UPDATE

Radiological management of patients with multiple trauma: history and current practice

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Abstract

The radiologist plays a crucial role in the multidisciplinary management of patients with multiple trauma. In the last few decades, technological advances and changes in the healthcare culture have led to changes in the imaging work-up of multiple trauma patients, with emphasis shifting from plain-film radiography to whole-body multidetector CT.

This article describes the evolution of the different protocols and the current practice in the management of patients with multiple trauma. As a member of the multidisciplinary team, the radiologist must decide imaging which one is the most adequate technique and protocol for each situation after taking in consideration the technological resources available.

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KEYWORDS

Multiple trauma; Protocol; Conventional radiography; Whole-body multidetector computed tomography

PALABRAS CLAVE

Politrauma; Protocolo; Radiología simple; Tomografía computarizada multidetector de cuerpo completo

Manejo radiológico del paciente politraumatizado. Evolución histórica y situación actual

Resumen

El radiólogo desempeña un papel crucial en el manejo multidisciplinar del paciente politraumatizado, que en las últimas décadas ha sufrido un cambio evolutivo desde la radiología simple hasta la tomografía computarizada multidetector de cuerpo completo, propiciado por los avances tecnológicos y los cambios culturales sanitarios.

En este artículo se muestra la evolución de los diferentes protocolos y la situación actual del manejo del paciente politraumatizado.

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Introduction

Polytrauma is defined as the injury to multiple anatomical areas as a result of life-threatening biomechanical trauma. The etiology of polytrauma includes traffic accidents, falls, crushes, explosions, and other serious events. It represents the third cause of global mortality and the first among young adults. Traumatic death often occurs quickly and, although its time course is influenced by factors such as age, mechanism, or area of injury, it is classically described as having a tridimensional distribution: early, by injuries incompatible with life; secondary, by hemorrhage, and late, as a result of multiple organ failure. Medical action should focus on the second phase, which determines the third. In the 70s, Cowley established the concept of the “golden hour” and systematized protocols for approach to a polytrauma patient (PP). This work provided the foundations for “advanced trauma life support” (ATLS) and described basic approaches such as “treat first what kills first.” Moreover, Cowley emphasized that the absence of a definitive diagnosis or appropriate medical records should not prevent the initiation of treatment measures and life support to ensure airway patency and respiratory function and maintain proper cardio-circulatory function. Only later the first approach, the causes of respiratory or hemodynamic instability and other possible injuries, are systematically investigated, prioritizing injuries by severity (life-threatening first) in a “head to toe” approach. Now, the clinician has to pay close attention to conditions and mechanisms of injury, vital signs, obvious anatomical damage and situations during patient pick up and transport. This information is often incomplete, but is useful to classify the injury as high or low impact to guide the radiological study, which is the only noninvasive option for assessing the real extent of injuries. Subsequently, one should perform a thorough review of systems and select the most appropriate treatment option.

Adherence to pre-established protocols improves handling of the PP and promotes a coordinated and effective response. Since the American College of Surgeons (ACS) incorporated the ATLS model in treatment protocols for polytrauma, imaging tests have come to be part of the initial assessment, together with the primary clinical assessment and life support maneuvers. Technological development provides increasingly reliable diagnostic methods, allowing for rapid, complete, and accurate assessment of all injuries. For this reason, continuous updating of these guidelines is required. In less than 20 years, there has been a shift from an almost exclusive use of simple radiology to increased direct application of Multidetector Computerized Tomography (MDCT) in the primary evaluation. The aim of this article is to provide an evolutionary view of the different protocols, describe the rationale underlying changes to protocols, and provide current guidelines for the use of each of the techniques. Five periods have been established. These have overlapping historical boundaries and are somewhat dependent upon the availability of technology and cultural habits of each center. These periods can be described as:

1. The conventional radiology period.
2. The focused abdominal sonography for trauma (FAST) ultrasound revolution.
3. “Justified” use of computerized tomography (CT) as second-line for diagnosis.
4. MDCT as first line of exploration in stable patients.
5. Whole-body MDCT protocol.

1. The conventional radiology period

The American College of Radiologists (ACR) establishes the clinical practice guidelines for the field of radiology. They define indication levels for radiological exploration, assigning values from 1 (least appropriate exploration) to 9 (optimal indication). In the late 1980s peritoneal lavage puncture (PLP) and the ‘basic radiological approach’ (lateral cervical spine radiographs, anteroposterior (AP) chest and AP pelvis) were recommended for the PP evaluation. PLP involves the introduction, and subsequent aspiration, of serum into the peritoneal cavity to test for the presence of blood. Its high sensitivity (95%) makes a positive PLP test a good indicator for immediate laparotomy to identify and treat the source of bleeding in an unstable patient. A negative PLP suggests that the bleeding is extraperitoneal and other possible sources of bleeding are sought (hemomediastinum, pelvic fracture, retroperitoneal bleeding). The level for indication of arteriography is 5/9. In stable patients with a negative PLP, clinical observation is considered sufficient. Indeed, the decision making for conservative treatment of a positive PLP is more difficult. Limitations of this technique include its invasive nature, the difficulty in interpreting results, and interference with imaging techniques due to introduction of liquid and air into the peritoneum. Today, the only indication for PLP is the suspicion of intestinal perforation without evidence of pneumoperitoneum.

The portable chest radiograph has been the most useful initial examination method for the identification of life-threatening injuries. It has high sensitivity but low specificity. It is appropriate to investigate the presence of hemomediastinum, pneumothorax, hemothorax, flail chest and subcutaneous emphysema (fig. 1), but it misses out small pneumothorax and pulmonary contusion/laceration. Pneumothorax appears in one third of serious chest injuries,
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of which half will not be identified initially and one third will progress to a tension pneumothorax. Tracheal or diaphragmatic rupture and double rib fractures are known causes of altered respiratory dynamics and exhibit mortality rates exceeding 30% when identified. The presence of subcutaneous emphysema is a warning sign that may indicate serious injury to the pleura, mediastinum, trachea or esophagus. The pleural cavity can store a large volume. Consequently, a severe hemothorax compromises both respiratory and hemodynamic status and, when its origin is blood a haemostatic treatment is required in addition to drainage. Hemorrhage is present in 40% of severe chest trauma (although only 0.1% is due to aortic rupture) and must always be ruled out when a widened mediastinum is present, regardless a left apical cap is present or not. Suspected pericardial effusion identified by radiography can be confirmed by FAST, which allows direct pericardiocentesis. The chest radiograph can also be used to monitor tubes and catheters.

Pelvic radiography (fig. 2) is useful in the PP because pelvic fractures are considered a marker of serious injury and associated with other relevant injuries in 11 to 20% of cases. Its sensitivity is 50-60% and its presence explains the presence hypotension when other bleeding sites have been excluded. They appear in 4-9% of blunt trauma cases and involve a risk of hypovolemic shock due to associated abdominal or retroperitoneal bleeding. Mortality mainly occurs in the first 24 hours and increases when the fracture is not diagnosed early, reaching a 54% in the presence of hemorrhagic shock. External fixation can control venous bleeding, but when its source is arterial, endovascular or surgical hemostasis is necessary. In the absence of an MDCT study that identifies it, this latter situation should be suspected in cases that present with a failed response to resuscitation with negative FAST. Usually, acetabular fractures only influence the functional prognosis.

Lateral radiography of Cervical Spine (CS) detects, with proper technique, up to 70% of cervical fractures but has a low probability of identifying additional injuries. Moreover, patient cooperation is required. Cervical lesions occur in 5 to 10% of major trauma cases and knowledge of their presence may be relevant for tracheal intubation. More commonly, fractures involve the posterior elements of C1-C2, the craniocervical junction, and C7 (fig. 3). It is assumed that up to 30% of fractures are not diagnosed initially due to technical limitations or defects in exposure and of these, 10% have clinical relevance.
2. The FAST ultrasound revolution

In the 90s, before CT was fast and accessible enough for critical patients, ultrasound was used in the management of abdominal trauma due to its portability and sensitivity in detecting free intraperitoneal fluid, a marker of visceral injury. Different teams of radiologists and surgeons applied special criteria with mixed results, until a committee of experts standardized basic aspects such as nomenclature, technique, and accreditation systems to achieve comparable results between different groups. FAST was defined as a simplified and rapid exploration (3 to 5 min) to identify free fluid, with a focus on the 4 “P”s (pericardial, perihepatic, pelvic and perisplenic) and extending to the pleura and retroperitoneum. By the year 2000, FAST had replaced PLP in most of the polytrauma centers in developed countries, because of its safety, possibility for intercalation with patient stabilization maneuvers, and potential for repetition after the clinical follow up.

Several factors were important in facilitating the intensive use of imaging techniques in management of PPs. A growing body of evidence illustrated the superiority of non-operative management of traumatic visceral injury. Moreover, it became apparent that the mere presence of peritoneal fluid did not predict, by itself, the need for urgent intervention. Thus, the use of imaging techniques to quantify the hemoperitoneum or its progression increased substantially. Indeed, the existence of so many approaches and classifications illustrates the difficulty in establishing a clear guideline for surgical intervention in cases of hemoperitoneum.

There are several parameters taken under consideration for the evaluation of intra-abdominal fluid, such as: thickness of the fluid in different areas, length of the major collection, other possible locations and number of locations. Of these, upper right quadrant fluid was the most useful independent factor for predicting the need for surgery. An important limitation for the ultrasound is beam transmission in patients with subcutaneous emphysema, pneumoperitoneum or obesity. Bladder filling by simply pinching the catheter can increase fluid detection up to 73%. The technique is equally operator-dependent, but with a learning curve and accreditation criteria less stringent than for a regulated abdominal ultrasound. The sensitivity of FAST depends on the reference standard, ranging from 43-63% when comparing with CT or

laparotomy and reaching up to 95% when clinical outcome is used. When comparing with CT, ultrasonography is much less sensitive and consequently, not as useful in stable patients, especially if one considers the high percentage (31-34%) of those that do not exhibit hemoperitoneum given that their lesions are retroperitoneal or pelvic in localization, contained bleeding, or isoeogenic clot. Nonetheless, because FAST is time intensive and requires an experienced practitioner, it is not the immediate choice for the detection of visceral injury. When conducted by an experienced radiologist and without a delay in treatment, the sensitivities of ultrasound in the detection of visceral injury are 87%, 77%, and 44% in the liver and spleen, kidneys, and pancreas, respectively. The main cause of false positive results is the impossibility of distinguishing blood from preexisting liquid (periovulatory, ascites) or even fluid-filled bowel loops. The use of ultrasound contrast increases the sensitivity for visceral injury and facilitates the detection of active bleeding regardless of its amount.

3. “Justified” use of CT as a second line diagnostic tool

Traumatic brain injury (TBI) is the leading cause of death in people under aged 45 years and accounts for half the deaths in PPs. Cranial CT scan is recommended in all protocols for TBI, with an indication level of 9/9. A thorough search for brain injury (for the purpose of an urgent decompression) is a high priority in patients presenting with a score of < 9 on the Glasgow coma scale (GCS) or with mydriasis or signs of decerebration, as long the vital signs allow it. CT can identify other possible associated head injuries, monitor their progress and response to therapy, and permit prognostic assessment.

Factors such as remoteness of the CT scan room, long scan times, and critically ill or unconscious patient status, result in risky excursions and deficient explorations. As a result, in these cases, the standard recommendation is “do not transport an unstable patient to Radiology”. The exception being neurological patients, who, once in the CT scanner, can have partial thoracic and abdominal studies performed (3 or 4 slices) with sometimes surprising results. With faster scanners, the indications for CT in hemodynamically stable patients are more flexible and the information retrieved more extensive than that provided by the clinical-radiology-ultrasound. The expanded indications for CT are:

- FAST positive, for identifying the bleeding organ.
- FAST negative and suspicion of abdominal injury.
- FAST positive/negative with other injuries involving high-energy trauma (pelvic/femur fracture) with high prevalence of occult lesions.
- Suspicion/evidence of neck injury or incomplete visualization of the CC in the lateral radiography.
- Assessment of mediastinal widening on AP chest radiography to investigate possible bleeding and its origin (venous, arterial, aortic).

While the utility of information derived from CT is apparent, the relative sluggishness of the equipment does not permit a comprehensive study in the PP, where multiple injuries are the rule. Effective use of CT requires identification of the anatomic segment where actions should primarily be focused, with a strategy that defines different “pockets of interest” such as brain, spine, soft tissues of neck, thorax/mediastinum and abdomen.

4. MDCT as exploration of the first line in stable patients

The introduction of the first multidetector systems demonstrated that the limiting factor in CT exploration of the PP is the transfer to the Radiology Department and not the duration of exploration. If the total time spent performing a CT brain scan, cervical scan, and thoracoabdominal scan is 40 min, 45% of that time is consumed in transportation, 35% in data acquisition, including disruptions caused by the patient’s condition, and the remaining 20% in image manipulation and reformating. The increasing availability of CT scanners in the areas of Emergency Radiology progressively illustrates the limitations of conventional radiology and ultrasound in the PP, and this is reflected in management guidelines. The CT of abdomen and pelvis has earned its position as the modality of choice in the evaluation of abdominal trauma, assigning a level of indication of 8/9, well above the FAST, due to the low sensitivity of the FAST in the detection of visceral injury. For cultural and architectural reasons, the management of the unstable patient by the traditional methods of conventional radiology and FAST, which indicates laparotomy in cases of frank hemoperitoneum without prior CT scanning, is largely accepted. However, in the clinical setting of the hemodynamically stable patient, the traditional that will be evaluated with CT, the need for the classic triad of conventional radiology in PP, (chest, pelvis and CS) which are time consuming and unlikely to offer new information, should be questioned.

Pelvic radiography (PR) is less sensitive than CT in detecting pelvic fractures. As such, it was proposed nearly ten years ago that PR should not be used in stable patients on whom the CT is performed during the initial assessment. Recent studies have confirmed that CT can identify up to 33% of pelvic fractures not detected by PR, so the later exclusion from the ATLS protocol was proposed in cases where CT scan is feasible. The presence of pelvic fracture is an important prognostic factor associated with abdominal hematoma in one third of cases, half of them with active bleeding, and there is still controversy about the optimal initial treatment. While some base their intervention on the fracture pattern, with immediate external fixation in fractures with high probability of venous bleeding. Others think that the presence of ongoing hemodynamic instability indicates arterial bleeding uncontrollable by external fixation and prefer early angiography before. PR was assigned a predictive value depending on the anterior or posterior location of the fracture. The dispute was resolved with the advent of MDCT, capable of identifying active bleeding, and providing a direct indication of embolization and information on the three-dimensional pattern of the fracture. Thus, routine use of PR makes little sense in the management of the PP, which provides no useful information and increases the radiation dose by up to 20%.
The usefulness of Cervical Spine radiography has been equally challenged by the technological evolution of the CT, in the 90’s the use of CT was limited to the confirmation of suspected or obvious lesions on the lateral radiography or when visualization was incomplete in high-risk patients, always with exploration limited to the area of interest.48 Progressively, the MDCT became the established technique for the evaluation of PP, making simple radiography unnecessary when there is likelihood of neck injury,49,50, especially in high-energy trauma, since it allows the full assessment of the CS.51 Multiplanar reformatting (MPR) facilitates the identification of fractures in the axial plane, and only in cases where the performance of CT is not possible conventional radiological studies will be performed.49 The CT identifies 99.3% of fractures, dislocations, and intracranal fragments throughout the spine with a sensitivity 2.5 times higher than that of X-ray,52 detects up to 30% of fractures, mainly of pedicles or laminae, not visible in the lateral projection; and predicts instability in 100% of cases.53 Low-risk patients do not need any cervical radiological study, and are identified by the criteria of national emergency x-radiography utilization study (NEXUS).54

- Absence of midline cervical pain.
- No neurological deficits.
- Normal level of consciousness.
- No evidence of poisoning.
- Absence of other distracting painful injuries to the patient.

This procedure must be particularly rigorous in children, where the indications for CT should be optimized in order to minimize unnecessary radiation doses. An over-indication of conventional radiological examinations that should not have been transferred to the CT has been reported, with found pathology indices of 0.98%, which indicates defective indication criteria.55 For children younger than 16 years old, the ARC proposes cervical, dorsal, and lumbar spine radiographies when there is an indication, unless a thoracoabdominal CT is going to be performed, in which case the last two may be disregarded.49

AP chest radiography has a diagnostic yield much lower than CT, but has been judged necessary in monitoring the PP, so it remains a part of the routine initial assessment, with an even higher ACR indication level (RX-9/TCMD-8).4 CT has a higher sensitivity for the diagnosis of vascular and diaphragmatic lesions56 without the limitations of radiography in the initial assessment of the pleura, parenchyma, airway and chest wall, which supports its use as a modality of choice in thoracic trauma.57 It detects 20-33% of injuries involving changes in therapeutic management, both in hemodynamically stable (pneumothorax) and in unstable (vascular injury) patients.41 With particular mechanisms of injury (e.g., being run over at a speed of more than 48 km/h, falls from more than 7 m), a routine chest CT is recommended, even with normal X-ray.58

MDCT angiography detects whether mediastinal hemorrhage is of aortic origin, and recognizes, with similar sensitivity to arteriography, the direct signs of aortic injury: pseudoaneurysm and abrupt change in contour, intimal tear, intramural hematoma, extravasation of contrast, pseudoacoarctation, double-light or dissection flap; for this reason the CT angiography has been proposed as the initial diagnostic technique, reserving arteriography for therapeutic use. Even as a baseline for monitoring, it has been postulated that a coronal MPR reconstruction with a thick volume provides a similar image quality and diagnostic accuracy as AP chest radiography, which could be eliminated from the initial assessment.59

Thus, technological development makes MDCT more adequate for seriously ill patients, but this fosters a cultural change,60 reducing the classical radiological approach for unstable cases that “cannot” be transferred to the CT room, usually located in the “central” service. Unsuspected lesions are being discovered early, and there is a growing belief that the most critical patients are precisely those who could the most benefit from the MDCT scan “from head to trochanters” that is becoming established the practice for the rest of PP.

5. Whole-body MDCT Protocol

Although studies published in German first indicated a different model of care for the PP with early use of CT, it is not until halfway through the 2000s when the concept of pan scan MDCT protocol began to spread in the English language literature, when it was proposed as the ideal technique for the primary assessment method for all PP, even in unstable patients. This demands some requirements such as a multi-disciplinary team, ensuring continuous care in the inpatient/outpatient setting, accessibility of the CT room, including architectural proximity, with adequate resuscitation equipment and 24h availability of CT.61-63 Modern MDCT teams are the best diagnostic tools in the initial management of severe PP because of the technique’s speed, wide coverage, high sensitivity, and accuracy in detecting and characterizing lesions. In addition, it provides comprehensive information on head, neck, thorax, abdomen, spine and extremities, with the definition of a three-dimensional image characteristic of routine use of isotropic voxels, which offers real multiplanar images as fast as the FAST. Its sensitivity in the detection of active arterial bleeding is similar to the first branch digital angiography and predicts the need for urgent treatment with a sensitivity above 95%, allowing the anticipation of hemodynamic instability, a crucial fact if one considers that the probability of death increases by one point for every three minutes of delayed intervention.62 In this way, it stresses the concept that hemodynamic instability should not be a contraindication for the performance of MDCT, once the barriers have been eliminated and exploration can be made immediately, with a well-designed protocol and in a well-prepared patient. The scanning can be completed in less than 15 min, with acquisition times below 15 sec, and serious injury information available immediately.64 The examination usually begins with a basal skull sequential acquisition, followed by a second one, from the odontoid to the lesser trochanter, on a portal phase (70 s after the start of injection, 3 cc/sec, total dose adjusted according to weight). For suspected vascular injury, an arterial phase of the region may be added prior to the portal phase and using the same injection of contrast (fig. 5). When suspicion
is established on the MDCT findings of the study itself (i.e., mediastinal hematoma with possible contained aortic injury) additional injections can be performed and a CT angiogram may be obtained if the patient’s condition allows it and additional information is considered essential. The presence of contrast extravasation, hematuria, or suspicion of excretory tract injury requires the conduction of a late phase (5 min) usually with a low-dose technique. \(^\text{64}\)

When comparing the results of the “MDCT protocol” with the conventional approach, the quality indicators show positive results for the first: shorter scan times (12 vs. 30 min), greater number of lesions identified early on (> 90%), lower missed lesions rate, and reduced length of stay in emergency room, and lower door to operating room, and door to ICU times. It also reduces the number of days on a ventilator, ICU and hospital stay, and multiorgan failure rate. A recent multicenter review found an improvement in survival of PP when the MDCT was performed early, after admission, thus its use is recommended in the primary assessment. \(^\text{65}\) To optimize these results, the radiologist should be integrated into the multidisciplinary team of polytrauma, know the classification systems in his/her center, and take responsibility for the proper use of a resource of great diagnostic performance but which has been, for many years, the first source of radiation with diagnostic purposes. Due to low specificity of clinical examination, the indication is usually set according to the mechanism of injury, vital signs, or anatomical lesions indicative of high energy trauma (table 1). In younger patients with less serious injuries, clinical observation and ultrasound (conventional) are useful tools, being aware that, in this age group, apparent hemodynamic stability
The authors declare not having any conflicts of interest. Thus, any unknown high-energy mechanism

### Conclusion

Radiological assistance to severe trauma patients has undergone important changes in recent years, imposed by technological development and medical culture changes. The incorporation of MDCT and its progressive accessibility to areas of critical patients has improved all indicators of quality in the PP, including survival, relegating all other imaging techniques to second place. Conventional radiography and FAST ultrasonography still have an important role in highly unstable patients with sustained hypotension, but the radiologist, integrated as an active member of the polytrauma team, is the one responsible for selecting the appropriate scan pattern to provide, in each case, the best possible information with the smallest radiation dose.

### Conflict of interest

The authors declare not having any conflicts of interest.

### Table 1 Indication for Whole-body MDCT PP

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<tr>
<th>Category I</th>
<th>Vital signs:</th>
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<tbody>
<tr>
<td></td>
<td>Hemodynamic instability (SBP &lt; 90 mm Hg, pulse &gt; 120)</td>
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<tr>
<td></td>
<td>Respiratory distress, mechanical ventilation and/or unstable airway</td>
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<tr>
<td></td>
<td>GCS &lt; 12</td>
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<tr>
<td>Evident injuries:</td>
<td>Penetrating injuries to head, neck, torso or proximal to knee and elbow</td>
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<tr>
<td></td>
<td>or neurovascular compromise</td>
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<tr>
<td></td>
<td>Traumatic amputation proximal to wrist or ankle</td>
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<tr>
<td></td>
<td>Burns with &gt; 15% of SCT and/or facial burns, suspicion of injury by inhalation</td>
</tr>
<tr>
<td></td>
<td>or respiratory distress</td>
</tr>
<tr>
<td></td>
<td>Open or unstable pelvic fracture</td>
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<tr>
<td></td>
<td>Outpatient positive Eco-FAST</td>
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<table>
<thead>
<tr>
<th>Category II patient with age &gt; 65 years</th>
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<tbody>
<tr>
<td>Patients with risk based on mechanism of injury*:</td>
</tr>
<tr>
<td>Car ejection</td>
</tr>
<tr>
<td>Fall from higher than 5 m or building collapse</td>
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<tr>
<td>Vehicle rolled, carrier deformity</td>
</tr>
<tr>
<td>High speed impact (&gt; 60 km/h or 48 km/h)</td>
</tr>
<tr>
<td>Car-pedestrian accident or bicycle (&gt; 10 km/h)</td>
</tr>
<tr>
<td>Motorcycle accident &gt; 30 km/h or separation of the bike rider</td>
</tr>
<tr>
<td>Any unknown high-energy mechanism</td>
</tr>
<tr>
<td>Altered level of consciousness by trauma with GCS &lt; 14</td>
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<tr>
<td>Stable patient with multiple trauma</td>
</tr>
<tr>
<td>Multiple fractures (more than two long bones)</td>
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<td>Stable pelvic fractures</td>
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</tbody>
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can be maintained until bleeding is massive and shock is inevitable. It is essential to find parameters substantiating the indication in these cases.66

**References**


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61. Heissmann MH, Hofmann A, Kreitner KF, Lott C, Rommens PM. The benefit of multislice CT in the emergency room


