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Adrenal Gland Injury after Blunt Thoracoabdominal Trauma: A 12-Month Period Prospective Study in a Tertiary Hospital and Review of the Literature

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Abstract

Purpose: The purpose of this study was to prospectively search for patients with isolated adrenal gland injuries (AGI) after blunt thoracoabdominal trauma in a 12-month period in a tertiary hospital and review of the literature.

Methods: All patients transported to the Emergency Department of our hospital subjected to thoracoabdominal trauma from October 2018 to September 2019 were included in the present study. Review of the literature was performed by collecting data from Medline and PubMed databases.

Results: 4565 patients were prospectively studied. 821 (0.18%) had some form of blunt thoracoabdominal trauma. Only two cases of adrenal gland injury (0.04%) were detected. Review of the overall prevalence for AGI was 0.43%. Isolated injuries appeared in 5.4%. The most commonly injured gland was the right. CT was the main diagnostic tool and primary radiologic findings were oval or round adrenal appearance and periadrenal fat stranding. Conservative treatment was the main practice and operative rates vastly vary between authors.

Conclusion: Adrenal hematoma (AH) is often overlooked lesion in both low and high violence trauma. Its existence requires monitoring. Surgical intervention is usually reserved for unstable patients. Radiologic evaluation and follow-up is essential for these lesions for proper management and differential diagnosis.

Keywords

Adrenal gland injury, adrenal hematoma, Blunt thoracoabdominal trauma, Prospective study

Introduction

Adrenal gland injury (AGI) is a rarely described entity, able to happen in both high and low force accidents. Isolated adrenal hematoma (AH) is a very rare condition in addition to the already rare involvement of adrenals in blunt thoracoabdominal trauma. Despite the limited cases described in the literature, expanding knowledge of physicians over the years and the development of imaging tools led to increasing diagnoses and improvement in patient management [1]. Herein we report two consecutive cases of isolated AGI happened during a 12-month period in a tertiary hospital, as well as review basic elements of prevalence, diagnosis, management, and follow-up.

Methods

All patients transported to the Emergency Department of our hospital from October 2018 to September 2019 who were subjected to thoracoabdominal trauma were included in the present study. In all patients, the diagnosis and hospitalization protocols were followed.

Review of the literature was performed by collecting data from Medline and PubMed databases regarding adrenal gland injury after blunt thoracoabdominal trauma. Studies that narrowed down the patient number according to the type of trauma or exam performed from the final evaluation were excluded.

Results

4565 patients presented to the Emergency Department from October 2018 to September 2019 and were prospectively analyzed by the authors. Of those patients 821 (18%) had some

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type of thoracoabdominal trauma due to motor vehicle accident, fall from height or blunt force trauma. We encountered two cases of adrenal gland injuries (0.04%): one isolated hematoma and one isolated adrenal contusion. Both patients had computed tomography (CT) scans with intravascular contrast and were evaluated by a clinical radiologist. Apart from those two cases, no other case of adrenal trauma was identified by any imaging examination in the study period.

The first case involves a 33-year-old Caucasian male who was victim of a low-speed motorbike accident, whereas the second case involved a 69-year-old Caucasian female who fell from 50 cm height. Both patients had no former history of thoracic or abdominal trauma and there were no abnormal signs on coagulation panel. They were complaining for intense and persistent pain in the right flank. Chest, spine and pelvis plain radiography was negative for fractures or any other abnormal findings. Focused assessment with sonography for trauma (FAST) performed by a clinical radiologist revealed no evidence of trauma. Due to the persistence of pain and high clinical suspicion, the patients were subjected to abdominal contrast-enhanced computed tomography scan (CE-CT), which revealed adrenal injury. The first patient proved to suffer from adrenal hematoma (Figure 1), whereas the second from a small round lesion of variable attenuation with a very small focal hyperdense area on the right adrenal, with no active extravasation (Figure 2).

Data collected from Medline and PubMed databases are mentioned in Table 1, and show AGI percentages of patient or patient CT populations analyzed throughout the literature. The prevalence of AGI in trauma patient populations ranges from 0.15%-0.83% (mean 0.43%), predominance of injuries on the right adrenal gland is definite in all studies ranging from 60-82% and isolated AGI appear from 0-27% (mean 5.4%). Most common associated injuries from thorax and abdomen involved the ribs and the liver respectively with no significant prevalence. Exploratory laparotomy was the most frequently performed operation with surgical intervention range from one to over fifty-five percent (mean 15.5%).

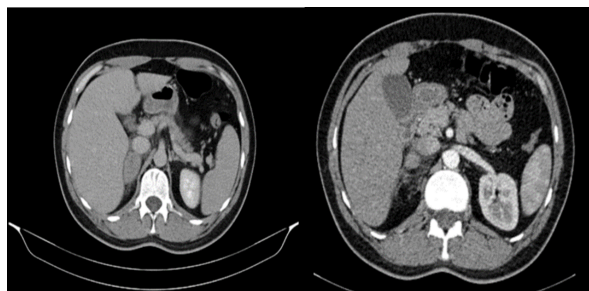


Figure 1: Oval, well-defined lesion (4.2x 2.7) with high density and crus thickening, indicative of acute AH in the initial abdominal CT. No contrast extravasation is noticed. Periadrenal fat stranding appears inferiorly.

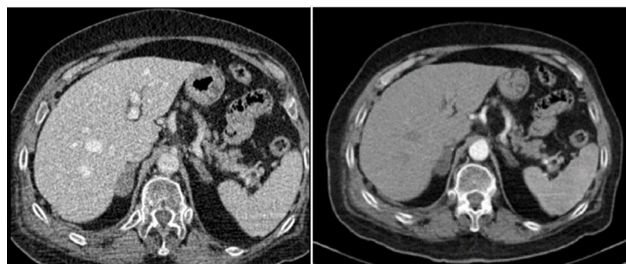


Figure 2: Initial Plain and CE-abdominal CT scan reveals a hypodense adrenal lesion and a contrast-enhanced dot-shaped focal area anterior to the gland

Discussion

Adrenals are small Y-shaped glands reside in the retroperitoneum, anteromedially attached to kidneys through the renal fascia and enclosed to perirenal fat. Posteriorly the fascia connects them with the crura of the diaphragm which fuses with the longitudinal ligament of the vertebral column. Typically the right crus is thicker and longer than the left, comes from the front of the bodies and intervertebral discs of the upper three lumbar vertebrae. The right adrenal, being slightly more posteriorly than the left, is anteriorly affiliated with the right lobe of the liver and the inferior vena cava (IVC) which the right adrenal vein joins and medially with the vertebral column. On the left, the adrenal is surrounded by major organs like the stomach and the spleen and resides further from the spine. Moreover, the left adrenal vein joins the left renal vein, making it less susceptible to contusions and edema from the backflow pressure raise of the vein [13]. During the fetal period the suprarenal arteries derive mainly from the inferior phrenic artery, and secondarily from the abdominal aorta and the renal artery [14]. The above mentioned anatomic characteristics justify the asymmetry of blood supply between the left and right adrenal glands and help to understand why the adrenal gland may be intact while a bleeding occurs.

Sevitt S. [1] in 1955 described the pathophysiology and mechanism behind adrenal apoplexy, through 50 autopsies of severely injured resulting in 14 adrenal gland injuries (26%), 11 of which were unilateral and 9 (70%) on the right adrenal [1]. Examining two of these cases due to controversies of the injuries (contralateral injuries and minor thoracoabdominal injuries respectively), we assume that lateral and decelerating force is probably a major factor in AGI. Additionally, every gland that was studied had centrally placed clots in the medulla possibly occurring due to the plethora of sinusoids and small vessels and venules of the region, providing evidence that AGI can happen in minimally damaged and not necessarily enlarged or ruptured glands [1]. It has also been reported that in 69% of the pediatric patients, some part of the adrenal gland was intact [15].

Adrenal trauma prognosis is still a subject of controversy, as many reports strongly state that AGI is associated with a higher Injury Severity Score (ISS) and mortality while others prove that the severity of the injury is not mandatory to exist, and ISS is an independent mortality factor. Stawicki et al. found five times higher mortality rate in trauma including AGI. On the other hand, Chen et al. reviewed and divided 305 multiple trauma patients with and without AGI, resulting in 0% mortality in the first group versus 9.8% in the later, while ISS and hospitalization period comparison was not significant [5,16]. Raup et al. [10] retrospective study had the highest number of AGI in the literature and mentioned that the severity of trauma scores and intestinal or penetrating injuries resulted in higher numbers of adrenalectomies and also deaths, although with variable probability. Furthermore, isolated AGI occurred primarily to penetrating trauma none of which was taken to the OR and with 0% mortality. Inducibly, the reviewed articles compared patients with vastly different injury scores and that the Injury Severity Score itself should be prognostic and not the possible AGI [10].

Although adrenal insufficiency happens at 16%-50% of bilateral AGI, possible complications associated with AH regarding blood pressure, electrolytes or cortisol serum levels can occur. Stawicki et al. mentioned two cases of low cortisol levels with unilateral adrenal injuries. ACTH stimulation test was normal in the first patient, who did not show any particular signs of adrenal insufficiency, but the second patient had blood pressure and electrolytic changes and refused any further exams of follow-up [5,16].

Clinically significant AGI may appear divergently in ultrasound sonography (U/S), as hyperechoic or isoechoic with the hepatic parenchyma with possible bright echo.

Although the U/S is a dependent tool, AGI can be left undiagnosed due to small size, lack of fluid appearance or examiners subjectivity and experience and even with the use of Contrast-enhanced ultrasound (CEUS), studies clear out that it lacks in diagnostic and follow-up value for adrenal lesions as opposed to CT or MRI [17,18].

	Number of patients	Number of AGI (%)	Right (%)	Left (%)	Bilateral (%)	Isolated (%)	Associated injuries (%)	Surgical intervention (%)
Kunhivalappil et al. [2]	4991	11 (0.22%)	82	9	9	0	Abdomen (100)	9
Rana et al. [3]	6808	51 (0.74%)	76	18	6	2	Ribs (66)	3.8
Mehrazin et al. [4]	58000	130 (0.22%)	78.5	21.5	5	6.2	Thorax (65)	-
Stawicki et al. [5]	210508	322 (0.15%)	-	-	-	-	Liver (>57)	>55
Pinto et al. [6]	2026CT ¹	82 (4%)	73	26	1	7	Liver (65)	7
Burks et al. [7]	1120CT ¹	20 (2%)	60	25	15	0	Thorax (>50)	-
Sinelnikov et al. [8]	-	73 (0.86%)	77	15	8	4	Liver (43)	-
Alsayali et al. [9]	3921 TA Trauma ²	96 (2.4%)	73	23	4	0	Thorax (>50)	25
Raup et al. [10]	1766606	7791 (0.44%)	-	-	-	1,5	Ribs (59)	1
Liao et al. [11]	9252	77 (0.83%)	76.5	21	2.5	6.5	Liver (66)	7.7
Lee et al. [12]	-	11	78	13	9	27	Liver (55)	9

Table 1: AGI percentages of patient¹Number of trauma patients examined with CT²Number of patients with thoracoabdominal trauma

Dashes imply that this information was not mentioned

	Round/Oval AH	Periadrenal fat stranding	Indistinct adrenal gland	Thickened crura	Diffuse retroperitoneal hemorrhage
Murphy et al. [16]	100%	100%	75%	75%	-
Pinto et al. [6]	74%	10%	17%	-	10%
Burks et al. [7]	83%	61%	9%	39%	9%
Sinelnikov et al. [8]	30%	93%	27%	10%	<2%
Alsayali et al. [9]	82% ¹	13%	82% ¹	-	-
Rana et al. [3]	100%	89%	-	-	-
Kunhivalappil et al. [2]	100%	100%	-	64%	36%
Stawicki et al. [5]	54%	-	35%	-	11%
Mehrazin et al. [4]	40%	92%	-	-	36%
Lee et al. [12]	100%	-	-	-	-

Table 2: Radiologic presentation of AGI¹Authors considered AH as indistinct adrenal glands

Dashes imply that this information was not mentioned

Computed Tomography with intravascular contrast (CE-CT) is widely accepted as the gold standard in adrenal imaging and differential diagnosis during trauma evaluation. CT imaging criteria associated with adrenal injuries commonly include oval hematomas, diffuse hemorrhage with or without active extravasation, diaphragmatic thickening of crus and periadrenal fat stranding. We reviewed the frequency of appearance of the imaging criteria that appeared in different studies in order to find the most pathognomonic ones (Table 2).

Round or oval lesions with high density signifying AH appeared in approximately 83% of the cases. Hematomas were mostly non-enhanced. Peri-adrenal fat stranding had the most diversity appearing in 10%-93% of the studies. However, in many articles, it was considered as a crucial factor in AH diagnosis. Crus thickening appeared in 10%-39% in adults and up to 61% in children. Diffuse hemorrhage was consistently rare with 1.4% to 10%. Adrenal pseudocysts and calcifications appear seldom and relate to chronic hematomas [8,9,15,17,19,20].

Recent hemorrhage and hematomas limited within the adrenal capsule are dense (40-90HU) while chronic hematomas acquire attenuation similar to water, develop heterogeneity and calcifications due to inflammation [4,8,9]. Mild adrenal swelling or contusion has been reported as a form of adrenal trauma. It requires further assessment with CT imaging and re-evaluation of the shape of the lesion in a 24-hour follow-up to avoid misdiagnosis of a delayed AH [7,21].

Follow-up is essential in all adrenal injuries. Total or partial resolution of AH happens in most cases after 2-4 weeks but some remain unchanged after the 7-day follow-up [9]. Chronic hematomas are considered lesions that remain for over 7 weeks, typically appear hypointense in MRI and contain hemosiderin deposits but although reduced in size, AH may appear with subacute characteristics as hyperintensity in T1W, even after 30 days [2,9,22].

Chronic AHs are still expected to resolve as in our first case but can also remain and form pseudocapsules and cysts that expand in size compress surrounding structures or become contaminated. Pseudocysts appear mostly as hypointense masses with hyperdense areas inside, depending on what they contain, they can cause a variety of vague symptoms such as chronic pain, fever, nausea and vomiting and must always be in the differential diagnosis of adrenal tumors from hemorrhagic pseudocysts (HPC) [23].

Nerli et al. reported a pheochromocytoma presented as HPC six months post-trauma. The patient suffered from chronic pain and hypertension and vanillylmandelic acid (VMA) levels in urine were raised. On contrary, Kyoda et al. presented three cases of imaging-diagnosed pheochromocytoma which histologically resulted in HPC. All of the cases clinically resembled pheochromocytoma but had negative I-metaiodobenzylguanidine scintigraphy and normal catecholamine levels. Importantly, two of them were on anti-coagulant medication [24,25].

Adrenal incidentalomas appear in around a bold 4-5% of annual CTs in the US [18,19]. In their majority, they are non-functioning

neoplasms. Small size (<4cm) and attenuation less than 20HU or 37HU after 15-minute wash-out is indicative for benign lipid-rich lesions, usually adenomas [26,27]. We suggest early follow-up CT/MR imaging within 7 days (the subacute AH window) when the first imaging is not diagnostic and the patient's status, lab values, and pain are indicative.

Though an uncommon finding in trauma, AGI occur sporadically due to blunt and penetrating trauma, variable trauma severity and chest wall and liver associated injuries. Isolated adrenal injuries result from low force accidents and are mostly treated conservatively, depending on patient status. They are challenging to diagnose and need a high level of clinical suspicion and a thorough evaluation of the patient's status in order to avoid misdiagnosis. It is of out-most importance to identify even the smallest of lesions and treat them with equal caution as in any other traumatic organ hematoma.

Data Availability

The authors declare that the data supporting the findings of this study are available within the article

Competing Interests

The authors declare that they have no competing interests.

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version. Additionally, there are no conflicts of interest in connection with this paper, and the material described is not under publication or consideration for publication elsewhere.

Ethical Approval

The study has been approved by the Ethics committee of General Hospital of Patras, Patras, Greece: approval number 41541.

Author Contributions

All authors have contributed in study concept and design, data collection, data analysis and interpretation.

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