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REVIEW

Indications for embolization in a French level 1 trauma center



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Summary Abdominal trauma accounts for nearly 20% of all traumatic injuries. It often involves young patients sustaining multiple injuries, with a high associated mortality rate. Management should begin at the scene of injury and relies on a structured chain of care in order to transport the trauma patient to the appropriate hospital center. Management is multi-disciplinary, involving intensive care specialists, surgeons and radiologists. Imaging to precisely define injury is best performed with whole body dual phase computed tomography, which can also identify the source of bleeding. Non-operative management has developed considerably over the years: this includes selective embolization in case of active bleeding or vascular anomalies in stable or stabilized patients after resuscitation. Embolization has become one of the corner stones of abdominal trauma management and interventional radiologists must play an active role on the trauma team. This overview details the different embolization procedures according to the involved organ and embolic agent used.

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Essential points

- Pre-hospital management and triage of trauma patients to appropriate trauma centers based on the degree of injuries are indispensable elements of regional care networks.
- Management of patients with abdominal trauma should be multi-disciplinary, involving the surgeon, the intensive care physician and interventional radiologist.
- Total body dual (arterial and venous) phase CT is the investigation of reference in visceral trauma.
- Embolization is indicated based on CT findings when faced with active bleeding or arterial anomalies that are at risk of bleeding.
- Prophylactic proximal embolization can be entertained for high-risk organs such as the spleen.

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Introduction

Abdominal trauma accounts for nearly 20% of all traumatic injuries. Mortality can be high depending on the organs involved and particularly when there are multiple injuries [1]. In France, most injuries result from blunt abdominal trauma. Each organ and type of injury may require specific treatment. Lesions vary greatly: deep organ contusion, hollow organ perforation, mesenteric tears, vascular injury with active bleeding, complex pelvic fractures that require multi-disciplinary management (intensive care, surgery and interventional radiology) in specialized trauma centers. For unstable patients, initial diagnosis relies on Focused Assessment with Sonography for Trauma (FAST) to identify intra-peritoneal fluid or air, and can orient care toward emergency surgery if needed [2]. For stable patients, sonography is inadequate and a total body CT scan should be ordered [3,4]. The indications for interventional radiology are determined according to the images obtained with this CT. The goal of this update is to clarify which abdominal injuries are amenable to interventional radiology and to elaborate the primary therapeutic principles.

Triage of patients with abdominal trauma: from the site of injury to the angiology suite

Triage of patients with abdominal trauma begins at the site of the accident; every effort must be made to determine where the patient should be directed based on the type and severity of injury and the available local facilities. In the region of Grenoble, we have set up a network called TRE-NAU (Trauma système du REseau Nord Alpin des Urgence) (North Alpine Emergency Trauma System network) that federates 40 hospitals in six regions (Drome, Rhône, Ain, Isère, Savoie, Haute Savoie) [5]. Patients are classified into three categories (A, B and C according to the VITTEL criteria: A: unstable patient; B: stabilized patient; C: stable patient with risk factor [6]) according to the severity of their trauma and the type of injury suspected, in order to organize their transport to the most appropriate medical facility. The University Hospital of Grenoble is the reference trauma center. This pre-hospital triage allows the patient to be rapidly transported to the best-adapted facility based on severity of injury, to decrease the delay in management and thereby to reduce mortality [7].

FAST

Upon arrival in the hospital, all unstable patients with free fluid detected by FAST are sent to the operating room for emergency operation. Conservative treatment is the rule for stable patients (or those who stabilize with resuscitation). Management of these patients requires the availability on-site 24/7 of a surgeon, an intensivist, and a diagnostic and interventional radiologist.

Total body CT

All stable patients with a suspicion of abdominal injury should have a dual phase (arterial and venous) total body CT that:

- allows better and more complete injury workup than sonography [4];

- decreases mortality [8] and reduces the duration of hospital stay [9];
- reduces the costs while allowing better management and limits the number of complementary investigations [10].

CT allows triage of the patients and notably selection of the patients who are eligible for interventional radiology.

Embolization

In case of active bleeding or a post-traumatic injury with a risk of delayed bleeding (such as a false aneurysm or arterio-venous fistula) embolization can prevent or rapidly control the bleeding. This is called hemostatic embolization. Depending on the organ involved, "preventive embolization" can also be proposed aiming to avoid secondary rupture, as in the case of splenic injury. An interventional radiologist should be consulted for all patients with an arterial injury or a deep organ injury with AAST grades 3, 4 or 5.

Patient position

Ideally, all patients referred for embolization should have an arterial phase CT. This CT angiography provides a complete arterial map while aiding to plan and anticipate the difficulties of catheterization. Embolization should achieve rapid control of bleeding. Patients with multiple injuries should be managed by the intensive care team who should remain with the patient in the angiography suite along with the interventional radiologist. This is because these patients can start to bleed actively and decompensate rapidly, even when young and hemodynamically stabilized.

Embolization technique

Approach

The procedure is performed with the patient lying supine, after injecting local anesthesia at the site of arterial puncture. The right common femoral artery is the preferred site because it is closest to the deep organs and therefore allows the most direct and precise catheterization. This means that the right common femoral artery should be spared as much as possible during the initial stages of resuscitation. If the right femoral approach is not accessible, then the left femoral or brachial arteries can be used.

Catheters

The procedure begins by insertion of a 4 or 5 Fr introducer catheter. Catheters have different shapes and are introduced into different vessels under fluoroscopic guidance according to the desired target and the iodinated contrast injected. Three Fr microcatheters can be used for difficult cases when the artery caliber is small. Digital subtraction angiography is best to obtain a precise arterial map. Image fusion systems exist that use tomographic slices to facilitate endovascular navigation in the angiography suite according to the type of apparatus available.

Embolization agents (Fig. 1)

Temporary agents

Gelfoam sponge is the principle embolic agent (Fig. 1A) for use in trauma because it is inexpensive, easy and rapid

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