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Helical CT examination in blunt abdominal trauma

Diagnosis and treatment of patients admitted to a trauma center with potential blunt abdominal injury has been a difficult and challenging task for the trauma surgeon and emergency radiologist. The multiple overt system injuries often seen with blunt trauma may divert attention away from the abdomen, making a complete and accurate diagnosis and triage more difficult and complex. The ability of spiral CT to obtain high resolution images during optimal contrast enhancement at unparalleled speed has made it the imaging modality of choice for evaluating hemodynamically stable patients with abdominal pain, tenderness, or a positive ultrasound examination for free intraperitoneal fluid (4, 7). Since its clinical introduction in the 1970s, computed tomography revolutionized the imaging work-up of patients in the emergency department. CT now is considered to be one of the most valuable tools in the diagnostic work-up of trauma patients and patients with non-traumatic emergency conditions. As a consequences, emergency patients now benefit from faster and more accurate CT examinations (5).

The aim of the study is to present the use of spiral CT examination of abdomen after blunt abdominal trauma.

MATERIAL AND METHODS

Material comprises a group of 43 patients after a blunt abdominal trauma, in whom CT examinations of the abdomen were performed. The scanning was performed with helical CT scanner Somatom Emotion by Siemens. The examination was performed before and after intravenous administering of 100 ml of contrast agent. No oral contrast was administered. After evaluation of axial CT section, both unenhanced and after administering of contrast agent, MPR reconstructions were created.

RESULTS

In 23 patients peritoneal fluid collections were seen on CT sections. In 15 of them those were high density fluid collections suggesting the presence of intraperitoneal haemorrhage, in the rest of them there were water-attenuation, posttraumatic peritoneal fluid collections (Fig. 1). The splenic injury was seen in 8 of them. Those were heterogeneous hypodense areas of spleen contusion in 4 of them, subcapsular and intraparenchymal hematomas in one and area of posttraumatic splenic infarct in 2 of them (Fig. 2). The injury of the liver was seen in 3 patients. In one of them parenchymal hematoma was seen, and the irregular areas of low attenuation representing parenchymal contusion were seen in the other one (Fig. 3). In 4 patients there was seen renal injury. In one of them the subcapsluar hematoma was seen (Fig. 4). The fragmentation of the renal parenchyma was seen in 2 patients (Fig. 5). In one patient the extravasation of the contrast material due to laceration of the renal pelvis was stated (Fig. 6).

Fig. 1. Posttraumatic peritoneal fluid collection of water-attenuation in the abdomen visible on axial CT section (arrow)

Fig. 2. Posttraumatic splenic hematoma (arrows)

Fig. 3. Hypodense area in the left liver lobe on enhanced CT sections represents posttraumatic parenchymal hematoma (arrow)

Fig. 4. Subcapsular renal hematoma on axial CT section (arrows)

Fig. 5. Fragmentation of the renal parenchyma after blunt abdominal trauma (arrow)

Fig. 6. Extravasations of the contrast enhanced urine after traumatic laceration of renal pelvis on CT section (arrow)

DISCUSSION

Helical CT is the most important CT development that offers a number of imaging advantages for the emergency patients. Shorter scanning time permits better intravenous contrast material opacification of blood vessels and improved IV contrast material enhancement of parenchyma organs. Fast scanning permits the performance of multiple consecutive CT examinations of the same trauma patient in a very short period of time. CT investigation of trauma patients is therefore possible today that could not have been performed in the past. The ability of helical CT to quickly image blood vessels when optimally opacified and to decrease respiratory and even pulsatile motion has made CT angiography a feasible alternative to catheter angiography in patients with aortic and other vascular emergencies (5).

CT is extremely sensitive in detecting even small quantities of intraperitoneal fluid or hemoperitoneum. In the supine position, the most dependent region of the peritoneal cavity is the hepato-renal fossa (Morison's pouch). Other areas where free fluid or blood is often seen in trauma patients are adjacent to the bladder in the pelvis, the paracolic gutters, and the perihepatic and perisplenic spaces. Careful inspection of these areas is necessary to identify small amounts of fluid or blood that may be the only CT sign of a subtle or occult intraperitoneal visceral injury. Density measurements should be obtained for all fluid collections identified by CT to help characterize its origin. Care should be taken to avoid volume averaging in measuring the density of free fluid. Using density measurements of intraperitoneal fluid, CT can help distinguish between simple ascites, blood, hematoma, bile, urine, chyle, and active bleeding. The highest density blood among several areas of intraperitoneal blood is adjacent to the injured organ, a concept they referred to as the "sentinel clot" sign. This sign is particularly valuable when the injury to the organ parenchyma itself is subtle (7, 8).

Free intraperitoneal fluid, as the sole finding on CT in blunt abdominal trauma, may indicate a significant occult injury, typically of the bowel or mesentery. Male patients without pelvic fracture, but who demonstrate isolated free intraperitoneal fluid (irrespective of magnitude), female patients with moderate or large amount of pelvic fluid, and free fluid in multiple locations or between the mesenteric leaves, require further evaluation to exclude bowel or mesenteric injury (7). The spleen is the most commonly injured solid abdominal organ during blunt trauma (3, 7). Only recently has the vital role played by the spleen in the immune defense system been fully appreciated, and this understanding has led to a more conservative approach in the management of splenic injury, both in adults and children. Over the past two decades, CT has had a significant impact in helping to implement a new, conservative approach to management of blunt splenic trauma. Many systems have been proposed to grade splenic injury following trauma. The splenic injury grades may be based on the extent of injury seen at laparotomy, CT, or autopsy. In order to compare outcome, treatment protocols, and standardize reporting of splenic injuries among patients in the same trauma center over a period of time, the American Association for the Surgery of Trauma (AAST) formed a committee to develop a uniform injury severity score. This injury scale is based on an anatomic depiction of splenic disruption, including the length and number of lacerations, the surface area involved, by the subcapsular or intraparenchymal hematoma (s) seen at laparotomy (3, 7).

Contrast-enhanced CT can accurately diagnose the four principal types of splenic injury, including hematoma(s), laceration(s), active hemorrhage, and vascular injuries such as pseudoaneurysm and post-traumatic arteriovenonous fistula. Splenic hematomas may be intraparenchymal or subcapsular. On unenhanced CT, subcapsular hematomas are hyperdense relative to normal splenic parenchyma. On contrast-enhanced CT, subcapsular hematomas are typically seen as low attenuation collections of blood between the splenic capsule and the enhancing splenic parenchyma. On contrast-enhanced CT, acute hematomas appear as irregular high or low attenuation areas within the parenchyma. Acute splenic lacerations have sharp or jagged margins and appear as linear or branching, low attenuation areas on contrast-enhanced CT. On contrast-enhanced CT, active hemorrhage in the spleen is seen as an irregular or linear area of contrast extravasation. Active splenic hemorrhage may be seen within the splenic parenchyma, subcapsular space, or intraperitoneally (7). On contrast-enhanced CT, post-traumatic splenic infarcts are seen as well-demarcated, segmental, wedge-shaped low attenuation areas with the base of the wedge toward the periphery of the splenic parenchyma. Infarct may be the only CT finding of blunt splenic trauma and may occur without any adjacent free fluid (3, 7).

The liver is the second most commonly injured solid organ following blunt trauma. From 70% to 90% of hepatic injuries are minor and either do not require surgery or have stopped bleeding at the time of laparotomy. Blunt or penetrating trauma may lead to intraparenchymal laceration and haematoma, subcapsular haematoma or capsular rupture with intraperitoneal haemorrhage. Intraparenchymal lacerations and haematomas are usually elliptical or linear in shape (2). Hepatic hematomas may be intraparenchymal or subcapsular. Most subcapsular hematomas are seen along the anterolateral aspect of the right lobe of the liver. Subcapsular hematomas cause direct compression of underlying liver parenchyma, and this CT sign is helpful in differentiating subcapsular hematoma from small amounts of free intraperitoneal blood or fluid seen adjacent to the liver (perihepatic spaces). On contrast-enhanced CT, a subcapsular hematoma is typically seen as a low attenuation, lens-shaped collection of blood between Glisson's capsule and the enhancing liver parenchyma (3, 7). Parenchymal contusions of the liver appear as irregular areas of low attenuation on contrast-enhanced CT, with possible intermixed high-density blood. On CT, acute hematomas appear as irregular high attenuation regions of clotted blood surrounded by lower density, non-clotted blood or bile (7). On contrast-enhanced CT, liver lacerations appear as irregular linear or branching low attenuation areas. The location of lacerations and their relationship to the hepatic veins may be important in predicting the likelihood of hemorrhage (3, 7). Hepatic lacerations with a branching pattern can mimic the appearance of unopacified portal or hepatic veins or dilated bile ducts and may require careful evaluation of serial images to differentiate among these various structures (7).

The incidence of pancreatic injury after blunt trauma is low. Like other retroperitoneal injuries, the diagnosis of a pancreatic injury can be difficult, and CT has been stated to be the diagnostic modality of choice (6). Pancreatic injury is relatively uncommon, being encountered in only around 3% of abdominal trauma cases that require surgical treatment. On initial imaging the signs of pancreatic trauma may be very subtle. Ultrasound may show evidence of pancreatic trauma, such as peripancreatic fluid or discontinuity in the normal pancreatic contour, but CT is the most effective imaging modality for the diagnosis of pancreatic injury (3). Pancreatic contusion may appear as low attenuation or heterogeneous focal or diffuse enlargement of the pancreas. Pancreatic lacerations are seen as linear, irregular low attenuation areas within the normal parenchyma. Unless the two edges of a fractured, or transected, pancreas are separated by low attenuation fluid or hematoma, the diagnosis of pancreatic transection may be difficult to recognize on CT (7).

Unrecognized bowel injuries are associated with significant morbidity, including fatal peritonitis from perforation, sepsis, and life-threatening hemorrhage. Bowel and mesenteric injuries are found in approximately 5% of patients suffering from blunt abdominal trauma (7). Blunt trauma to the duodenum can result in either hematoma, leading to obstruction, or to perforation. The diagnosis of duodenal injury is difficult because of the paucity of clinical signs. However, a delay in diagnosis can significantly increase the morbidity and mortality of such injuries (2, 3, 6).

Renal injuries occur in about 10% of patients with blunt abdominal trauma. In most cases, hematuria is the first indication of renal injury. However, hematuria is absent in approximately 20% of patients with significant renal trauma. Overall, in a majority of cases, the renal injury is relatively minor, consisting of contusions or intrarenal and subcapsular hematoma. Major renal injury, ie, deep lacerations, shattered kidneys, or pedicle injuries, occurs in only about 10% to 15% of trauma patients with renal injury (6). Segmental renal infarcts are relatively common in blunt renal trauma, and result from stretching and subsequent occlusion of accessory renal artery, extrarenal or intrarenal branches of renal artery, or a capsular artery. These infarcts appear sharply demarcated wedged-shaped areas of very low attenuate typically involving the renal pole(s) (7). Subcapsular renal haematomas are rare (3). Major renal injuries are seen in about 10% of cases of penetrating trauma to the flank and back. They occur in 15–42% of such patients with only microscopic haematuria but the absence of haematuria does not exclude injury to the kidney or collecting system (3).

Diaphragm injuries (DIs) are thought to occur in approximately 1% to 8% of patients with blunt abdominal trauma. The detection of DIs can be difficult as the clinical and radiographic findings may be obscure, especially if the injury occurs in isolation. A prompt diagnosis is important, however, as increased morbidity and mortality are likely to be associated with a delay in the diagnosis and treatment of DIs. An accurate diagnosis is arguably even more critical as the radiographic identification of DI mandates laparotomy, and thus a low positive predictive value (PPV) for DI using CT without oral contrast would lead to an unacceptably high rate of negative laparotomy for the injury. The sensitivity of CT imaging for DI in the other ranges from 42% to 84% (7).

CONCLUSIONS

CT has become the imaging modality of choice to evaluate hemodynamically stable blunt trauma patients. Rapid advancement of CT technology and postprocessing of image data has revolutionized cross-sectional imaging in trauma radiology and has been a major factor for successful nonoperative management of solid organ injuries. New spiral CT technology, will improve the detection of visceral injuries as well as the diagnosis of hemorrhage and vascular injuries of the abdomen and pelvis, and will do so within a shorter period of time. Optimal scan protocols and parameters for intravenous contrast administration will have to be developed by trauma radiologists to exploit the true potential of these ultra-fast CT scanners.

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SUMMARY

The aim of the study is to present the use of spiral CT examination of abdomen after blunt abdominal trauma. Material comprises a group of 43 patients after a blunt abdominal trauma, in whom CT examination of the abdomen was performed. The scanning was performed with helical CT scanner Somatom Emotion by Siemens. The examination was performed before and after intravenous administering of 100 ml of contrast agent. No oral contrast was administered. After evaluation of axial CT section, both unenhanced and after administering of contrast agent, MPR reconstructions were created. In 23 patients peritoneal fluid collections were seen on CT sections. In 15 of them those were high density fluid collections suggesting the presence of intraperitoneal haemorrhage, in the rest of them there were water-attenuation, posttraumatic peritoneal fluid collections. The splenic injury was seen in 8 of them. Those heterogeneous hipodense areas of spleen contusion in 4 of them, subcapsular and intraparenchymal hematomas in one and area of posttraumatic splenic infarct in 2 of them. The injury of the liver was seen in 3 of them. In one of them subcapsular hematoma was seen, and the irregular areas of low attenuation representing parenchymal contusion were found in the other one. In 4 patients there was seen renal injury. In one of them the subcapsluar hematoma was seen. The fragmentation of the renal parenchyma was seen in 2 patients. In one patient the extravasation of the contrast material due to laceration of the renal pelvis was found. CT has become the imaging modality of choice to evaluate hemodynamically stable blunt trauma patients. Rapid advancement of CT technology and postprocessing of image data has revolutionized cross-sectional imaging in trauma radiology and has been a major factor for successful nonoperative management of solid organ injuries. New spiral CT technology will improve the detection of visceral injuries as well as the diagnosis of hemorrhage and vascular injuries of the abdomen and pelvis, and will do so within a shorter period of time. Optimal scan protocols and parameters for intravenous contrast administration will have to be developed by trauma radiologists to exploit the true potential of these ultra-fast CT scanners.

Spiralna tomografia komputerowa w tępych urazach brzucha

Celem pracy jest przedstawienie zastosowania spiralnej tomografii komputerowej w diagnostyce tępych urazów brzucha. Materiał stanowi grupa 43 pacjentów po tępych urazach brzucha, u których wykonano badanie TK spiralnym tomografem komputerowym Somatom Emotion firmy Siemens. Badanie wykonywane było przed i po podaniu dożylnym 100 ml środka kontrastowego. Oceniano przekroje osiowe oraz wtórne rekonstrukcje MPR. U 23 pacjentów stwierdzono obecność wolnego płynu w jamie otrzewnowej. U 15 z nich był to płyn wysokiej densyjności, odpowiadający wynaczynionej krwi, u pozostałych płyn o densyjności wody. Uszkodzenie śledziony stwierdzono u ośmiu pacjentów. U czterech pacjentów były to niejednorodne obszary hipodensyjne przedstawiające stłuczenie śledziony. U jednego widoczny był krwiak podtorebkowy i śródmiąższowy. U dwóch stwierdzono pourazowy zawał śledziony. Uszkodzenie wątroby stwierdzono u trzech pacjentów. U jednego był to krwiak podtorebkowy, a u pozostałych dwóch pacjentów obszary niejednorodne densyjnie stłuczenia miąższu wątroby. U czterech pacjentów stwierdzono uszkodzenie nerek. U jednego był to krwiak podtorebkowy. U dwóch stwierdzono rozfragmentowania miąższu nerki. U jednego widoczne było wynaczynienie kontrastującego moczu w wyniku uszkodzenia miedniczki nerkowej. Spiralna tomografia komputerowa jest metodą obrazowania z wyboru u hemodynamicznie stabilnych pacjentów po tępych urazach brzucha. Umożliwia szybką i bardzo dokładną ocenę uszkodzeń narządów wewnętrznych. Przewyższa pod tym względem inne metody obrazowania, umożliwia szybką ocenę oraz kontrolę u pacjentów pozostających na obserwacji.