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Polytraumatism and solid organ bleeding syndrome: The role of imaging



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Abstract In multiple injuries, features of bleeding from solid organs mostly involve the liver, spleen and kidneys and may be treated by embolization. The indications and techniques for embolization vary between organs and depend on the pathophysiology of the injuries, type of vascularization (anastomotic or terminal) and type of embolization (curative or preventative). Interventional radiologists should have a full understanding of these indications and techniques and management algorithms should be produced within each facility in order to define the respective place of the different treatment options.

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Traumatology is becoming increasingly important in our everyday practice because of developments in sports and leisure activities. At present, injuries are the leading cause of death in patients under 40 years old. This increase in incidence and the urgent nature of these injuries is a driving force towards increasingly complex, rigorous organization into traumatology networks and centers. Within this organization, the place of the interventional radiologist is increasing as embolization plays a major role in the treatment of patients because of its efficacy and low complications rate.

Radiologists need to understand the pathophysiology of injuries and its consequences on endovascular treatment, together with the indications and techniques for embolization in trauma.

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Organization of patient care

Depending on the severity of the injury, the patient may be admitted through an emergency department or into a resuscitation unit.

If the patient is hemodynamically stable or has been stabilized by initial resuscitation procedures, he/she will have a whole body CT with contrast enhancement and chest and abdominal views in the early phase of opacification, followed by views at a later phase. These two phases are essential to detect and study the kinetics of the hemorrhage, which is important in deciding on the indication for embolization.

If the patient is hemodynamically unstable or in uncontrolled shock, he/she will have a minimum assessment with a chest radiograph, pelvic radiograph and screening ultrasound (fast-echo). The purpose of pelvic and chest radiographs is to exclude potentially hemorrhagic injuries at these levels. Ultrasound can triage patients with abdominal injuries: if a large peritoneal effusion is present the patient is generally managed surgically, whereas if the ultrasound does not show a peritoneal infusion but solid organ injuries or a retro-peritoneal hematoma, patients are directed to the angiography suite for arteriography and possible embolization.

Embolization is generally reserved for solid organ injuries not associated with a hemoperitoneum. However, in some circumstances in which a hemoperitoneum and multisite hemorrhages are present, particularly if these are combined with pelvic and solid intra-abdominal organ injuries, or aortic injury, endovascular treatment can allow successive, rapid and particularly effective treatment of these different bleeding sites. The indication for its use should be discussed on an individual case basis in conjunction with the traumatology team in the resuscitation room.

General principles of catheterization and embolization

Angiographic investigation for active bleeding should be performed both with overall opacification after intra-aortic injection of contrast medium, and by selective catheterization. The overall injection is designed to provide wide anatomical detection of bleeding sites but is relatively non-sensitive, whereas selective arterial catheterization increases the sensitivity of detection, but is limited to the area being investigated. Conversely, excessively selective catheterization can reactivate a bleed by injecting contrast medium at excessive pressure into an area in which hemostasis has been achieved without treatment through an intravascular clot or spasm.

Depending on each patient's situation, investigations may begin with overall or selective opacification, although both investigation methods should be performed during the investigation.

Catheterization of arteries in a polytrauma patient uses low diameter (4F), highly-flexible atraumatic catheters in order to reduce the risk of spasm in these patients, many of whom are receiving pressor amines (noradrenaline). The end of the catheter should not contain side holes because

of the possible use of coils, which may become blocked in these openings.

The choice of embolization materials always raises the debate between temporary or permanent devices. In young patients with healthy arteries, we feel it is preferable as a general rule to use resorbable materials in order to allow the vasculature to return to normal after the injury and not leave materials within the body. Some situations, however, require permanent materials to be used. These include occlusion of a large diameter arterial trunk, the need for very precise embolization of a small diameter artery or when necrosis of an occluded area is likely to occur (in which case there is no benefit in restoring normal vascularity). The overall cost of implantation materials is also a factor which should be considered when several devices offer equal performance.

It may be necessary in traumatology practice to repeat the embolization because of secondary reactivation of other bleeding sites. The introducer sheath should therefore preferably be left in position until the patient has become stable.

Liver injuries

Pathophysiology of injuries

The liver is a partially intra-peritoneal organ. Because of this, bleeding may occur into the liver parenchyma, the retroperitoneum or the peritoneal cavity. Various traumatic injuries are seen, with combinations of injury to the parenchyma itself, the biliary tract, and branches of the hepatic artery, portal veins or hepatic veins. Peri-hepatic surgical packing is designed to treat venous and biliary injuries by increasing tissue pressure, whereas embolization only applies to hepatic arterial injuries, which are difficult to achieve hemostasis with surgery. The hepatic artery vascularization is terminal in nature, although in practice, the co-existence of arterial and venous vascularization may explain why no complications occur with arterial embolizations outside of the gall bladder territory. These embolizations cause no ischemic biliary complications in healthy people, as opposed to hepatic artery embolization in liver transplant patients. Only obstruction of the cystic artery may result in gall bladder necrosis and this artery should therefore be spared wherever possible. Biliary injuries in liver trauma are responsible for an intense inflammatory reaction in the initial weeks of hospitalization, which very often requires surgery to clean up effusions or drain collections. Embolization therefore forms part of a global management process in which surgery plays a predominant role [1,2].

The place of endovascular treatment in management

The indications for embolization are listed in the guidelines of the American Association for Surgical Trauma (AAST) [3].

Embolization is indicated in a hemodynamically stable patient in whom CT has shown an intrahepatic leak of contrast medium (Fig. 1).

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