VENOUS TRAUMA

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Epidemiology

- The incidence of named venous injury concomitant with extremity arterial trauma ranges between 15% and 35%.
- The presence of a vein disruption does not consistently predict amputation, and there is no broad consensus as to whether such injuries should be repaired and whether failing to do so predisposes the patient to long-term morbidity.
- Long-term limb edema in particular appears to be unrelated to whether a venous injury was repaired or not.

Diagnosis

- Although DUS is inexpensive and noninvasive, it is unreliable for the detection of arterial injuries in extremity trauma.
- CTA remains the most appropriate initial study for this purpose.
- DUS may have a role in the detection of occult venous injuries and should be considered an adjunctive imaging modality in extremity trauma.
- In addition, DUS may have a role in the surveillance of known injuries selected for nonoperative management (see later).
- Gagne et al. 31 published a small study confirming the questionable reliability of DUS in the trauma setting. In this study, however, DUS was also compared with contrast venography for the detection of venous injuries. DUS identified seven injuries, four of which were missed by venography, which captured only one injury (to a calf vein) missed by DUS.

Diagnosis

- These results confirm the lack of necessity for routine arteriography
- and suggest that nonoperative management of selected arterial injuries is reasonable, but a high index of suspicion for the possible development of pseudoaneurysm or ischemic complication is necessary during a period of close clinical followup.
- Injuries identified on imaging that may be considered for observation include those that produce no active hemorrhage or distal ischemia, such as small intimal tears or flaps, pseudoaneurysms, and arteriovenous fistulas.
- Serial surveillance with an appropriate imaging modality such as CTA or DUS is recommended; early repair might be more appropriate if prospects for follow-up are uncertain.

Patency

- Shunts placed in the venous system fare surprisingly well in terms of patency, despite the absence of systemic anticoagulation and dwell times of up to a few hours.
- In a combined review of two recent military reports, only a single episode of thrombosis was noted among 14 shunted vein injuries (93% patency).

Venous Repair Versus Ligation

- The decision whether to repair or to ligate major extremity venous injuries remains controversial.
- There has been no consistently reported association between major venous ligation and eventual amputation.
- Conventional wisdom has been that vein repairs are highly likely to acutely thrombose, a conclusion supported by data from Timberlake et al. who performed DUS on 138 patients with venous repairs. They found that between 24 and 96 hours from operation, all repairs had occluded.
- The high incidence of acute thrombosis of venous repairs is supported by data from Smith et al. who reported 45% occlusion rate at 72 hours.
- The occlusion of venous repairs may be transient, however, as they found that at 12 weeks, more than 85% of the vein repairs were patent.
- The development of limb edema is seen as the primary potential adverse outcome when a major extremity venous injury is ligated.

- The development of edema is more common when ligation is performed at the popliteal than at the femoral level, with transient swelling seen in up to 90% of ligated popliteal and 50% of ligated femoral injuries.
- Repair reduces the transient edema by about half, to 50% and 29%, respectively.
- Nearly all patients, regardless of the status of the injured vein, experience near-complete resolution of edema by the time of or shortly after discharge from the hospital.
- Edema is far less common after ligation of major upper extremity veins.

Venous Repair Versus Ligation

- Venous thromboembolism is also a risk after major extremity venous injury, and the rate of deep venous thrombosis in patients undergoing major venous ligation appears to be approximately twice that of patients undergoing repair.
- There is no clear indication of whether the thrombi seen in this population are the result of the venous ligation, however, and the rates of pulmonary embolism are similar between patients undergoing ligation and repair.
- The decision to repair or to ligate a major extremity vein injury should be made in the context of the patient's overall physiologic condition. If it is safe to take the time required to repair an injury, it is reasonable to attempt to do so.
- End-to-end anastomosis, lateral suture venorrhaphy, patch venoplasty, and interposition grafting are all viable options for repair, depending on the anatomy of the injury.
- Ligation should be performed if the patient's condition will not tolerate the additional operative time.
- Regardless of whether ligation or repair is performed, a period of leg elevation and gentle compression can help reduce the incidence of postoperative edema and possibly eventual venous insufficiency.

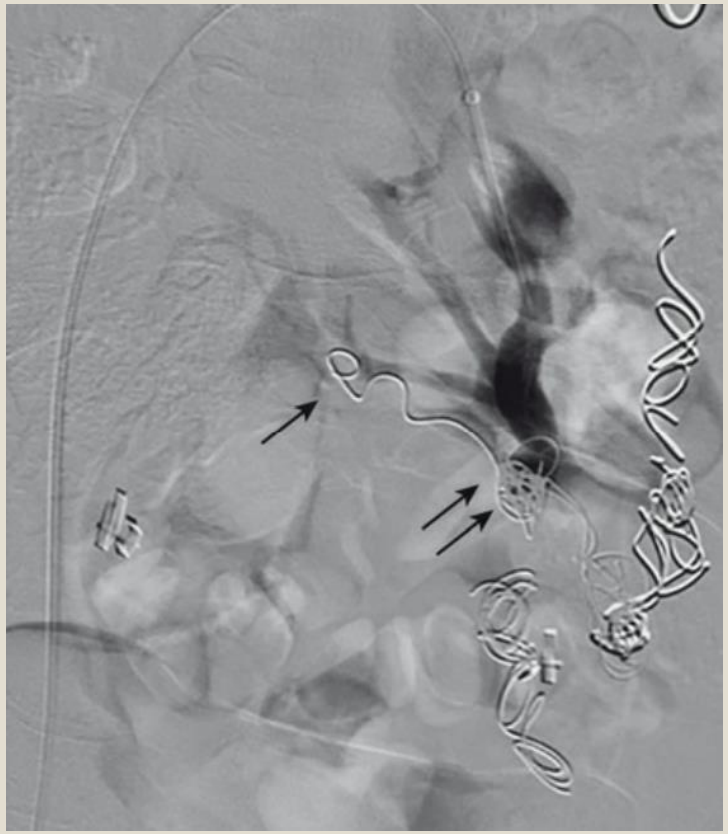
Caval injuries

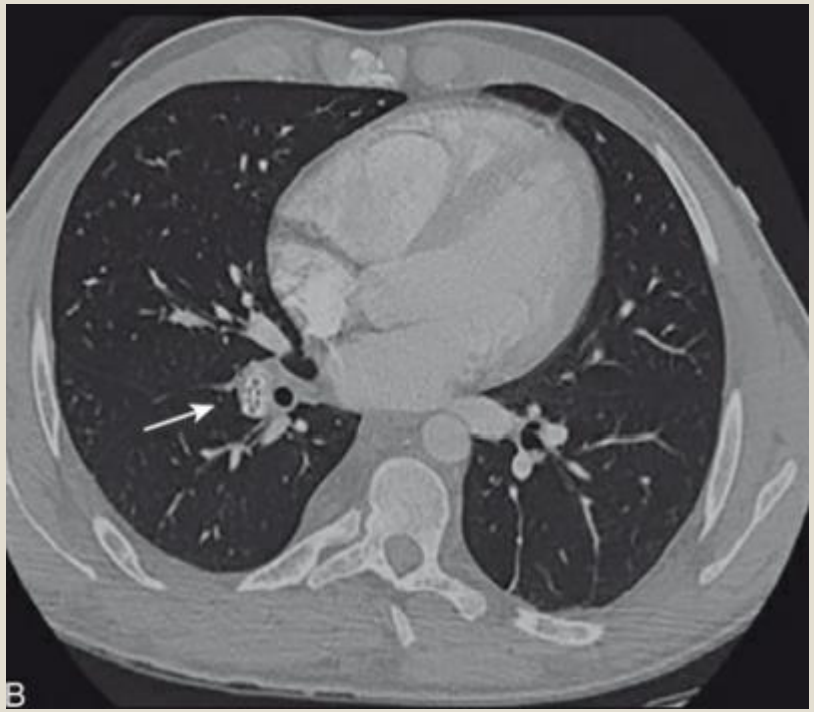
- For caval injuries, endovascular repair options include balloon occlusion or control, and even coverage with a covered stent or aortic cuff. These interventions are usually performed in a hybrid OR.
- Balloon occlusion with large, low-pressure balloons from above and below the injury, either inserted percutaneously from the jugular and femoral sites or inserted through the injury, can slow down blood loss and may allow enough visualization for an open repair.
- If the injury is being managed percutaneously, there are reports of covered stent grafts in the IVC. These are difficult to size, as the injured cava may have ill-defined walls and the size of the tear may be difficult to appreciate on CT or venogram.
- In addition, there may be spasm of the IVC or underfilling from blood loss that leads to placement of cuffs that could embolize once the cava is fully expanded.

- In the event of a posterior vena caval injury, this difficult problem can possibly be managed by control of the cava and opening the cava on the anterior surface to visualize the posterior tear.
- This can then be repaired from inside the cava and the anterior exposure site can be primarily closed in a transverse manner.
- If there is a significant loss of domain in any of these large veins, and the patient is hemodynamically stable, the injured section of vein can be replaced with a Dacron prosthetic graft, usually 20–24 mm in diameter, or a spiral vein graft if time allows.
- If a prosthetic graft is used, consideration should be given to prolonged systemic anticoagulation, a distal arteriovenous fistula, or both to optimize patency.
- Severe venous injuries, especially in the infra or suprahepatic regions of the IVC, carry a very high morbidity and mortality.

Endovascular Complications From Venous Interventions

- Most venous ruptures are self-limiting due to the low pressure of the venous system and will seal after a brief period of balloon tamponade.
- A balloon slightly smaller than the surrounding venous diameter should be placed across the perforated venous segment and gently inflated to low pressure (<5 atm) for at least 5 minutes.
- If there is still extravasation after this maneuver is performed, a covered or even bare metal stent can be placed across the perforation to achieve hemostasis.

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- Migrated stents are often percutaneously retrieved with snares if they can be pulled into a large sheath.
- Migrated stents can also be removed through surgical cutdowns, and the venous system may need to be reconstructed.

- Venous embolization devices can also migrate. Coils and plugs have been found in the heart and lungs (Fig. 51.5), as the venous diameter has a large variation and may be in spasm at the time of instrumentation. Placing plugs or coils in the internal iliac veins should be done with great caution, as these can embolize.

- If this vessel needs to be coiled, the ends of the coils should be anchored in branch vessels and extended into the larger veins