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Techniques in Vascular and Interventional Radiology

Evaluation and Treatment of Blunt Pelvic Trauma

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Trauma is a significant contributor to mortality, especially in the young. Pelvic trauma with pelvic ring fractures may result in associated arterial injury, necessitating endovascular intervention. As a result, interventional radiology plays a critical role in partnering with trauma providers in the care of these patients. Management is determined by the acuity of the patient's clinical status, radiographs, ultrasound, and the results of computed tomography imaging when available. Numerous embolic agents are available for treatment of arterial hemorrhage.
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Clinical Evaluation

Trauma is the leading cause of death in patients under the age of 45. Embolization for pelvic trauma was first described in 1972[1] and interventional radiology has become an integral component of the management of pelvic trauma patients. Approximately 1%-2% of patients with pelvic fractures will be hemodynamically unstable. Of these patients with pelvic fractures presenting in shock, mortality rates are 30%-50%.[2] Pelvic fractures are highly associated with internal iliac artery branch injuries. At our Level 1 trauma center a collaborative approach is taken in triaging patients with pelvic trauma to surgical, endovascular, or conservative management.

The primary predictors of mortality in pelvic trauma are hemodynamic status and computed tomography (CT) imaging characteristics.[3] On initial presentation patients should be evaluated by a trauma protocol. In our institution, a coordinated effort is led by the emergency department and the trauma surgeons. Vital signs, physical examination, and focused assessment with sonography for trauma are performed. Radiographs are obtained of the chest and pelvis. If the patient is stable for CT, a split bolus helical CT angiography (CTA) plays a critical role in planning treatment.

If a patient is hemodynamically unstable, they are often brought directly to the operating room before a CTA can be performed. If the patient remains unstable and cardiac tamponade and tension pneumothorax have been excluded, a Resuscitative Endovascular Balloon Occlusion of the Aorta (ER-REBOA, Prytime Medical, Boerne, TX) catheter will be deployed in the descending thoracic aorta, at level 1 (superior to the celiac artery).[4] A pelvic binder is usually placed. If stability is obtained, the ER-REBOA will be lowered to the abdomen and positioned above the aortic bifurcation, at level 3. If the patient becomes unstable at this lower station, the source of bleeding can be localized and the ER-REBOA can be advanced to a cephalad station. In patients with ongoing hemorrhage, fluid resuscitation is essential; a massive transfusion protocol is initiated at our institution. If the patient is hemodynamically stable, CT is reliable in the detection of arterial extravasation and is an appropriate screening examination before angiography. Moreover, multiphase multidetector computed tomography has been shown to differentiate arterial injuries requiring angiography and embolization from venous injuries that can be treated conservatively. In patients that are deemed to have pelvic trauma with hemorrhage, continuous resuscitation is important. Laboratory analysis is essential if available, as correcting coagulopathies is a primary aim.

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Worsening base deficit is the most sensitive indicator for hemodynamic shock.[5]

When pelvic fractures are present and hemodynamic instability is ongoing, a pelvic source of hemorrhage is often the culprit. However, in the setting of a CTA with no contrast extravasation in the pelvis, this carries a negative predictive value of 100%.[6] Therefore, a negative CTA is highly informative and often negates the need for angiography.

Standard Techniques

In the trauma setting, arterial access can be obtained via the common femoral artery. In some instances, the previously placed sheath for the REBOA balloon catheter may be used for access. In other instances, a location for access must be cut away from the pelvic binder. A sufficient window should be created so as to allow for ultrasound guided access in to the common femoral artery. In other instances, the superficial femoral artery can be accessed below the pelvic binder, lower than standard access, and this low access can be closed with the aid of a closure device or direct delayed open closure. Access is gained in standard technique, and a flush pelvic aortagram is then performed, usually through a 5 Fr Soft-Vu Omni Flush catheter (AngioDynamics, Latham, NY), to obtain a "bird's eye" view of injury laterality. However, selective bilateral internal iliac and external iliac arteriography is mandatory for the complete evaluation of arterial extravasation, occlusion, arteriovenous fistula, intimal tear, pseudoaneurysm, and stretch injury.[7] If evidence of injury is present, multiple catheters may be used to select the internal iliac artery, including a 5 Fr Roberts Uterine Catheter, 5 Fr Uterine Artery Catheter, or a 5 Fr Cobra Catheter. If a focus of extravasation or pseudoaneurysm is identified, we will often try to cross the area of injury with a microcatheter and coil back across it. However, if diffuse injury is present, we will often gelfoam the internal iliac artery through the base catheter. There are several agents to choose from for embolization.[8] In scenarios requiring fast control, Gelfoam is most often used. Coils are used for focal injuries, with detachable coils and microvascular plugs used in situations requiring precision. Stent grafts can be used for large vessels requiring preservation of the lumen, for example, arteries supplying the lower extremity.

Recognizing and Treating Complications

Nontarget embolization is an important complication to address prospectively and can be avoided with careful technique.[9] When introducing gelfoam through the base catheter, care should be taken to ensure the base catheter is well-seated within the internal iliac artery and embolization should be performed with close monitoring for reflux. Keep in mind that complete stasis does not usually need to be the goal, as significant pressure reduction with resolution of hemodynamically significant hemorrhage can be obtained before complete stasis.

Impotence is encountered by approximately 2% of patients with pelvic trauma.[10] Sexual dysfunction is more common in patients with pelvic fractures than patients without pelvic fractures. It is unknown what percentage internal iliac embolization contributes to this population.

Gluteal necrosis can be seen in the setting of pelvic fracture with hematoma.[11] At our institution, if particles are selected for embolization, they are larger than 300 μm in size. Ischemic complications are more common with compounding factors such as traumatic soft tissue injury or hypotension.

Clinical Follow-Up

Patients should be monitored specifically for postprocedure bleeding with serial evaluation of hemodynamic status, physical examination, and blood work with frequency depending on the severity of the hemorrhage.[2] A significant change in clinical status including hypotension, tachycardia, or drop in hemoglobin should prompt repeat CTA of the abdomen and pelvis.

Expected Outcomes

Time to intervention is known to affect the outcome with faster interventions having better results.[3] Pelvic trauma interventions have a high technical success rate, reported from 85%-100%. Clinical success rates have been reported from 90%-95%. Rebleeding after embolization is seen in 6%-8% of cases, however, there is a 97% clinical success rate in these cases after repeat embolization.[8] Overall, mortality has been seen to decrease from 50%-20% after the introduction of pelvic embolization in to trauma center treatment protocols.

Case 1

A 68-year-old woman presented 24 hours after a ground level fall to an outside hospital and was found to have a pelvic hematoma. She was subsequently transferred to our Level 1 trauma center. On admission, her blood pressure was 101/62 mmHg, and her heart rate was 80 bpm. The outside hospital CT without contrast demonstrated a 9 cm x 7 cm pelvic hematoma (Fig. 1) in addition to minimally displaced pubic rami and sacral fractures. After evaluating the patient, we recommended a CTA as the patient had been hemodynamically stable during the 24 hours since the original trauma. This CTA revealed a tiny pseudoaneurysm in an anterior midline location, adjacent to the pubic rami fracture (Fig. 2). On work-up, the patient was noted to be anticoagulated with warfarin for prior cardiac valve replacement