Radiology plays a major role in emergency medicine, both for diagnosis and for interventional management. Emergencies that require immediate interventional radiology as a life-saving procedure can be divided into traumatic and non-traumatic. Injuries can involve the thorax (for example, rupture of thoracic aorta), smaller arteries (such as the intercostals arteries), upper and lower extremities (usually comprising arterial injuries after fractures), abdomen (the abdominal organs, that is, liver, kidney, spleen, etc) and blood vessels (aorta and other arterial injuries). Non-traumatic emergencies include ruptured abdominal aneurysm, gastrointestinal ischaemia and spontaneous or post-surgical bleeding. However, infection and other medical diseases may also present as emergency situations requiring immediate intervention.

**Acute bleeding**
Active bleeding in trauma patients is the most common condition requiring emergency arteriography. Nowadays, the use of dynamic spiral computer tomography (CT) is the gold standard for identification of vessel dehiscence, dissection, pseudoaneurysm and traumatic aneurysm, and for precise localisation of bleeding sites. In a trauma centre, evaluation by a multidisciplinary team (anaesthetist, surgeon, orthopaedic radiologist and interventional radiologist) is the foundation of the correct approach. After identification of acute bleeding and clinical indication for arteriography, the procedure can be extended to provide transcatheter intervention. In many instances, embolisation can be necessary to prevent a late bleed after clot lysis of the thrombosed vessel.

**Thoracic injuries**
Trauma to the thorax includes rupture of the thoracic aorta and vessels of the chest wall. Post-traumatic rupture of the aorta has been identified as the second most common cause of early death after motor vehicle accidents, only preceded by brain injury.\(^1\)
Stent-grafting can be successfully employed to treat a wide range of pathologies of the thoracic aorta, with a mortality, morbidity and resource utilisation that is considerably less than with conventional surgery.(2) Since stent-grafting avoids thoracotomy and cross-clamping, the operative insult is markedly reduced, leading to lower morbidity and mortality.(3) Operation time, period of time in the intensive care unit (ICU) and total hospital stay were less when compared to conventional surgery results in the literature.(4)

**Injuries to the aorta**

Traumatic ruptures of the aorta are often associated with extensive accessory lesions due to the nature of the trauma. Only 15–20% of patients reach hospital alive.(2) Of the patients who reach the operating theatre, on average 7.8% die during the operation, and another 13.5% die in the postoperative period. In the acute phase of blunt aortic trauma, thoracotomy is associated with major blood loss and operation risks and can cause additional damage.(2,5) The risk of neurological complications appears to be equal to that of conventional treatment.(2)

Endovascular aneurysm repair (EVAR) offers a significant peri-operative survival advantage when compared with open surgery regardless of the indications for repair. But in the Medicare population, the five-year survival is similar between the two cohorts.(6)

**Major artery trauma**

Arterial injuries are observed in approximately 5% of patients with upper extremity trauma, especially penetrating and crash trauma, joint dislocation and laceration from broken bones.(7,8) Moreover, iatrogenic arterial injury can also result from several endovascular and surgical procedures or central venous catheterisation.(8,9) In haemodynamic instability and/or severe distal ischaemia, immediate treatment is mandatory. Surgery has long been considered the treatment of choice and may include end-to-end anastomosis, arterial suture with a patch or graft interposition, or ligation.(8) Moreover, surgical stress, frequently combined with concomitant injuries and poor medical condition, results in significant morbidity. Parodi et al(10) reported having successfully treated 29 cases of peripheral post-traumatic pseudoaneurysm and arteriovenous fistula with endovascular stent grafts. From a technical point of view, percutaneous approach of upper limb arterial injury is multimodal and depends on the site and morphology of the lesion.

**Injuries to the spleen**

The spleen is the most commonly injured solid abdominal organ, closely followed by the liver, with injuries occurring as the result of blunt or penetrating trauma.(7) Less frequently the kidney, mesentery, adrenal gland, small bowel or pancreas is injured. In the past, surgery was the only treatment for control of haemorrhage.(7,8) However, transarterial embolisation (TAE) quickly earned a role in the non-operative management of these injuries, particularly where organ preservation was important.

Patients with haemodynamic instability and evidence of splenic trauma typically undergo immediate surgery. Haemodynamically stable patients with splenic injury are triaged to observation or TAE. Currently, the accepted indication for angiography is the presence of active extravasation or pseudoaneurysm formation at CT.(7,11)
Liver trauma
Hepatic trauma can result in injuries to the hepatic arteries, portal veins and/or hepatic veins. In some cases, super-selective catheterisation and embolisation can be performed to preserve uninjured tissue(12) (Fig. 1). Less selective ‘scatter’ embolisation of an entire hepatic lobe or segment may be performed using gelfoam or particles.(12) This method is preferred to treat multiple injury sites simultaneously and when prompt cessation of haemorrhage is necessary and superselective catheterisation is too time-consuming.(7) (Fig. 1)
Renal injuries can also be treated with TAE.(7) Embolisation should be performed as selectively as possible to preserve uninjured renal parenchyma. Superselective TAE preserves renal function, sometimes better than surgery.(12) Both gelfoam and coils are appropriate, though gelfoam may allow for recanalisation and tissue preservation. With increasing experience, the role of interventional treatment may expand to include stent-graft insertion for repair of large vessel injury.(7)

Injuries to the pelvis
Most patients with pelvic fractures are haemodynamically stable. However, a small percentage, particularly those with unstable fractures, present with haemodynamic instability.(7) Pelvic haemorrhage most commonly arises from fractured bones or disrupted pelvic veins with only 10–20% of severe haemorrhage from arterial injury.(13) Treatments for traumatic pelvic haemorrhage include external fixation of unstable fractures, TAE and pelvic packing. Open-surgical procedures such as packing are not advised due to the loss of the tamponade effect of the contained haematoma, risking large volume, uncontrolled venous and/or arterial bleeding.(14) Some surgeons advocate prompt stabilisation of the bony pelvis, although others prefer immediate TAE.(14) Most arterial hemorrhage originates from branches of the internal iliac arteries. Non-selective pelvic arteriography can be useful to localise and lateralise a hemorrhage site. Selective arteriography of the internal iliac arteries should follow. Currently accepted indications for TAE include active extravasation, arterial branch irregularity or truncation, one or more pseudoaneurysms and arteriovenous fistula formation.(7,15) Additional indications, less uniformly accepted, include persistent haemodynamic instability and the presence of a large pelvic haematoma without evidence of active extravasation.(15) Tissue necrosis, paresis, impotence, abscess formation and sepsis have all been attributed to pelvic TAE. Unfortunately, it is difficult to separate the complications of TAE from the sequelae of pelvic fractures and their treatment. A recent study noted the rate of sexual dysfunction to be similar in patients with pelvic fractures regardless of whether they had TAE. Nevertheless, based on the potential complications, empiric embolisation cannot be recommended, and bilateral embolisation should be carefully elected.(15–17)

Retroperitoneal vessel trauma
Retroperitoneal injuries are known to occur in a significant minority of abdominal trauma cases (12% of haemodynamically stable patients). Major retroperitoneal vascular structures include the abdominal aorta, inferior vena cava, renal vessels, proximal celiac axis and superior mesenteric arteries, superior mesenteric vein, lumbar arteries and veins, and ilioc vessels within the pelvis.

Blunt injury to the abdominal aorta is uncommon – with thoracic aortic injuries occurring 20 times more frequently than abdominal aortic injuries in several autopsy series – and involve the infrarenal abdominal aorta in almost all cases (98%).(18) The degree of injury may include subtle intimal injuries, with creation of an intimal flap, pseudoaneurysm and transection; thrombus formation may occur with
partial or total aortic occlusion. The treatment of retroperitoneal haematoma remains controversial. There are no specific guidelines to suggest when to intervene with endovascular or open surgery to stop the bleeding. The main options are selective intra-arterial embolisation or stent-grafts to stop the bleeding. Intra-arterial embolisation is being used with increasing frequency in cases where the angiogram shows active bleeding sites.(18) The indications for embolisation are based on the haemodynamic stability of the patient and the degree of blood loss. Embolisation is becoming more common as an alternative to open surgery in the treatment of retroperitoneal bleed following iatrogenic injuries, after procedures such as percutaneous lumbar sympathectomy, renal biopsy, percutaneous nephrostomy or following iatrogenic ilio-femoral vessel injuries. Open surgery is indicated if the patient remains unstable despite adequate fluid and blood product resuscitation, or if interventional radiology is not successful or unavailable.(18)

**Non-traumatic emergencies**

The role of interventional radiology as a life-saving procedure in non-traumatic emergencies includes the treatment of ruptured abdominal aortic aneurysm positioning a stent graft, the endovascular treatment of acute spontaneous or iatrogenic bleeding and the treatment of critical ischaemia, such as gastrointestinal or lower limb. EVAR of an abdominal aortic aneurysm (AAA) has been confirmed as an effective alternative to open surgery due to its lower invasiveness and reduced morbidity and mortality and lower overall treatment cost. Other benefits of endovascular repair are reduced hospital stay, shorter recovery time and return to baseline functional capacity and less blood loss.(19,20) (Fig.2)

Over the past two decades, TAE has become the first-line therapy for the management of upper gastrointestinal bleeding that is refractory to endoscopic haemostats.(21) Transcatheter interventions include the following: selective embolisation of the feeding artery, sandwich coil occlusion of the gastroduodenal artery, blind or empiric embolisation of the bleeding vessel based on endoscopic and/or CT scan findings and coil pseudoaneurysm or aneurysm embolisation by three-dimensional sac packing with preservation of the parent artery.(22)

Endovascular stenting in symptomatic chronic mesenteric ischaemia (CMI) has become a common practice and widely accepted treatment strategy.(23) Open revascularisation in patients with CMI is considered the gold standard. Percutaneous transluminal angioplasty and stenting is often reserved for symptomatic patients not suitable for open revascularisation.(24) The two-year primary patency rate has dropped to 60%, but symptomatic in-stent stenoses can often be treated successfully with renewed endovascular techniques. Fourteen per cent of patients needed open revascularisation during follow-up, including one conversion.(24) Endovascular approach in selected symptomatic patients not suitable for surgery, can be considered a possible approach.(23,24)

**Conclusions**

Advances in cross-sectional imaging and increased understanding of which patients will best benefit from embolisation promise to further refine the interventional radiologist’s role. As the applications of transcatheter therapy broaden to include embolisation of unstable patients with solid organ injuries and endovascular repair of major arterial injuries, the interventional radiologist must be increasingly prepared to provide prompt, efficient and high-quality service.
INSTRUCTIONS

- Read through the article and answer the multiple choice questions provided at the back of the article.
- Please note that some questions may have more than one answer; in the case of the latter please “tick” every correct answer.
- When done only fax through your answer sheet to the fax number given on the answer sheet.

QUESTIONNAIRE

HOW RADIOLOGY IN EMERGENCY MEDICINE SAVES LIVES

**Question 1:** Which one of the following is the most common condition requiring emergency arteriography?

- A Ruptured abdominal aneurysm
- B Gastrointestinal ischaemia
- C Infection
- D Active bleeding in trauma patients

**Question 2:** Which one of the following has less mortality, morbidity and resource utilisation to treat a wide range of pathologies of the thoracic aorta?

- A Stent-grafting
- B Conventional surgery

**Question 3:** What percentage of patients reach the hospital alive after traumatic rupture of the aorta?

- A 7.8%
- B Less than 5%
- C 15-20%
- D Between 30 and 45%

**Question 4:** Which one of the following solid abdominal organs is the most commonly injured?

- A The kidney
- B The pancreas
- C The liver
- D The adrenal gland
- E The spleen

**Question 5:** Is it TRUE or FALSE that super selective TAE has never preserved renal function better than surgery?

- A TRUE
- B FALSE

**Question 6:** Which of the following are currently uniformly accepted indications for TAE in patients with pelvic fractures?

- A Active extravasation
- B Persistent haemodynamic instability
- C Arterial branch irregularity or truncation
- D One or more pseudo aneurysms and arteriovenous fistula formation
- E The presence of a large pelvic haematoma without evidence of active extravasation

**Question 7:** With regard to the treatment of retroperitoneal haematoma, which one of the following options is being used with increased frequency in cases where the angiogram shows active bleeding sites?

- A Stent-grafts
- B Intra-arterial embolisation

**Question 8:** Which of the following are benefits of endovascular repair of an AAA?

- A Reduced morbidity and mortality
- B Lower treatment costs
- C Lower invasiveness
- D Reduced hospital stay
- E Shorter recovery time and return to baseline functional capacity

**Question 9:** Which one of the following is considered the gold standard in patients with CMI?

- A Stenting
- B Percutaneous transluminal angioplasty
- C Open revascularisation
How radiology in emergency saves lives

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