injury—a wound near an artery; a small, non-pulsating hematoma; a questionable history of arterial bleeding, with shock; and neurologic deficit—should undergo emergency arteriography. Compartment syndrome also requires early recognition since failure to do so may place that limb in jeopardy.

It is hoped that this article and the examples described will assist the emergency physician in his triage duties.

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