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FREQUENCY, IMAGING PATTERNS AND PITFALLS IN BLUNT ABDOMINAL TRAUMA, A SINGLE CENTER EXPERIENCE STUDY

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Abstract

Blunt abdominal trauma is a life-threatening condition and imaging is key in identifying the next step in patient management. The objective of this study is to determine the frequency and pitfalls of blunt abdominal trauma findings in multiphasic Multidetector Computed Tomographic (MDCT) examinations in patients with road traffic injuries and falls in the setting of polytrauma.

After institutional review board approval with a waiver of informed consent was obtained, a retrospective study was performed focusing on a three-month period in 2023, from May to July in patients referred to our department with the diagnosis of superficial injuries involving multiple body regions – T00. A review of the Picture Archiving and Communication System (PACS), the electronic medical records and dictated reports identified patients who met the criteria of abdominal blunt trauma.

A total number of 321 patients were identified, who met the criteria of superficial injuries involving multiple body regions (average age, 37.5 years). 220 patients were male. 2,8% (9 patients) had imaging findings of blunt abdominal trauma. 55,5 % of patients had spleen traumatic injuries, the remaining percentage was liver, kidney, retroperitoneal hematoma and isolated free abdominal fluid.

MDCT and administration of intra venous contrast is crucial in recognizing many of the spectral findings blunt abdominal trauma. A protocol of biphasic "Combi" scan should be implemented in order to minimize radiation exposure and duration of the scan. Multiphasic Computed Tomography (CT) acquisition is key to avoid pitfalls.

Key words: Blunt abdominal trauma, Multiphasic MDCT, spleen injury, liver injury, kidney injury, retroperitoneal hematoma, isolated free abdominal fluid.

Introduction

Blunt abdominal trauma is defined as trauma to the abdomen which is caused by a blunt force damaging the abdomen and/ or abdominal organs, resulting from impact with a blunt object or surface. The national library of medicine states that blunt abdominal trauma in adults and children is a common presentation [1].

The World Health Organization (WHO) in 2014 published a brochure with the global data from in the WHO Global Health Estimates, which stated that more than 5 million people die each year as a result of injuries. According to the data, every six seconds someone in the world dies as a result of an injury. In global incidence this accounts for 9% of the world's deaths. Road traffic injuries and falls were ranked number 9 and 15 in the 2012 as leading causes of death following ischaemic heart disease, stroke, chronic obstructive pulmonary disease, lower respiratory infections, cancer of the trachea, bronchus and lung, HIV/AIDS, diarrhoeal diseases, diabetes mellitus. Its incidence is calculated to rise in 2030 at number 7 for road traffic injuries and number 17 for deaths caused from falls [2].

As part of the ABCD approach to trauma patient care, radiology plays an integrated part, illustrated in Figure 1. According to Hussain et al the radiologist plays a crucial role in lowering morbidity and mortality in trauma patients [3]. Chest X-ray for checking airway and breathing, pelvic X-ray, extended Focused Assessment with Sonography for Trauma (eFAST), computed tomographic (CT)

chest abdomen pelvis (CAP), and Damages Control Interventional Radiology (DCIR) are part of the algorithm as imaging modalities in the acute trauma setting.

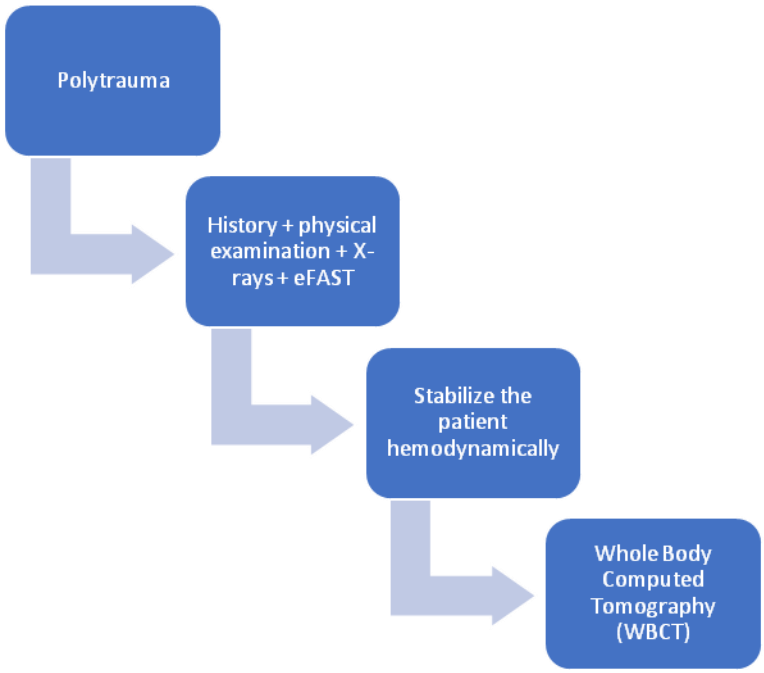

Figure 1. Polytrauma imaging algorithm

The leading cause of blunt abdominal trauma is road traffic accidents, and have been cited to cause around 50-70% of injuries encountered in the polytrauma setting, with the leading injuries being liver and spleen [4]. In this study we aim to evaluate the pattern and radiological findings of blunt abdominal trauma in our center. Above that we aim to identify some of the pitfalls that should be avoided and also provide a picturesque view of imaging spectral findings.

Materials and Methods

It is a retrospective analysis of the data obtained from the electronic medical records and dictated reports which identified patients who met the criteria of abdominal blunt trauma.

After institutional review board approval with a waiver of informed consent was obtained, a retrospective study was performed focusing on a three-month period in 2023, from May to July. A review of the electronic medical records and dictated reports together was analysis of scans from the PACS system patients who met the criteria of abdominal blunt trauma were identified. Patients demographics was collected.

Multiphasic CT scans were undertaken in all patients. The types on injuries were analyzed focusing on the mechanism of injury and the pattern of imaging findings. The exclusion criteria comprised of penetrating traumatic injury.

Results

Out of 321 patients, with the average age of 37.5 years old 9 patients were identified with CT finding of blunt abdominal trauma. 5 of them had splenic injuries, and one each had liver injuries, kidney

and retroperitoneal and findings of isolated free abdominal fluid. Most of the patients were adult males 68.5 %.

Five patients presented with splenic injury, two of them with a subcapsular hematoma visualized on imaging as a low-attenuated zone and the remaining three with splenic laceration (Figure 2.).

Figure 2. The image on the left shows an axial view of the unenhanced CT scan, where the splenic lesion is not very well depicted. The image in the middle, in arterial phase, depicts best the low attenuation zone, which is also delineated in the venous phase, image on the left. Finding in keeping with splenic laceration with active bleeding.

One of the patients presented with liver injury, depicted as localized subcapsular hematoma (Figure 3.).

Figure 3. Multiphasic CT evaluation of hepatic hematoma, localized in the 6th segment.

One of the patients presented with free abdominal fluid. Its origin could not be concluded, and it was followed up with sequential imaging (Figure 4.).

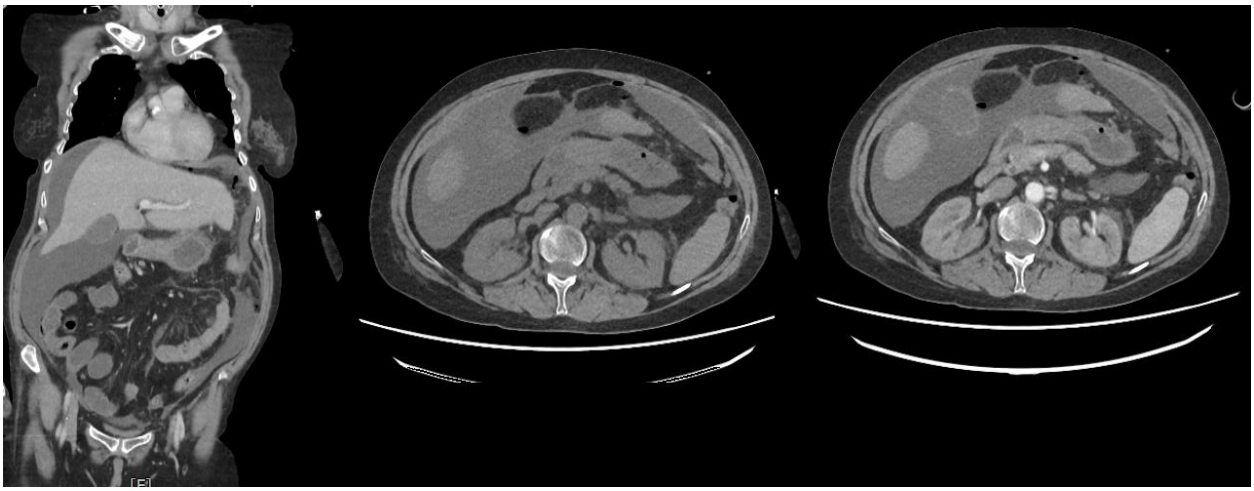

Figure 4. Isolated free abdominal fluid in all compartments.

Discussion

Many studies have reported liver to be the most frequently injured organ, but others have also stated spleen to be the most common [5]. Consistently, our analysis states that the most frequent injured abdominal trauma in blunt traumatic injuries is spleen, followed by liver, kidneys, followed by retroperitoneum with hematoma in the iliopsoas muscle and isolated free abdominal fluid.

Splenic injuries

Nowadays with the improvement of technology, optimization of imaging protocols and the increased awareness radiologists depict splenic injuries more often. Understanding the imaging findings of various splenic emergencies is crucial for diagnosing and managing potentially life-threatening conditions. Ultrasound is commonly used for initial assessment, but CT is more reliable for diagnosis, especially in cases of subtle vascular injuries. Pseudoaneurysms and delayed capsular rupture have been reported, and it is estimated that 95% of bleeds occur within 72 hours. According to the retrospective study from Lee et al, conducted for a period of 7 years, in 20% of blunt trauma CT images revealed contained vascular splenic injuries, where as 22% of patients had active splenic hemorrhage [6].

One of the most widely used classification of splenic injury is the American Association for the Surgery of Trauma (AAST) splenic injury scale (2018 revision), that classifies splenic injuries into five categories [7].

Laceration, hypoperfusion, subcapsular and/ or parenchymal hematoma, active bleeding and pseudoaneurysms can be readily seen on CT. On CT imaging hematomas and laceration have a low-attenuated appearance where as a vascular injury appears as a localized collection of contrast, that decreases in attenuation on delayed imaging. In the cases of active bleeding the contrast material in delayed imaging increases in size and in attenuation. Any patient with active splenic hemorrhage and contained vascular injury limited to the splenic capsule on imaging should be given a grade 4, whereas trauma associated with active bleeding beyond the splenic capsule should be graded a grade 5.

Liver injuries

In scenarios of blunt trauma Yoon et al reported a prevalence of 1%-8% of liver injuries, and a mortality rate of 4.1% to 11.7% [8]. The AAST injury scoring system can also be used in the classification of liver injuries, from hematoma to laceration and vascular injuries, based on the extend of the injury. Some centers prefer the classification based on the mechanism of injury, especially when proper history is undertaken. This classification divides the injury into two categories. Type A, when the injury is along the falciform ligament, where segment IV1/b, III or II are involved, and is usually as a

result of frontal impact of energy. Type B is a result of an impact of injury from other directions other than frontal and from more complex mechanisms resulting in injury of segments V to VIII [9].

The parenchymal liver injuries are best depicted when contrast is administered, since it lights up the parenchyma and marks the lesion as an unenhanced portion. Some of minor findings that can be suggestive of traumatic liver injury especially in hemodynamically unstable patients is a flat, crescent inferior vena cava and periportal low attenuation.

CT is not only useful in the acute setting, but in patients with high grade liver injuries follow up imaging is recommended to identify potential complications such as delayed hemorrhage and pseudoaneurysm formation, complication involving the biliary tract with hemobilia, biloma formation and/ or bile peritonitis, as well as hepatic or perihepatic abscess formation. According to the educational exhibit published in Radiographics, the majority of blunt hepatic injuries are successfully managed non-surgically under CT guidance [8].

According to Asensio et al the multidisciplinary approach in hepatic injury improved mortality rates and outcomes, especially in complex (Grade IV and V) hepatic trauma when interventional radiologists where involved in the management of patients from 36% to 12% [10].

Kidney injury

The kidneys are the most common injured organ from the urinary tract in the setting of abdominal trauma patients, with an incidence reported at 10%, and blunt force is responsible for 70-80 % [11].

According to the AAST kidney trauma is also classified in five grades, ranging from microscopic hematuria caused from renal contusion to complete shattered kidney with laceration and vascular involvement.

Hemodynamically unstable patients, that is AAST grade V, immediately undergo surgical exploration, whereas the stable patients undergo a so called “watchful waiting” approach, where assessment of visceral injuries with imaging studies should be undertaken to guide treatment. A widely available imaging modality in this setting can be sonography, with a relatively high diagnostic yield. However, according to Jalli et al sonography has limited value in accurate diagnosis, and it can overlook subtle injuries, thus in hemodynamically stable patients CT is recommended as the modality of choice [12].

CT findings range from decreased enhancement in renal contusion to high density collection in cases of hematoma, whereas perinephric hematoma is an ill-defined area of high-density material. Renal lacerations are characterized by parenchymal defects, that lack enhancement in the nephrogenic phase. Segmental infarcts show as low attenuation areas where as laceration of the renal artery is characterized by retrograde opacification od renal vein from the inferior cava vein.

Free abdominal fluid

The detection of free abdominal fluid can be one of the first signs of traumatic organ injuries when performing eFAST in the setting of trauma. Nevertheless, CT is the modality of choice in depicting even the smallest amount of free abdominal fluid and above all in determining its nature and origin. The nature of the free abdominal fluid is achieved by measuring its attenuation values using a region of interest (ROI) tool.

The density of the fluid can help distinguish between ascites, blood, bile, urine, chyle, hematoma or active bleeding using the Hounsfield Unit (HU) provided. Bile usually has the lowest density and it can have values below zero, simple ascites ranges between 0 – 15 HU, unpacified urine is similar, whereas opacified urine leakage is a clear sign of urinary collecting system injury.

In cases when a clear organ injury cannot be defined, but free abdominal fluid is present, the concept of “sentinel clot” sign is helpful in determining where the site of injury is, demonstrated as the area with the highest density [13].

The density of free blood in unenhanced CT measures 20 – 40 HU, clotted blood and hematoma 40 – 70 HU and active bleeding is within 10 HU. Differentiation between active bleeding and hematoma is the attenuation of the extravasated contrast material, in the former it ranges within 85 – 350 HU, whereas in the latter between 40 – 70 HU.

In approximately 3% of patients the free abdominal fluid will be isolated [14]. Isolated free abdominal fluid can be a diagnostic dilemma in the management of blunt abdominal trauma patients. Isolated free abdominal fluid can have an unclear clinical significance. These patients should be admitted and serial imaging for the next 48 hours should be undertaken in order to identify patients for surgical treatments [15].

Retroperitoneal hematoma

The retroperitoneum is a rich compartment, comprising of visceral, neurovascular and muscle structures. Duodenal injury, pancreatic injury, adrenal injuries, vascular injuries, paraspinal and and/ or spinal injuries, retroperitoneal air and fluid are among the injuries we can encounter. Retroperitoneal traumatic injury is said to be present in a minority of cases, and reported to be 12% by Daly et al [16].

Retroperitoneal hematoma is a condition that requires special attention since the tamponade from surrounding structures influences its formation, which can have a rapid discourse in cases of arterial injury. Therefore, prompt diagnosis is crucial, with the goal in imaging being the identification of its location, origin and the determination of the presence of active extravasation. Hematoma location is classified into three zones, Zone I the midline retroperitoneum with the supramesocolic and inframesocolic region, Zone II the upper lateral retroperitoneum and Zone III the pelvic retroperitoneum [17].

In the study by Wang et al the most common type of retroperitoneal hematoma was in Zone III, with pelvic fractures being the most common cause [18].

Imaging finding include a hazy margin from fat stranding by the involved structures, high attenuation areas in cases of acute hematomas that can become chronic with a well-defined margin with no enhancement after the administration of intravenous contrast.

CT evaluation plays a crucial role in identifying this life-threatening condition. In penetrating traumatic injury surgical exploration should be performed, whereas in blunt abdominal trauma when the patient is hemodynamically stable imaging is preferred in managing patients.

One of the pitfalls in imaging patients with abdominal blunt injuries is the optimization of protocols. As stated by research in the past unenhanced MDCT is no longer warranted unless previous CT has been done, the patient had a gunshot or they have had an intervention where contrast administration was used.

Many centers are working of the optimization of protocols in trauma setting in achieving a shorter acquisition time and reduction of radiation exposure. This protocol was first followed in the military setting and its purpose was to decide management plan, either non-operatively or damage control surgery.

Hakim et al worked on assessing the image quality in conventional dual-phase and modified biphasic injection, where the compares three groups of trauma patients with different protocols.

One group underwent an arterial phase at 30 seconds and portal venous phase at 60 seconds. The second group referred to as the biphasic group received contrast injection with a single acquisition at 60 seconds and the third group, the modified biphasic, had injections with a 70 seconds delay in receiving a single acquisition. This work proved that the modified biphasic protocol achieved excellent image quality, with vascular and parenchymal enhancement compared to dual phase [19].

Another strategy in managing patients in trauma setting where the radiologists can have a lot of influence is the standardization of reporting. Royal College of Radiology (RCR) has published a report with standards of practice and guidance for trauma radiology in severely injured patients. This report aims to define factors in achieving the best service for patients in trauma setting with a compilation of 20 standards discussed further in detail. Standard 10 to 13 discuss the way the trauma team leader should issue a primary report that will be available to the radiologists at the time of imaging. One of the standards is focused, while active management continues, in giving an indication to life-threatening injuries such as reviewing thoracic injuries that impair breathing, vascular injuries that cause life-threatening bleeding and neurological injuries that cause disability if not attended rapidly. It also discusses the fact that the final report should be provided within one hour of imaging acquisition [20].

Conclusions

In conclusion, our retrograde study demonstrates the most common injuries present in blunt abdominal trauma. It reviews the imaging characteristics of blunt abdominal trauma and focuses on pitfalls and identifying key findings crucial for further patient management.

Additionally, it concludes that MDCT is the most sensitive imaging method in identifying blunt abdominal trauma and administration of intra venous contrast is crucial in recognizing many of the spectral findings. The implementation of the biphasic "Combi" scan is recommended in minimizing radiation exposure and duration of the scan.

Another point where radiologists can improve patient outcome is developing standardized reporting tool. Furthermore, it should be kept in mind that improving communication between imaging units and referrers has been shown to improve patient outcome and it should be the goal of every trauma center to implement a multidisciplinary protocol.

The limitation of our study is the study time period, but this can be further expanded to a wider period of retrograde analysis with continued research.

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