Current management of arterial blush and other vascular lesions identified by multidetector-CT in trauma patients.

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Learning objectives

- Determine the frequency of vascular injury in trauma patients studied with multi-detector computed tomography (MDCT) in the emergency department at our institution in a period of 1 year.

- Analyze the influence of the type and location of the vascular lesion in the decision making process of the immediate management for these patients and try to determine if this variables are predictive of the type of treatment to be performed, either surgical, interventional or conservative.

- Conclude if type and location of vascular injury have prognostic value on clinical status at admission and subsequent recovery after treatment.

Background

Types of vascular lesions:

Active bleeding or Blush:

It is defined as extravasation of contrast from the intravascular to the extravascular space and it may be arterial, venous or mixed, categorized depending on the phase of the study in which we find the active bleeding.

- Arterial active bleeding: It will be detected as contrast extravasation in the arterial phase and usually will be linear in morphology (hence the terms jet or blush) and similar in attenuation to the nearest blood vessel. This finding is usually located within a hematoma and in late phases it diffuses into a poorly defined area with similar densitometry, once again, to the nearest blood vessel. Of all types of traumatic vascular lesions, only severe arterial active bleeding ensures immediate active management (Fig 8)

Figure 8. Axial contrast-enhanced MDCT in arterial (A), venous (B) and late (C) phases. Green arrows show a linear contrast extravasation in the arterial phase (A) at the level of right pubic rami diffusing into a hematoma in the adjacent muscle (B) and loosing attenuation in the late phase (C)
Venous active bleeding: It will be detected as contrast extravasation in the venous phase. Morphology is less characteristic than arterial active bleeding, however it will still spread into a poorly defined area in late stages and it will still be found commonly within a hematoma.

Other vascular lesions found in our study:

Pseudoaneurysm:

Intimal injury with haemorrhage contained by the adventitia or surrounding perivascular tissues which allows the formation of a sacular or nodular vessel wall protrusion. Differentiated from active bleeding because the persistent morphology in different phases (Fig 9)

Figure 9. Axial contrast-enhanced MDCT in arterial (A), venous (B) and late (C) phases showing pseudoaneurysm semiology. Nodular hyperdensity originating near a left iliac wing fracture. It doesn't change morphology in different phases but it does loose attenuation accordingly to the vascular pool in each phase.

Arterio-venous fistula:

Injury of the vessel, usually a small artery, with fistulization of the lesion into an adjacent vein. It can be detected as early opacification of a vein in the arterial phase.

In our review, other types of traumatic vascular lesions such as dissection and acute thrombosis were not identified.

Management:

Hemodynamic status is still the most important factor deciding immediate treatment; however, in young adults classic clinical findings may not be found (eg: low blood pressure) because of their sufficient vascular compliance. For instance, radiologic findings may help decide the management.

Arterial active bleeding can be addressed both surgically and with embolization and this will depend on the vascular territory affected and, once again, clinical findings.
**Venous active bleeding** can be managed in a conservative form; for example in pelvic fractures, compression with pelvic stabilizers usually controls the venous or osseous hemorrhage with a high rate of success.

**Pseudoaneurysms**, once a surgical indication, are currently managed in most of the cases with different endovascular techniques, many of those image-guided.

The rest of vascular injuries, except for dissection which usually ensures immediate active management, have specific management depending on each case and location.

Images for this section:

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**Fig. 8**

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**Fig. 9**
Findings and procedure details

A retrospective review was conducted in the electronic system of data collection and clinical history in our hospital during the period from August 2012 to August 2013. We included, for primary revision patients who suffered serious multiple injuries and were managed by the intensive care unit (ICU). Subsequently, on this database, patients who were studied with chest and/or abdominal MDCT (see protocol below) at the time of admission were finally selected, identifying 343 patients.

As main variables, we obtained the following data from the medical record, and also describe the age, gender and presumptive cause of injury:

- **Type of management performed on the vascular lesion** (we discarded treatments that aimed at managing other non-vascular lesions) and these were categorized into three groups: surgical, interventional or conservative management.

- **Hemodynamic stability at admission.**

By analyzing the MDCT study raw data and corresponding radiological report, the following were obtained:

- **Type of vascular injury:** active bleeding or blush (either arterial, venous or mixed), pseudoaneurysm, arterio-venous fistula and other lesions.

- **Location of vascular injury.**

**TECHNICAL PROTOCOL**

The study by MDCT of the patient who has suffered serious multiple injuries involves a commitment by the physician in charge (in the case of our institution by the physician at the ICU) to provide as much information as possible regarding the hemodynamic stability and about the suspected diagnosis.
The commitment of the radiologist should be to provide, as soon as possible, information that in turn responds to the questions posed. Thus, taking into account especially the hemodynamic stability of the patient, the emergency team shall undertake a study focused on finding a cause, hopefully, solvable on short term.

At our institution the basic protocol to be considered in this situation, for the radiologist on duty, includes:

- **If a vascular injury is suspected** (either by the mechanism of trauma or by clinical and laboratory data) a study with intravenous administration of water-soluble non-ionic iodinated contrast media with a 300-350mg/dl concentration, in a 2cc/kg dose and with a 4cc/second rate (taking into account the venous catheter available) is performed.

This study is usually done after head and cervical spine CT (if needed) and is performed with *bolus tracking technique* (BT) after placement of the region of interest in the descending aorta. Generally thoraco- abdomino- pelvic *arterial phase* study (BT + 10 seconds) is followed by a study on *venous phase* of the abdomen and pelvis (BT + 55 seconds).

- **If there is no vascular injury suspicion** it is possible to perform two protocols depending on the severity of the patient:

  - Early venous study of the thorax and upper abdomen (executed with a fixed time of 30 seconds) and portal venous study of the abdomen and pelvis (execute with a fixed time of 70 seconds).

  - Early venous study of the thorax and abdomen with portal venous timing (fixed time 65 seconds).

- **Use of other phases** (late phases or focused on extremities) depends on the presence or absence of findings on the previous phases and clinic (for example, hematuria).

**IMAGE ANALYSIS**

The image analysis is performed through specific programs that allow multi-planar and volumetric reconstruction along with the possibility of transmission to the electronic portal of images (*PACS* picture archive and communication system).
In the case of suspected traumatic vascular injury, the arterial phase of the study is the phase we should pay attention initially because it enables us to detect the presence of vascular injury of arterial origin, and therefore to detect the most serious injury of all.

It is often necessary to increase thickness and reconstruction as well as using maximum intensity projections (MIPs) to get an overall idea of the state of the studied vascular territories. Multi-planar, volumetric and curved reconstructions are also essential for the detection of vascular lesions.

RESULTS

Of 343 patients 68 had acute vascular injury. Secondary variables distribution was: 41 men and 27 women, between 16 and 79 years (mean 39.5 years) with traffic accident being the most common trauma mechanism. Forty patients had hemodynamic stability on admission.

Active bleeding was the most common type of vascular injury identified in 59 patients (Fig. 1), followed by pseudoaneurysm identified in 6 patients. The majority of vascular lesions, 47 cases, were found in a single location, while 13 were identified in two locations and the rest in 3 or more.

Figure 1. Comparison of coronal contrast-enhanced MDCT in arterial phase (A) and late phase (B) Contrast extravasation near the left iliac wing in arterial phase (arrow in A) that is less defined and is less dense in venous phase (arrow in B) showing arterial active bleeding.

22 vascular lesions originated in abdominal organs:

- Nine in liver: All were active bleeding (Fig. 2) 5 lesions were treated with conservative management, one (associating significant renal injury) with surgical management and 3 with interventional management (one was not identified during arteriography and therefore was handled conservatively).

Figure 2. Axial contrast-enhanced MDCT. A) Venous phase B) Arterial phase C) Late phase. Arterial active bleeding (thin arrow in B) within a haematoma (thick arrow in B) in right liver lobe.
- **Six in spleen**: All were active bleeding (Fig. 3). 4 lesions were treated with conservative management and 2 with interventional management (one required subsequent surgical management). One of them was accompanied by concomitant left renal injury.

**Figure 3.** Axial contrast-enhanced MDCT in portal venous phase (note arrow). Contrast extravasation in subcapsular spleen hematoma. This finding wasn't seen in the arterial phase (not shown).

- **Seven in kidney**: 5 were active bleeding, one was an arterio-venous fistula and one was a pseudoaneurysm. Both the arterio-venous fistula and the pseudoaneurysm were treated with embolization, while the latter required subsequent surgery. 2 active bleedings were accompanied by concomitant liver injury.

**Figure 4.** Axial contrast-enhanced MDCT. Thin arrow indicates active bleeding in perinephric posterior hematoma of this shattered left kidney which also shows signs of infarction (thick arrow). Free fluid can be seen in other abdominal compartments (cross)

30 vascular lesions of bone and muscle origin were identified (Fig 5):

- 3 dependent of psoas muscle injuries.
- 1 dependent of injury to the iliopsoas muscle.
- 5 dependent of injury of obturator muscle.
- 2 dependent lesions of the muscles of the inguinal- genital region.
- 5 dependent of fracture injuries to the symphysis of the pubis.
- 4 dependent of injuries and fractures of the ilio-ischial pubic rami.
- 8 dependent lesions of the abdominal wall.
- 2 dependent lesions of the gluteal muscles.
- 2 lesions located in the extraperitoneal prevesical space.

**Figure 5.** Comparison of coronal reconstruction of contrast-enhanced MDCT in arterial (A) and late (B) phases. Arterial active bleeding near the right iliac wing.

Of these, 18 were treated surgically, 9 conservatively and 3 with interventional techniques.
All other lesions (9 cases) were distributed in the chest (3 lesions), non-visceral peritoneum (5 lesions) and non-visceral retroperitoneum (1 lesion) Fig. 6

**Figure 6.** *Arterial active bleeding originated in a superior mesenteric artery branch.* A) Sagittal reconstruction of contrast enhanced MDCT showing contrast extravasation or blush. B and C) Axial contrast-enhanced MDCT in arterial and venous phases, respectively showing active bleeding (arrows) within a peritoneal hematoma. D and E) Digital subtraction angiography of the abdominal vessels showing arterial blush in the capillary phase (circle in D) and post-embolization results (E).

Five lesions showed other specific vascular dependence:

- Four lesions (all pseudoaneurysms) originated in the aorta (Fig 7) and one in the external iliac vein.

**Figure 7.** *Traumatic pseudoaneurysm of the descending aorta.* A) Sagittal reconstruction of contrast-enhanced MDCT with maximum intensity projection (MIP) showing descending aortic pseudoaneurysm (green arrow). B) 3D Volume Rendering display reconstruction showing correlation with conventional projections.

Images for this section:
Fig. 4
Conclusion

Vascular injury is a common finding in trauma patients being found nearly in 20% of the cases and the majority being active bleeding with about 86%, followed by pseudoaneurysms with 9%. Of the latter, most were found in major vessels in our review.

Although closely followed by abdominal visceral injury, the muscular compartment was the most common location for vascular lesion and hence surgical management (usually minor surgery) was applied in most of the cases.

When found in the abdomen there was no clear majority in distribution between liver, spleen or kidney injuries and conservative management was the treatment of choice. The rest of the injuries had non-visceral peritoneal, retroperitoneal and thoracic locations and, except for the aortic lesions that had specific surgical or endovascular management, treatment was conservative for the majority of cases.

Hemodynamic stability was found in 40 of 68 patients, which probably explains for the choice of treatment. We identified that not all cases with hemodynamic stability were treated conservatively probably because many of them had muscular compartment injuries that were managed with minor surgery, or had pseudoaneurysms that were eventually managed with endovascular techniques. This exemplifies that the type and location of the lesion does have important treatment implications. In our review, arterial bleeding did not necessarily implicate immediate management or hemodynamic instability.

Personal information

References