Radiology in the trauma setting

RAD Magazine, 39, 453, 15-16

Dr E L Gerety
Specialist registrar in clinical radiology

Dr S J Freeman
Consultant radiologist

Dr S S Upponi
Consultant radiologist

Cambridge University Hospitals NHS Foundation Trust, Cambridge

Evolution of the major trauma centre

Trauma is defined as ‘wounding due to physical injury’, resulting from a wide variety of causes. Major trauma is defined as ‘trauma that has the potential to cause death or severe disability’. Trauma is a leading cause of mortality and morbidity in patients under 45 years of age. The primary goal of management is to reduce death and disability. This is achieved by timely diagnosis and prompt treatment of life-threatening injuries by an experienced multidisciplinary team.

The American College of Surgeons’ Advanced Trauma and Life Support (ATLS) guidelines, developed in 1976 following an orthopaedic surgeon’s experience of poor trauma care for his family after a plane crash, sets out a safe, reliable system for the immediate management of trauma patients. ATLS revolutionised trauma care by setting out a reproducible pathway to minimise mortality and morbidity. The initial primary survey detects potentially life-threatening injuries (A – airway, B – breathing, C – circulation, D – disability, E – environment/exposure). The secondary head-to-toe survey detects further non life-threatening injuries. Studies have found improved outcomes for trauma patients when treated by experienced trauma teams that see large numbers of patients per year.

In order to provide experienced trauma teams and optimised patient pathways, major trauma centres (MTCs) have been established in the UK. A minimum of 400-650 major trauma patients per year should be managed in order to maintain experience and optimise outcomes. This is only achievable with a centralised approach. An MTC should provide the appropriate surgical specialities and support services to manage all types of major trauma patients with well-optimised management pathways.

Evolution of trauma radiology

In the past, radiology played a relatively minor role in the management of the trauma patient in ATLS training. During the primary survey, standard trauma radiographs of the chest, pelvis and cervical spine might be requested. Focused assessment sonography for trauma (FAST) has been utilised in the UK since the 1990s to look for pericardial or intra-abdominal free fluid. In the secondary survey, thoraco-lumbar and extremity radiographs might be requested, along with computed tomography (CT) if indicated.

FAST has been found to have a poor sensitivity and poor negative predictive value; free intra-abdominal fluid may be found in normal, non-compromised patients. In a recent study at a major London trauma centre, the accuracy of FAST was 59.2% and the negative predictive value 0.39. The Royal College of Radiologists (RCR) currently only considers FAST scanning to have a useful role in the scenario of triage of multiple trauma patients presenting simultaneously, as in a major incident.

Radiology now plays a central role in guiding the management of the trauma patient with multi-detector CT (MDCT) as part of the primary survey. Indeed, the use and safety implications of immediate total-body CT of trauma patients is being assessed in an ongoing international, multicentre randomised clinical trial, REACT-2. Although CT has been referred to as the ‘doughnut of death’, reduced scanning times and increased spatial resolution of current multi-detector, helical CT scanners make MDCT invaluable for diagnosis of the trauma patient. Whereas the cervical spine was cleared on the basis of plain radiographs in the past, the British Orthopaedic Association guidelines now state MDCT imaging as the gold standard for cervical spine clearance in adult trauma patients who are unconscious, unable to cooperate or who have distracting injuries.

CT scanners are usually located in the radiology department, often distant to the emergency department (ED). However, there are now RCR recommendations for the availability of digital radiography in the ED, and MDCT in or adjacent to the ED.

Interventional radiology (IR) is rising to the forefront for haemorrhage control in trauma patients, contributing to ‘damage control radiology’ as an alternative to immediate surgical intervention. Again it is recommended that MTCs have an IR suite close to the ED. MRI must also be available at the MTC but has a secondary role in patient management, especially for the management of musculoskeletal and neurological injuries. In MTCs, radiology and IR must be available 24 hours a day, seven days a week, to manage trauma patients.

MDCT protocols

There must be clear, rehearsed protocols for the preparation of the trauma patient for MDCT and their transfer to the scanner. The trauma radiologist and radiographer should be alerted in order to prepare for the arrival of the patient. The patient must be accompanied by appropriate staff and have venous access for the administration of contrast medium. Staff should be trained for safe transfer of patients with potential spinal injuries onto the MDCT table. The patient must be positioned to avoid artefacts, including those from monitoring apparatus. There have been many studies on the effects of arm positioning, with better image quality when the arms are elevated above the head.

An unenhanced head CT is acquired first, followed by the cervical spine including the inferior endplate of the T1 vertebral body. The chest, abdomen and pelvis are imaged, from C6 to the groin in the arterial phase (25s post contrast) and the abdomen/pelvis in the portal phase (60s post contrast). Protocols vary between departments and these are available from the RCR. If clinically indicated, delayed phase imaging of the urinary system, and vascular imaging of the legs, may also be acquired.

Oral and rectal contrast should be considered in penetrating trauma to the abdomen or pelvis, to help detect bowel injury.

Paediatric trauma protocols aim to reduce radiation exposure. Recently published RCR guidelines emphasise careful consideration of the clinical context and use of radiographs in the first instance whenever appropriate. When CT is
required, the dose should be optimised to the patient’s age and weight and appropriate shields considered. Ultrasound does not have a role in these new guidelines.

Management at the time of MDCT

Following MDCT, an appropriately trained radiologist performs an immediate primary imaging survey of life-threatening injuries (ABC) while the patient is on the MDCT table.14 A trauma radiology proforma may be utilised to aid communication and standardisation.14 Prompt review allows an immediate, informed decision regarding the patient’s pathway after MDCT, whether back to the ED for further assessment or directly to the IR suite or to surgical theatre.

It is well established that good communication and teamwork between the multidisciplinary trauma team members is paramount.14 A recent study of delays in the patient pathway related to MDCT included coordination problems, communication failures, interruptions, patient-related factors and equipment issues; disruptions with the highest clinical impact were related to patient movements while in the scanner, ordering systems, equipment unavailability and ineffective teamwork.15

Reporting of trauma imaging

A full trauma study involves all subspecialities of radiology and requires a timely and accurate report. The radiologist reporting a trauma series must reduce interruptions and distractions as far as possible. Many papers investigating missed trauma injuries were published before whole body MDCT was routinely used.16 However, there are common pitfalls in interpretation of MDCT. A recent American study of on-call resident MDCT discrepancies found fractures, haemorrhage and liver lacerations were the most commonly missed injuries.17

Minimally displaced fractures may be missed, especially if reformatted imaging is not scrutinised in the coronal and sagittal planes (figures 1 and 2). A recent study found that the most commonly missed fractures of high clinical importance were of the sternum, proximal humerus and forearm.18 Subtle intracranial haemorrhage, followed by subdural and subarachnoid haemorrhage, are important findings in the head that may be missed.19 Vascular injuries such as dissection may also be missed, especially if correctly reformatted and windowed images are not carefully scrutinised (figure 3).

Bowel and mesenteric injuries are challenging to detect despite MDCT, as many of the signs, such as bowel wall thickening, abnormal bowel enhancement, mesenteric fat stranding and focal free fluid, are not specific to traumatic injury (figure 4). More specific signs such as bowel wall defects, intra-peritoneal and mesenteric air, bowel infarct and extra-luminal contrast medium from bowel or mesenteric vessels, must be carefully sought.20

Structured reporting has been found to improve the quality of oncology imaging reports in the recent CASPAR project (RCR). The complexity of the pathology and massive volume of images for trauma patients may also benefit from standardised, structured reports; proformas are available in the RCR guidelines.8

Conclusion

Radiology is indispensible in the management of trauma patients. MDCT is at the centre of the diagnostic pathway, with interventional radiology having an integral role in management. Effective teamwork between clinical and radiology departments is essential.

References

8. Ward P. Act now to ensure CT is not ‘the doughnut of death’ in trauma. RCR Today 2012;11.

Figure 1

A 26-year-old male in a road traffic accident, resulting in a left hip fracture dislocation. Plain radiograph (A) acquired in the ED demonstrates a comminuted fracture of the femoral head. Axial CT imaging (B and C) demonstrates posterior dislocation of the head of the femur, with fracture of the anterior, inferior femoral head and posterior lip of the acetabulum. The acetabulum was surgically fixed (D).
Figure 2
A 64-year-old male who fell four metres onto concrete, resulting in multiple rib fractures with a flail segment. Multiple fractures of the ribs (A and B) and vertebral transverse processes (B) can be identified on axial CT images. The flail segment is more easily depicted on 3D reformatted images (C).

Figure 3
A 43-year-old male who was ejected from a vehicle in a high speed road traffic accident, resulting in a pseudoaneurysm of the inferior aspect of the aortic arch. The mobile chest radiograph acquired in the ED was unremarkable (A). Although the aortic arch injury (arrow) can be seen on axial CT imaging (B), it is better appreciated on reformatted imaging (C). Reformatted CT imaging shows management of the pseudoaneurysm with an endovascular aortic stent (D).

Figure 4
A 58-year-old male lorry driver who was in a road traffic accident, resulting in a mesenteric and small bowel injury. Immediate CT imaging showed non-specific signs of pelvic haematoma (arrow, A) and hazy mesenteric fat stranding (arrow, B). The following day, the patient developed an acute abdomen clinically. Repeat CT demonstrates more extensive fat stranding with thickening and loss of definition of the ileal wall (arrows, C-D), indicating mesenteric injury. This was confirmed at laparotomy.