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Polytrauma Patients and the Significant Role of the Radiologist Diagnosis Through the Imaging Management

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Abstract
This study aimed at recognizing that images have become important not only for diagnosis but also for treatment, and also lies in the analyzing processes of the imaging diagnosis of multiple trauma patients and the significant role of the radiologist diagnosis through the imaging management. The researchers adopted the survey methodology for gathering data upon the recent worldwide studies concerning the polytrauma patients and the significant role of the radiologist diagnosis through the imaging management. The study concluded that the decision to manage the patient surgically or by percutaneous intervention depends upon the clinical severity and secondarily on the findings of whole body MDCT; which identifies blunt polytrauma related injuries which require intervention.
Keywords: Polytrauma, Radiologist, Imaging Management and Diagnosis.

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This research was conducted upon joint efforts of the authors in gathering data, analyzing the literature concerning the subject under investigation. Data was validated, categorized and sorted in the order in which they were received.
Dr. Atheer Abdullah alhoshan , Dr. Ali Ibrahim Alsalbi, Dr. Leejin Saleh Bin Kleib are the main authors, and Dr. Hamad Faihan Jubair Almotairi, Dr. Aledrisi Maryam Khalid I, Dr. Nora Ahmed Altorbak and Dr. Amani Mohammad Abbad Alwadei as co-authors.
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1.1 Introduction

The initial evaluation of a person who is injured critically from multiple trauma is a challenging task, and every minute can make the difference between life and death. Over the past 50 years, assessment of trauma patients has evolved because of an improved understanding of the distribution of mortality and the mechanisms that contribute to morbidity and mortality in trauma. Mortality can be grouped into immediate, early, and late deaths. Immediate deaths are caused by a fatal injury of the great vessels, heart, or neurologic system.
Early deaths may occur minutes to hours after the injury. Injured patients frequently arrive at a hospital before death which usually occurs because of hemorrhage and cardiovascular collapse. Late trauma mortality peaks from days to weeks after injury and is primarily due to sepsis and multiple organ failure. Organized systems of trauma care are focused on the salvage of a patient from early trauma mortality; whereas, critical care is designed to avert later trauma mortality. Early deaths result from failed oxygenation of vital organs, massive central nervous system injury, or both. Mechanisms of failed tissue oxygenation include inadequate ventilation, impaired oxygenation, circulatory collapse, and insufficient end organ perfusion. Massive central nervous system trauma leads to inadequate ventilation and/or disruption of brain stem respiratory centers. Injuries that cause early trauma mortality occur in predictable patterns based on mechanism of injury; the patient's age, gender, and body habitus; or environmental conditions. Recognition of these patterns led to the development of the Advanced Trauma Life Support (ATLS) approach by the American College of Surgeons. ATLS is the standard of care for trauma patients, and it is built around a consistent approach to patient evaluation. This protocol ensures that the most immediate life-threatening conditions are quickly identified and addressed in the order of their risk potential (American College of Surgeons, 2012).
As a major public health concern throughout the world, trauma is probably the most serious of all health problems facing the developing countries. In the Arab world countries, injuries are the leading cause of death up to the age of 45 years. The improvement in imaging techniques that occurred during the past 30 years have deeply modified the conception and the understanding of trauma patients management. Before the advent of computed tomography (CT) and sonography, surgery was liberally used for both diagnostic and therapeutic purposes with the drawback of nontherapeutic surgical procedures being associated with a significant increase of morbidity (Poletti, Platon & Becker, 2007).
Trauma is the most common cause of death for people under the age of 50 and it causes greater losses of life. Time is one of the most relevant factors for the survival of injured patients, particularly the time elapsed from trauma until the resuscitation procedures. As a member of the trauma team, the radiologist contributes to the

rapid diagnosis of traumatic disorders, with appropriate imaging modalities. Based on the evidence, the most appropriate diagnostic tool for severe/multiple trauma is computed tomography (CT). With the advent of multi-detector CT (MDCT), radiologists are able to more effectively characterize life-threatening traumatic disorders within a few seconds in stable or stabilized patients. Considering the diagnostic potential of MDCT, conventional radiographs could be virtually abandoned in the diagnostic algorithms for adult polytraumatized patients. The radiologist helps to facilitate triage and to assess the optimal individual treatment for polytrauma patients, thus contributing to the improvement of patient outcomes (Schueller, Scaglione, Linsenmaier, Schueller-Weidekamm, Andreoli, Macciucca & Gualdi, 2015).

In trauma, time is one of the most crucial factors in predicting prognosis. Whole body multi-detector computerized tomography (MDCT) can decrease this critical time and increase survival. Emergency CT plays a major role in diagnostic in the evaluation of patients with trauma; these patients usually have simultaneous injuries to several anatomic regions or organs (Huber-Wagner, Lefering, Qvick, Körner, Kay & Pfeifer, 2009).

CT can detect small pneumothoraxes, which are occult on radiographs, which may become potentially life threatening when the patient is on positive pressure ventilation. Contrast-enhanced MDCT has now almost completely replaced DPL (diagnostic peritoneal lavage) as principle diagnostic modality for evaluation of abdominal trauma. CT can help in selecting patients requiring operative management. It can identify majority of patients who can be managed non-operatively, by identifying the extent of visceral injury. MDCT is markedly superior to radiographs in musculoskeletal injuries, especially in areas of complex bony anatomy owing to its spatial resolution and multi-planar reconstruction techniques. Furthermore, it also provides useful information about adjacent soft tissue and vascular injuries. It is considered as a problem solving modality in this regard and particularly used in evaluation of fractures of tibial plateau, ankle joint and epiphyseal trauma (Mauffrey, Vasario, Battiston, Lewis, Beazley, & Seligson, 2011).

1.2 Problem statement

Deaths and injuries caused by accidents and acts of violence are of grave concern for current society and are among the main causes of morbidity and mortality in the world, affecting both developed and developing countries alike (Motta-Ramírez, 2016).

The mortality rate is elevated, and the population suffering such accidents is part of the economically active population that would otherwise be healthy and productive were they not affected by these problems. The practice of medicine in the 21st century implies a multidisciplinary approach1. Trauma represents an urgent clinical-surgical condition that is difficult to assess because of the different possibilities of injury that deserve specialized multidisciplinary treatment2. Management of the polytrauma patient is a race against time. The clock starts ticking at the moment of the incident. The golden hour is the first one after the injury, during which the patient has to be systematically evaluated and all life-threatening injuries have to be identified. The problem of this study lies in recognizing that images have become important not only for diagnosis but also for treatment, and also lies in the analyzing processes of the imaging diagnosis of multiple trauma patients and the significant role of the radiologist diagnosis through the imaging management.

1.3 Computed tomography (CT) findings in polytrauma

There are multiple complications caused by polytrauma the requires surgery or percutaneous Intervention:

1.3.1 Major vascular injuries

Major vascular injuries as show in figure (1) are rare but serious complication that occur in 0.11% to 2% of cases, most frequently involving the aorta and common iliac vessels. Major vascular injury will present with sudden hypotension/ tachycardia and with rapid accumulation of blood in the abdominal cavity, a mesenteric hematoma, or an expanding retroperitoneal hematoma (WHO, 2017).

With the advent of multi-detector CT, major vascular injury can be accurately diagnosed in a noninvasive timely fashion, allowing optimization of patient care and efficient use of department resources.

Figure (1): Major vascular injury

1.3.2 Active haemorrhage

Major haemorrhage is a life threatening emergency which can result from trauma (blunt, penetrating, or mixed) or a range of surgical and medical pathologies. This operating procedure is primarily focused on haemorrhage following trauma but the general principles of haemorrhage control and resuscitation apply to medical, surgical and obstetric patients (Williams-Johnson, McDonald, Strachan & Williams, 2010).

Contrast-enhanced multi-detector CT images of patients with blunt abdominal trauma can be reviewed for finding the represented active hemorrhage. The site and appearance of the hemorrhage could be noted on multi-detector CT images, as shown in figure (2). These findings could be compared with surgical and angiographic results or with clinical follow-up later.

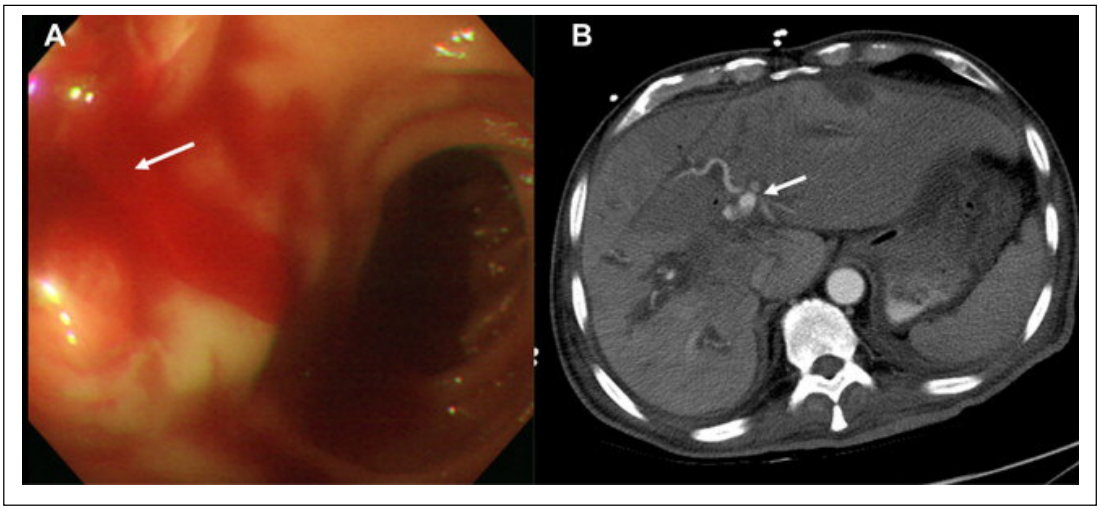

Figure (2): Active hemorrhage and the site and appearance of the hemorrhage noted on multi-detector CT images

1.3.3 Unstable spinal fractures

Spinal fractures are frequently located at the thoracolumbar junction for biomechanical reasons. The imaging modalities of choice are standard radiographs and CT scans. A CT scan should routinely be made to visualize bony injury, as shown in figure (3).

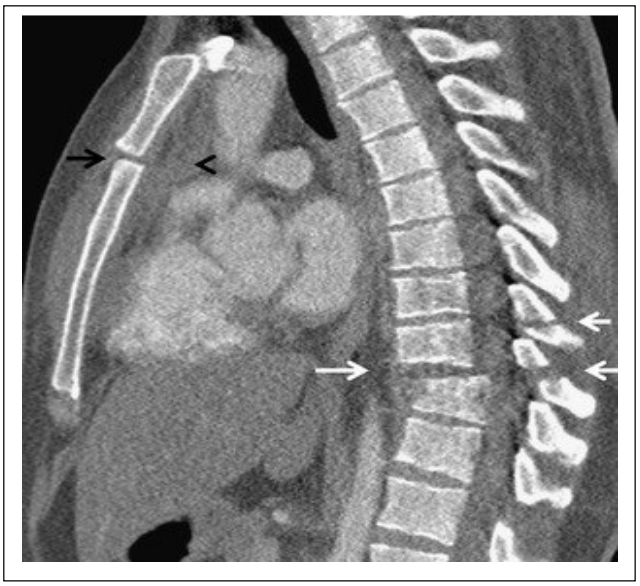

figure (3): Unstable spinal fracture

1.3.4 Diaphragmatic rupture

Traumatic diaphragmatic injury has been found in 3%–8% of patients undergoing surgical exploration after blunt trauma and in 10% of patients with penetrating trauma. The rate of initially missed diagnoses on computed tomography (CT) ranges from 12% to 63%.

Various imaging modalities including chest radiographs, ultrasonography, CT as shown in figure (5), and magnetic resonance imaging have been used in the diagnosis of diaphragmatic rupture. Currently, multi-detector CT (MDCT) is the modality of choice for the detection of diaphragmatic injury as shown in figure (6) (Panda, Kumar, Gamanagatti, Patil, Kumar & Gupta, 2014).

Figure (5): CT image demonstrate an acquired diaphragmatic rupture (arrowhead)

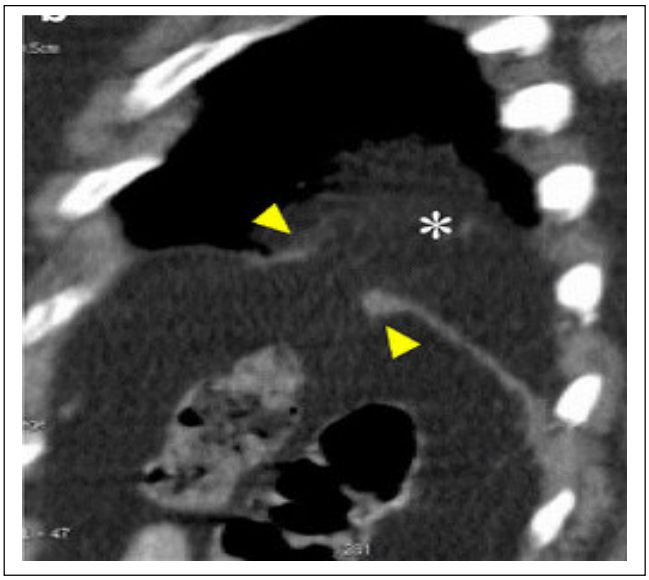

Figure (6): MDCT image demonstrate diaphragmatic rupture (arrowhead)

1.3.5 Pancreatic injury with ductal involvement

Pancreatic injury can pose a formidable challenge to the surgeon and failure to manage it correctly may have devastating consequences for the patient. Detailed knowledge and correct application of the available operative choices is important. The purpose of this review is to discuss extensively such management options, as well as to highlight technical issues and potential pitfalls, in the hope of assisting surgeons unfamiliar with these injuries (Degiannis, Glapa, Loukogeorgakis & Smith, 2008).

Pancreatic trauma occurs commonly in connection with multiple injuries after motor vehicle accidents in adults and bicycle handlebar injuries in children. Conservative management is mainly advocated for pancreatic trauma without ductal injuries. Computed tomography (CT) is routinely used as the first-line imaging modality in acute abdominal trauma cases and is helpful in recognizing injuries to the pancreas and other organs and their associated complications, as shown in figure (7) (Degiannis, Glapa, Loukogeorgakis & Smith 2008).

Figure (7): CT imaging of Pancreatic injury

1.3.6 Injuries of the mesentery or hollow viscera

Although trauma-related injury to hollow viscera is rare, it is a common cause of missed injuries, and often presents with subtle imaging signs. And hollow viscus injury (HVI) is an infrequent diagnosis in multiple trauma patients, its incidence hovering around 1% (0.7-8.5%)[1]; other authors indicated an incidence of bowel and mesenteric injuries in 5% of blunt abdominal trauma (BAT) patients, at laparotomy (ftimie-Năstase & Beuran, 2011).

The diagnosis of hollow viscera injury following blunt abdominal trauma is notoriously difficult to pinpoint to both the surgeon and the radiologist because of the lack of specific and reliable clinical and radiological findings. This is even more challenging during the first 4-6 hours from admission because the clinical picture is usually dominated by solid organ injuries, hemodynamic instability, equivocal clinical examination, missed lesions placing the patients with bowel trauma to an increased risk for developing peritonitis and subsequent severe complications, including death (Diebel, 2008).

Although it has a high rate of false-negative results, the CT scan is the most commonly used diagnostic modality in evaluating the abdomen in hemodynamically stable blunt trauma victims (Fakhry, Watts, Daley et al., 2001).

1.4 Objectives of the radiologist

To recognize the integration of the physician radiologist to the multidisciplinary medical team in the management of the polytrauma patient, responsible for the polytrauma patient approach institutional systematization regarding any radiology and imaging study, in which the role of the physician radiologist is:

- To treat the patient, NOT the images.
- To review the images in their entirety, each one as a whole.
- To examine and reexamine the patient if there is inconsistency between findings and clinical data.
- To establish communication with his/her physician surgeon colleagues.

The presence of certified physician radiologists all the time is essential in the assessment, subsequent management and error reduction in trauma patients.

1.4 Role of Multi-detector CT in evaluation of polytrauma patients

Clearly there are many abnormalities that might be detected on whole body MDCT in the severely injured patient and protocols should be designed to image these as clearly as possible. Protocols should be same across networks so that repeat scanning is not required where transfer is necessary. A MDCT protocol should be agreed across the trauma network to ensure consistency (The Royal College of Radiologists (2011).

The protocols used may vary among different trauma set up depending upon unit geography and resources available. We usually follow the guidelines outlined by Royal College of Radiology. In polytrauma the usual protocol which is followed incorporates the following techniques:

1- Segmented Whole body CT scan.
2- CTA Chest.
3- Portal Phase Abdomen and Pelvis.
4- Single Pass whole body CT.
5- A single pass technique through neck, chest, abdomen and pelvis. Cervical spine included with head CT and fast scanning is performed with overlap of mid-face.
6- Unenhanced CT of the brain with gantry tilt. It has the advantage standardization of angulations of anatomic structures and >50% dose reduction for eye lenses.
7- Delay: empiric 20 seconds.
8- No oral contrast.
9- Automated exposure control (reference 200 mAs).

Studies showed direct whole-body CT reduced the diagnostic interval from a median of 70 to 23 minutes & definitive management plan interval from another median of 82 to 47 minutes. Studies also found MDCT had higher diagnostic accuracy than conventional imaging (Wurmb, Frühwald, Hopfner, Keil, Kredel, Brederlau, et al., 2009).

The main limitation of MDCT at present is cost. It needs significant amount of investment to adequately locate and refurbish CT suites near emergency department enabling simultaneous resuscitation of critically injured patients. It is not always financially viable to relocate existing CT suites or built new ones near the emergency departments especially in small district general hospitals. However, it is recommended that all newly built CT suites should be near the emergency departments ensuring quick transfer of patients with minimal movement. Since polytrauma management is based on a multidisciplinary approach characterized by a coordinated interaction between trauma surgeons, anaesthesiologists and radiologists, members of all involved disciplines need adequate teaching. Guidelines and algorithms contribute to optimize the early management (Hessmann, Hofmann, Kreitner, Lott & Rommens, 2006).

1.5 Conclusions

In assessment of patients of polytrauma the study can concluded that there is no universally accepted standard protocol, and the decision to manage the patient surgically or by percutaneous intervention depends upon the

clinical severity and secondarily on the findings of whole body MDCT; which identifies blunt polytrauma related injuries which require intervention. And the possible pitfalls like improper technique, variants, and artefacts should be kept in mind. Indiscriminate use of Whole Body CT for patients with minor injuries is not justified, and due to data explosion remove unnecessary series (bone, lung algorithm reconstruction). Excessive radiation and unnecessary studies should be avoided besides the use automated exposure control, and the use of low dose for extremities CTA, arterial and delayed images.

MDCT is currently imaging modality of choice in polytrauma and accurately answers most of the aspects of trauma care. It further helps in optimal selection of management protocol for the patient and preventing unnecessary surgeries.

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