Traumatic adrenal hematoma: clinical and imaging findings

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Aims and objectives

Though rare, with an incidence in blunt abdominal trauma reported to range from 0.15 to 4%, adrenal trauma is usually an important indicator of severity of multisystem organ injury and is associated with increased rates of morbidity and mortality [1-4]. It was first reported by Canton in 1863 [5]. Physical examination and laboratory findings are usually nonspecific in the diagnosis. Essentially, radiology has greatly changed the diagnosis and management approach to trauma patients and decisions on patient management are based essentially on CT findings [6]. Furthermore, radiological findings are also used in critical decisions such as determining the surgical technique [7]. Computed tomography (CT) is the preferred imaging technique in hemodynamically stable emergency patient with blunt abdominal trauma due to its easy and fast accessibility, accuracy, and minimally invasive characteristic. Before the advent of CT, the condition was usually identified at surgery or autopsy. Although clinical and imaging findings of adrenal hematoma have been studied extensively, detailed CT findings such as the diameters of the hematomas have not been fully interpreted.

We primarily aimed to describe the CT findings of traumatic adrenal lesions, to help radiologist be aware of the condition. The correlations of imaging findings with clinical findings, patient outcomes and follow-up findings were also analyzed.

Methods and materials

Patients

Between December 2013 and June 2015, we retrospectively reviewed 318 contrast enhanced CT examinations of emergency patients with abdominal trauma. Two radiologists reviewed all CT images and documented findings suspicious or specific for adrenal injury. Associated CT findings of adrenal hematomas and concomitant injuries including injuries of solid organs, lung, skeletal system and as well as hemathoraces/pnemothoraces, hemoperitoneum and retroperitoneal hematomas were also recorded. Cases where adrenal gland lesions or abnormalities were thought to irrelevant to existing trauma were not included. A detailed information chart is filled in order to define etiological factors, imaging and clinical findings, associated and concomitant injuries, need for hospitalization, intensive care unit and laparotomy requirements, and clinical outcomes.

This retrospective study was performed in one single center and approved by the Institutional Ethics Board and informed consent was waived. All the clinical and radiological data acquired during the study were under the control of two particular radiologists.
**CT examination**

The CT examinations of the abdomen and pelvis were performed with 5-mm or 10-mm thick slices obtained from the diaphragm through the symphisis pubis. The scanners were Siemens Somatom Spirit dual-slice CT-scanner and multislice CT device with 64 detectors (Aquilion 64, model TSX-101A; Toshiba Medical Corporation, Tochigi, Japan). Power injection of nonionic contrast media (100 mL, 1.8 mL/s) was administered by manual or automatic (Missouri, Ulrich Medical, The Netherlands) IV bolus injection.

**Image analysis**

All CT images were re-assessed conjointly by two radiologists (A.S.K. and B.K.). The adrenal hematomas were round, oval or irregular in shape. The diameters of adrenal hematomas were measured on contrast enhanced CT images. Subsequently, associated findings including surrounding fat tissue stranding, hemorrhage and extravasation were evaluated. Furthermore, concomitant injuries constituting hemathoraces/pnemothoraces, liver injury, skeletal injury, and kidney injury, if present, were also documented.

**Statistical analysis**

The distributions were analyzed to test normality via the Shapiro-wilk test. Eventually, the data of diameters of lesions were in normal distribution (P>0.05) whereas the data of days of discharge from hospital were not in normal distribution (P<0.05). Correlation between the etiology and rate of mortality, etiology and days of discharge, etiology and diameters of lesions, presence of periadrenal fat stranding and diameter of the lesion, need for laparotomy and rate of mortality, and diameters of lesions and extravasation were analyzed.

**Results**

Retrospectively CT imaging of 318 trauma cases reassessed. Fifteen patients (7 male, 8 female) with blunt abdominal trauma and diagnosis of adrenal hematoma were included in this study, as detailed in Table 1. The mean age of patients was 48 years (ranging from 7 to 78 years). The incidence of adrenal hematoma was 4.71 %. Of the all-traumatic injuries 80 % were unilateral (right-sided) and 20 % were bilateral. Unilateral left sided adrenal injury was not recognized. The causes of trauma were vehicular accident in 12 patients (80 %), fall in 2 patient (13%) and burn after motor vehicle collision in 1 patient (7%). Of the vehicular accident, 9 patients were passengers and 4 patients were pedestrians. US examinations were done in 14 of all patients before CT imaging and no adrenal injury was recognized with US. Of the all-traumatic injuries 80 % were unilateral (right-sided) and 20 % were bilateral. No unilateral left sided adrenal injury or isolated
adrenal hematoma was identified. In all patients, adrenal hematomas were predominantly oval in shape with lesion size varying from 20 to 56 mm (mean=34.3) in length, 10 to 25 mm (mean=19.5) in width and 10 to 54 mm (mean=28.1) in height for all right sided adrenal hematomas and from 14 to 25 mm (mean=19.0) in length, 10 to 16 mm (mean=13.3) in width and 12 to 30 mm (mean=19.3) in height for left sided ones. Besides, in patients with bilateral adrenal hematomas, the lesion sizes of right-sided hematomas ranged from 30 to 34 mm (mean=32) in length, 14 to 20 mm (mean=14.0) in width and 22 to 35 mm (mean=28) in height. The most common associated finding was the stranding of periadrenal fat tissue (73.3%).

Associated injuries comprised hemathoraces/pnemothoraces (80 %), liver injury (53 %), skeletal injury (46 %), and kidney injury (7 %). Supportive medical treatment was sufficient in twelve patients. Surgery or interventional embolization was not needed for adrenal hematoma, but each case had one or more associated injury to other organs or systems. Although the incidence of liver laceration was more than 50 % (n=8), exploratory laparotomy required in 3 cases (20%) to do partial liver resection in 1 case and suture of liver laceration after lavation of intraabdominal hematoma in 2 cases. The mortality rate was 33 %. The day of mortality ranged from 1 to 18 days (median=6.2) whereas the day of discharge from hospital ranged from 3 to 19 days (median=7.7). There were no significant difference between mechanism of trauma and rates of ICU admission, mean hospitalization days, mortality or need for laparotomy.

Follow-up CT images obtained in three patients, showed various degrees of resolution of hematoma and one patient, treated conservatively, had complete resolution in 9 months follow-up CT (Figure 1, Figure 2). Adrenal gland calcifications were not detected on follow-up images.
**Fig. 1:** Axial contrast-enhanced CT images obtained in 72-year-old female after vehicular accident. Liver laceration, T12 and L1 vertebral fractures and pleural effusions revealed on radiological evaluation. Initially obtained CT image (a) shows right adrenal hematoma, hypo-dens areas on posterior part of segment VI-VII, perihepatic hemorrhage and pleural effusions. Follow-up CT images obtained 1 month after (b) and 2 month after (c) trauma show decrease in attenuation and size.

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Fig. 2: Follow-up axial contrast-enhanced CT image of 45-year-old male obtained 9 month after vehicular accident reveals complete resolution of hematoma.

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Conclusion

The liver and the spleen are the mostly injured solid organs in the setting of blunt abdominal trauma [8]. Traumatic injury to the adrenal glands is uncommon due to their sheltered location deep in the retro-peritoneum and protection with surrounded organs and their small size as well. The incidence of adrenal hematoma in this study was 4.7%, similar to that found in previous reports [1-4]. If present, it is frequently unilateral and right-sided because of its unique position and the certain mechanism of trauma [2, 9, 10, 11]. Several factors have been proposed to explain the mechanism of traumatic adrenal hematoma. Severe anterior to posterior compression of the adrenal gland between liver and spine, short-term increased adrenal venous pressure because of compression of the inferior vena cava and adrenal capsule perforation due to deceleration forces that tears small vasculature are the accepted possible mechanisms for adrenal hematoma [12]. Owing to clinically benign nature, conservative treatment is the preferred approach in such cases. Bilateral adrenal hematoma can lead to life-threatening adrenal crisis and it requires replacement treatment with corticosteroids [9, 11]. All patients in our study had right-sided adrenal injury that can be explained by two probable mechanism as mentioned above. The first one is compression of adrenal glands by surrounding organs, which correlates with the preponderance of liver laceration in our study population. The other theoretical explanation is that the right adrenal vein directly drains into the inferior vena cava. Furthermore, three of them had also left sided injury and therefore 20% of cases had bilateral adrenal injury.

Sonography, in some centers, is a primarily used imaging technique in the evaluation of hemodynamically stable emergency patient with abdominal trauma. The enlargement of adrenal gland with hypo-echoic/anechoic areas of hemorrhage may be the suspicious US finding of adrenal hematoma. The interpretation of hypo-echoic lesions of the adrenal gland may be challenging with US. Incidental lesions of adrenal gland such as adenoma or other miscellaneous masses may render the evaluation of adrenal lesions in emergency trauma patients difficult. Known limits of this technique in the evaluation of adrenal gland are frequently related to its’ relatively deep location and poor or absent patients cooperation in the majority of cases. In our study, no adrenal hematomas were diagnosed with the US. Notwithstanding this does not mean that this examination can be bypassed. Sonography is very practical in the detection of solid organ injury, intraperitoneal hemorrhage, hemothorax and pericardial fluids. However, isolated adrenal hematoma, without associated injury, may not to be noticed and obligation of CT examination should be kept in mind by radiologists.

Traumatic adrenal hematoma has not specific clinical findings and is usually overlooked at emergency department [11]. The diagnosis of this condition was predominantly done during radiological evaluation. The low diagnostic rate of adrenal lesions by sonography has contributed to CT examination to be the best imaging tool in the detection of adrenal gland injury. CT examination is performed as the initial imaging technique to quickly
get the correct diagnosis of any intra-abdominal injury in patients with blunt trauma and worsening of patients' hemodynamic status. CT imaging plays an important role in the detection of adrenal hematoma, its size and extent of the hematoma. Well-known CT findings of adrenal injuries are enlargement of adrenal gland with increase in density, periadrenal fat stranding, thickening of ipsilateral diaphragmatic crus and concomitant abdominal and or thoracic injuries [12, 13]. Our findings, confirming previous reports, investigated that the most frequent finding was the stranding of periadrenal fat tissue [9,10]. At non-enhanced CT examination, recent hematoma appears as a soft tissue density mass (30-60 HU). CT examination after the injection of contrast media is very important for optimal detection of adrenal hematoma.

Surgery, embolization or conservative treatments have been preferred according to the patients' hemodynamic status and the severity of the injury [14-17]. The extent of the injury, viability of unaffected adrenal tissue, endocrine related conditions and associated-concomitant injuries are important clinical key factors in deciding proper management. The rates of adrenalectomy reported by Mehrazin et al and Gomez et al were about 3.1 % and 50 % respectively [9, 14]. However, no patients in our study required an adrenalectomy that may be related with small sample size. An isolated adrenal hematoma was not seen in presented study. All our patients had concomitant injuries to the other organ or system, hemathoraces/pnemothoraces being present in 80 % (n=12). Although the incidence of liver laceration, as a concomitant injury, was more than 50 % (n=8), exploratory laparotomy required in 3 cases (20%) to do partial liver resection in 1 case and suture of liver laceration after lavation of intraabdominal hematoma in 2 cases. Therefore, the presence of any injury to the other organ or system, in patients with blunt abdominal trauma, should alert the radiologist for the eventual unilateral or bilateral adrenal hematoma. One-third of our patients died, a mortality rate nearly same (32.6 %) with previous study [3].

The presence of bilateral adrenal hematoma on CT examination should signal the possibility of endocrine-related conditions like adrenal crisis and the need for close follow-up. None of our patients had adrenal crisis during follow-up clinical evaluation. Our results compared with that of literature might be explained partly by patient population that unilateral adrenal hematoma (80%) included by a majority. In our study, the mean diameters of the right-sided adrenal hematomas, either in all patients or in patients with bilateral adrenal hematomas, are greater than the left-sided ones. The small size of the hematoma may allow a higher percentage of residual viable tissue of the adrenal gland. This finding highlights the possibility of sufficient viable adrenal tissue even in patients with bilateral adrenal hematoma prevent the development of adrenal crisis. In previous studies, the mean maximum diameter of the right and/or left sided adrenal hematomas were found as 28 mm and 26 mm, which were smaller than we found [2, 17]. Nevertheless, to our knowledge, this is the only single center series reported to date that dealt with and pointed the relationship between diameter of the lesions and present and/or possible clinical findings. Further comprehensive studies, including those performed in large patients groups with and without clinical signs of adrenal crisis, are required.
to confirm this hypothesis and shed light on the definite effect of diameter of lesion on clinical status.

There are some incidental adrenal lesions that can be misdiagnosed on CT as adrenal gland injury. Firstly, adrenal adenoma often contains fat tissue and may be easily differentiated from a hemorrhage within the adrenal gland. Another lesion of adrenal gland is the myelolipoma, a relatively uncommon benign tumor, can be differentiated from adrenal hematoma with specific appearance of macroscopic fatty component. Hemorrhage into a preexisting lesion of the adrenal gland is also probable and it should always be taken into consideration. Recently, 133 patients with spontaneous hemorrhagic adrenal masses reviewed by Marti et al, allowing to understanding the awareness of this condition [18]. Interestingly, median sizes of hemorrhagic adrenal masses in this review, were much more greater than our results and other previously reported ones that measured in traumatic hematomas [18]. The associated and concomitant injuries including stranding of periadrenal fat tissue, ipsilateral visceral and/or skeletal injury, thickened diaphragmatic crus and peritoneal/retroperitoneal hemorrhages are helpful in differential diagnosis of adrenal hematoma from preexisting adrenal lesions. In addition to these contributory findings, the diameter of the lesion might also be taken into consideration. MRI examination plays an important role in the discrimination of hematoma from these lesions or preexisting lesion with hemorrhage. In our study, none of the patients have examined with MRI scan. However, in our daily practice, follow-up MRI findings of patients with non-traumatic adrenal hematoma were initially low to intermediate signal intensity in centers and the high signal intensity superficial ring that followed by increased intensity in centrally and decreased intensity in peripherally with reducing in size on T1W images (Figure 3). This technique was also found to be sensitive and specific for both diagnosis of hematoma and assessing if blood is the only component in hematoma [19]. If there is any suspicion in the diagnosis, MRI should be performed and the lesion should be followed for resorption of hematoma.

There were some limitations of our study that result from its retrospective projection. Firstly, small number of patients with adrenal hematoma, that limit the statistical analysis, was the weakness of this study. A short-term follow-up could have limited the clinical outcomes. Further studies, consisting of a larger number of patients with traumatic adrenal hematoma and adequate follow-up interval may be necessary to support our results.

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Adrenal hematoma usually eventuates in the setting of multisystem organ injury. US examination is prone to miss adrenal hematoma in trauma cases. The assessment of adrenal gland with CT is the principal necessity. The awareness of specific and associated CT findings of adrenal injury is important for the radiologist to diagnose the condition and direct proper management.
Fig. 3: A 59-year-old male after orthotopic liver transplantation. Contrast enhanced axial CT (a) and axial fat saturated T1-Weighted images (b) at the time of postoperative 1. month shows right adrenal hematoma. Follow-up axial fat saturated T1-Weighted images (c) on postoperative 6. month shows resorption of hematoma with changes in signal characteristics.

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