REVIEW ARTICLE

Blunt adrenal gland trauma in the pediatric population

Stylianos Roupakias*, Marinos Papoutsakis, Paraskevi Mitsakou

Pediatric Surgery Department, Hippokration General Hospital of Thessaloniki, Macedonia, Greece

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Summary A retrospective review of the literature was performed to determine the natural history, prevalence, prognosis and management of adrenal injury associated with blunt abdominal trauma in pediatric population. Blunt adrenal injury in children is uncommon, rarely isolated, and typically present as part of a multi organ trauma. Adrenal hemorrhage is being diagnosed more frequently since the emergence of computed tomography in modern emergency rooms. Obstetric birth trauma during vaginal delivery of a macrosomic fetus may result in neonatal adrenal hemorrhage. In children appear to be an incidental finding that resolves on follow-up imaging. Most of these injuries are self-limited and do not require intervention. The differential diagnosis of an adrenal neoplasm, especially in children with an isolated adrenal hemorrhage, must be considered. The presence of adrenal hemorrhage in the absence of a trauma history should alert to the possibility of pediatric inflicted injury.

1. Introduction

Adrenal gland hematoma is often a complication of surgical procedures, anticoagulant therapy, trauma,1 stress and shock.2 Trauma is a leading cause of death in children,3 and impacts to the torso frequently cause solid-organ injuries.4 Abdominal trauma accounts for 8–10% of all trauma admissions to pediatric hospitals and more than 80% of traumatic abdominal injuries in children result from blunt mechanisms.5

The adrenal glands, because of their small size and retroperitoneal location, are protected by the surrounding structures and are infrequently injured.4 Adrenal gland trauma is a rare and largely coincidental finding diagnosed either during an initial radiological examination or during surgical exploration for other injuries.6 Many patients with undiagnosed adrenal injury undergo laparotomy on account of intra-abdominal bleeding, but adrenal damage may be never revealed.7

The first description of adrenal hemorrhage after traumatic injury was reported by Canton in 1863.8 Gomez et al
estimated that traumatic adrenal injuries comprise 0.3% of all traumatic hospital admissions. Autopsy studies have shown adrenal hematomas in up to 25% of adult blunt trauma victims. In a 1955 postmortem study of a series of young victims of fatal car accidents, Sevitt reported a 28% rate of adrenal hemorrhage following severe abdominal trauma.

Adrenal trauma tends to be more frequent in patients with severe trauma, and has been diagnosed more frequently since the emergence of computed tomography (CT), ultrasonography and magnetic resonance imaging (MRI). The significance and true incidence of traumatic adrenal injury hemorrhage in children is not known. In the pediatric population, blunt adrenal injuries are rare and typically present as part of a multi-organ trauma, which is an increasingly frequent phenomenon in the modern emergency room. Although adrenal gland trauma is associated with high injury severity and mortality in adults, in the pediatric population it has been perceived as an incidental finding with limited clinical significance in the evaluation of abdominal trauma.

The main goal of this study was to evaluate the frequency of detection of trauma-induced adrenal gland hematoma in children. The mechanisms of this injury, the associated injuries, clinical presentation, diagnosis, severity and the management of blunt adrenal gland trauma in the pediatric population is also reviewed.

2. Epidemiological overview

Most adrenal gland hematomas, which are more common in children than adults, are associated with anticoagulant therapy, septicemia, low blood pressure, tumors, pregnancy complications or traumas. Vella et al classified them into seven categories: incidentalomas (non-symptomatic idiopathic hematomas), spontaneous hematomas, anticoagulant therapy-associated hematomas, post-surgical hematomas, adrenal hematomas with heparin-associated thrombocytopenia, severe stress or sepsis associated hematomas, and hematomas due to traumas. Adrenal gland hemorrhage is a rare entity that is mostly encountered in trauma patients.

Adrenal gland trauma has received little attention in the past. Except for a few small series, the literature regarding adrenal gland trauma has largely consisted of case reports as of 1992, and only eight such cases were documented in the literature among hospitalized pediatric patients. Other than case series, not many reports of large patient series dealing with adrenal gland trauma have been published until now, especially about children. The low reported incidence may be explained by the fact that unilateral and even bilateral adrenal hemorrhage do not necessarily lead to signs of adrenal insufficiency and that in the past injury to these tiny retroperitoneal organs was difficult to detect using imaging techniques during the acute phase.

Adrenal trauma in the general population is relatively rare and appears to be equally rare in children. The overall incidence in trauma patients has not been well characterized, however, and studies in the literature give percentages ranging from 0.03% to 4.95%. The incidence of adrenal trauma in autopsy series of blunt abdominal trauma victims increases to approximately 7–20%, and for Sevitt in up to 25%, raising the question as to whether a significant degree of under-diagnosis of these injuries exists. In children, especially, the significance and true incidence is unknown.

We reviewed the experience of adult patients with adrenal gland trauma who had presented to different trauma centers the past 15 years. In the Rana et al series, adrenal hematoma was detected in 51 of 6808 patients (0.8%) who were entered in the trauma registry. Mehrazin et al reported that of more than 58,000 presenting with trauma, only 130 patients were identified as having adrenal injuries (0.22%). Stawicki et al determined the incidence of traumatic adrenal injuries to be 0.15% (322 out of 210,508 admitted injured patients). Since CT examinations have become available in trauma management there has been an increased frequency in the detection of adrenal hematoma. Rana et al found that the incidence was 1.9% (51) of 2692 patients who underwent trauma CT, while when the denominator was all patients examined for trauma the frequency was only 0.8% (51 of 6808 patients). The higher incidence (1.9%) is surprisingly similar to the frequency of 2% reported in the Burks et al study, despite the availability of CT for the evaluation of severe trauma patients. One possible explanation for this seeming paradox could be that, concomitant with the increased use of CT to evaluate patients with more severe injuries, there has been an increased tendency to perform CT to evaluate patients with less severe injuries compared to the past. Pinto et al identified 82 patients (4%) with adrenal injuries in a group of 2026 emergency multidetector row CT examinations that were performed in the setting of major blunt trauma. By inference, the incidence of adrenal trauma diagnosed in the adult population increased with advances in CT scanning, as the proportion of adrenal trauma decreased with the increased number of admitted or CT examined patients presented in the study (Table 1).

Only a few small series (in comparison with adult population) have been documented in the literature among hospitalized children. Iuchtmann et al identified adrenal hemorrhage in 1% of 313 children admitted to the trauma unit with abdominal or thoraco-abdominal blunt trauma within a 10-year period. Among 9199 pediatric trauma cases, Gabal-Shehab and Alagiri identified 20 adrenal injuries (0.22%). Schwarz et al, using CT, determined the rate of adrenal gland injury in children following blunt abdominal trauma to be 4.95%. Of a total of 121 children admitted to their medical center within a 4-year period who were examined by emergency CT for suspected abdominopelvic injury, six had adrenal hemorrhage. In another study using tomography evaluation of pediatric abdominal trauma, Sivit et al established 3% adrenal trauma in 1155 children with abdominal CT. The incidence of adrenal injury diagnosed in the pediatric population therefore seems likely to increase with the continued use of CT (Table 2).

The proportion of pediatric adrenal trauma also decreased with the increased number of children of reviewed in each series (Table 2). In conclusion, the incidence of blunt adrenal trauma in children ranges from about 0.2% to 1% in those admitted and evaluated for abdominal trauma and between 3% and 5% of children examined using CT.
3. Anatomy and the mechanisms of trauma

Following the head and extremities, the abdomen is the third most commonly injured anatomic region in children. The abdominal contents are very susceptible to injuries in children because the abdominal wall is thin, the diaphragm is more horizontal and the ribs are very elastic.

The relative rarity of adrenal injury is consistent with the relatively good protection of the gland between the lower rib cage and back musculature, in the retroperitoneal space. The bilateral adrenal glands are triangular-shaped structures located high in the retroperitoneum, just superior and medial to the upper poles of the kidneys. The right gland is in close proximity to the posterior surface of the right hepatic lobe and may be shielded from anterior blunt force by this relationship. The left gland is adjacent to the stomach, upper pole of the spleen, and tail of the pancreas. Posteriorly, both touch the diaphragm. Compression of the adrenal glands between these surrounding structures and the adjacent vertebral column may result in injury. The adrenal glands in the perirenal space are surrounded by fat and enclosed by Gerota’s fascia, a thin fibrous capsule. They are also protected because of their small size, measuring only 2 × 1.5 cm in infants. In children, however, the adrenals are relatively large and may be more susceptible to injury following external compressive forces. Although the right gland lies deep in the abdomen, it appears to be vulnerable. Anatomically it is adjacent to the spine and is more likely to be compressed during a forceful impact.

The etiology of adrenal hematoma is multifactorial and it is reported to be more common in adults and in the pediatric population. Left-sided and bilateral post-traumatic bleeding have been recorded. Adrenal injury usually results from blunt trauma and is rarely seen in penetrating trauma. The exact mechanism of traumatic adrenal injury is still unknown, although the adrenal glands are susceptible to massive intraglandular bleeding due to their complex vascular supply. Each adrenal gland is supplied by the inferior phrenic artery, the renal artery and the aorta. Each arterial trunk is divided into 10–20 smaller branches that communicate over the outer aspect of the gland; other branches course directly to the medulla. The adrenal medulla in infants may be particularly vulnerable to hemorrhage because the venous sinuses within the medulla are poorly developed and fragile, with unequally distributed supporting muscular walls. Adrenal gland trauma has been defined either as ischemic necrosis of the adrenal gland caused by intra-adrenal pressure increase secondary to post-traumatic intra-adrenal hemorrhage (contusion) or direct disruption of the adrenal gland (laceration or fragmentation), and a combination of the two may occur in a given patient.

The main possible mechanisms suggested for adrenal injury include direct compression, sudden increase in venous pressure and shearing of friable adrenal vessels. The first mechanism involves compression (severe hyperextension and lateral compressive force) of the adrenal glands by the blunt trauma itself or by the surrounding organs, i.e., direct violent compression between the spine and the surrounding organs by direct trauma to the upper abdomen and flank. Direct compression is by far the most common mechanism of injury. This hypothesis correlates with the frequently associated ipsilateral injuries. This also explains the high number of associated abdominal and thoracic lesions. A short-term sudden rapid rise in intra-adrenal venous pressure has also been considered a possible mechanism due to the compression of the inferior vena cava. Finally, deceleration forces can produce shearing of the small vessels that perforate the adrenal capsule.

Several possible mechanisms may explain the high right adrenal vulnerability owing to idiosyncrasies in the anatomy of this structure. First, the proximity of the right adrenal gland to the inferior vena cava may cause its mechanical compression during impact. Hydro-dynamically, the right adrenal gland along with a very short direct adrenal vein lies directly posterior to the inferior vena cava. With rapid deceleration injury and blunt trauma to the abdomen, very high abdominal pressure is probably transmitted through the vena cava, and thus through the adrenal vein, for a short duration. On the left, this pressure would dissipate through the left renal venous system, but on the right, it is transmitted directly to the adrenal gland through the short right adrenal vein. This mechanism could also explain the possibility of right adrenal hematoma in.
patients restrained by a combination of lap and shoulder belts and an airbag who experience a sudden deceleration with high abdominal pressure but avoid impact or hyperextension and are without an associated liver injury. The greater propensity for right adrenal hematomas may be explained by the more confined space of the right adrenal gland between the liver and the spine and the greater mass of the liver. We suggest that at the moment of acceleration—deceleration the liver, which is the heaviest abdominal parenchymal organ, moves in dorsal and/or caudal directions, pushing the right adrenal gland against the spine, such that the adrenal is clamped between these two structures, much like a nut in a nutcracker. The pathological appearance of adrenal hemorrhage after trauma has been described as intra-adrenal hematoma with distention but no disruption of the cortex, and periadrenal edema, congestion and limited hemorrhage. It seems unlikely that hemorrhages after blunt trauma are stress related.

4. Severity of trauma and the associated injuries

Although the exact mechanism of adrenal gland injury has not been proven, it is not surprising that these injuries occur in patients who have sustained more severe trauma because the adrenal glands are small, relatively well-protected structures in the retroperitoneum. Blunt abdominal trauma happens more commonly in childhood and frequently occurs due to motor vehicle accidents.

Other causes are fall from a height, seat belt injuries, and even vigorous resuscitation. Adrenal gland trauma was noted to be associated with a high injury severity score, implying that it is associated with high injury severity and mortality. It most frequently occurs in the setting of multisystem organ injury.

Ipsilateral solid viscous lesions, mainly of the liver and kidney in right-sided adrenal injury and the kidney, pancreas or spleen in left-sided adrenal injury, must always be looked for.

Lower chest injuries, including lung contusion, rib fractures, and hemopneumothorax usually are seen. Associated vertebral injury, pelvic fracture, extremity fracture, head injury, aortic injury, bowel injury and diaphragmatic rupture have been found.

In most of reports in the literature, in children the adrenal injury was accompanied by trauma to other abdominal organs, usually by ipsilateral chest trauma or closed head injury. The liver (most commonly), spleen, kidneys and pancreas are the most frequently injured organs in pediatric blunt-force injuries of the abdomen. Motor vehicle accidents (most frequently) and falls from a large height promote high-energy forces, that may injure many organs simultaneously or successively. This factor is compounded in children by the higher energy transfer per body size coefficient. Therefore, traumatic adrenal hemorrhage in children is a strong indicator of visceral injury.

In adult patients bilateral adrenal hemorrhage ranges between 1.25% and 6% of blunt adrenal injuries. Despite this, it seems unlikely that hemorrhage after blunt trauma is stress related and that bilateral adrenal hemorrhage can occur due to severe stress associated with high injury severity trauma or with major surgery. Possibly only an extremely high energy trauma and probably fatality can produce this type of injury.

Isolated adrenal hematoma may be diagnosed on admission to the emergency department. The incidence of isolated adrenal trauma in adults ranges from about 2% to 7.5% of total blunt adrenal injuries. In children, isolated adrenal trauma seems to be a little more common than in adults, but only small series among hospitalized children have been documented in the literature. When isolated adrenal lacerations are demonstrated in the pediatric population, child abuse must be strongly considered as the etiological factor, although such damage could occur follow sporting activity.

Adrenal gland injury secondary to penetrating trauma is extremely rare and almost always associated with a high incidence of shock and severe, devastating injuries. Penetrating injuries in children are less common and result in about 10% of the abdominal trauma admissions in most trauma centers. No penetrating adrenal gland injury in a child has been reported.

5. Clinical presentation

Clinical manifestations of adrenal hemorrhage are rare. Even though unilateral adrenal injuries have limited clinical significance, the identification of bilateral adrenal hemorrhage can be of critical importance, since it may lead to acute adrenal insufficiency and can be considered a potentially fatal condition. Primary adrenal insufficiency manifests clinically when 90% or more of each gland is destroyed. This compounds the burden of body trauma, stress and shock.

Adrenal insufficiency rates ranging from 0% to 10% have been reported for blunt abdominal trauma. Baccot et al reported a 50% rate of adrenal insufficiency in their series of bilateral adrenal hemorrhage. The signs of adrenal cortical insufficiency are fever, hypernatremia, hyperkalemia, acidosis, refractory hypotension and lethargy. Adrenal insufficiency can be life-saving in these critically ill patients. Udobi and Childs documented adrenal insufficiency using an adrenocorticotropic hormone stimulation test and showed that patients dramatically improved after hydrocortisone administration. Schmidt reported a case of a post-traumatic adrenal mass accompanied by extreme hypertension, increased urine normetanephrine with normal plasma levels of metanephrines. Using alpha-blocking agents for stabilization, a laparotomy with drainage of a hematoma was conducted, with complete resolution of the reactive post-traumatic

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Hemorrhage appears to commonly occur in the acute stage. 

Unilateral adrenal trauma is often asymptomatic and is masked by injuries to other organs. Unilateral adrenal injury is, by itself, of no clinical significance in children. Even if unilateral adrenal infarction were to occur, the contralateral adrenal gland would prevent the development of adrenal insufficiency. Right-side hematoma may nevertheless cause compression of the inferior vena cava with thrombus formation. Adrenal hematomas should also be considered a source of possible abscess formation or delayed infection causing posttraumatic sepsis, like any other hematoma.

Patients with an isolated adrenal injury is usually present with right hypochondrium pain and vomiting. Vomiting is not endocrine related. It is caused by retroperitoneal irritation and should not be falsely attributed to the possibility of central nervous system injury. Isolated injuries have also been reported, with severe hemorrhage requiring blood transfusion. Non symptomatic adrenal gland hematomas are sporadic and often follow sports activity. It therefore seems likely that a few adrenal hematomas are missed in those patients in whom CT was not warranted on clinical grounds, because not all trauma patients undergo abdominal CT. We would not recommend routine use of an adrenocorticotropic hormone stimulation test or even simple hormone measurement, preventive cortisone administration in the setting of a diagnosed unilateral adrenal injury trauma, or even in absence of abovementioned signs and symptoms in children. A child with an adrenal injury during hospitalization should be observed closely for any change of vital signs or electrolyte disturbance.

6. Radiological features

Mild radiographic enlargement of the adrenal gland in a trauma patient can be an early sign of an impending adrenal hemorrhage. Abdominal CT scanning is the investigative technique of choice in the imaging of adrenal gland injuries secondary to blunt trauma. Plain abdominal films are nonspecific. The abdominal ultrasound can, rarely, and in very experienced hands, reveal a mildly hyperchoic mass in the suprarenal area that may raise the suspicion of injury. Sporadic reports have been published regarding MRI for the diagnosis of adrenal trauma, mostly owing to the significant logistic limitations associated with this type of imaging in the acute trauma setting.

As with other injuries, grading should be determined and recorded according to the American Association for the Surgery of Trauma Organ Injury Scale for adrenal gland injuries (Table 3). Adrenal hematomas can be localized or massive, with spread through the retroperitoneal space. Adrenal gland hematoma on CT characteristically shows a high attenuation mass either occupying the adrenal gland or obscuring the normal adrenal gland, which can be considered evidence of injury because it may be a pre-existing incidental lesion. Determining the attenuation of lesions may be useful in distinguishing adrenal hematoma from incidental adenoma in CT performed after intravenous contrast material administration. Most acute adrenal hematomas are relatively hyper-attenuating, while most adenomas are relatively hypo-attenuating. If a tumor is suspected, further evaluation—e.g., biochemical markers, imaging—may need to be carried out. The distinction between hematoma and adenoma is not clinically urgent and can be made at follow-up, particularly because many trauma patients undergo follow-up examinations.

CT follow-up imaging is preferred when there are associated abdominal injuries and can show hyperdense adrenal masses that are lower in attenuation. Ultrasound seems to be adequate for follow-up imaging (moderately echogenic adrenal mass decreasing in volume, and usually shows resolution within 3 months in children). Follow-up MRI scans show resolving hematomas characterized by increased central signal intensity and a peripheral decrease in intensity.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description of injury</th>
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<tr>
<td>I</td>
<td>Contusion</td>
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<tr>
<td>II</td>
<td>Cortex laceration &lt;2 cm</td>
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<tr>
<td>III</td>
<td>Laceration extending into medulla &gt;2 cm</td>
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<tr>
<td>IV</td>
<td>&gt;50% parenchymal destruction</td>
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<tr>
<td>V</td>
<td>Total parenchymal destruction</td>
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<tr>
<td></td>
<td>Massive intraparenchymal hemorrhage</td>
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<td>Avulsion from blood supply</td>
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On rare occasions a pseudocyst can be formed that grows slowly. As seen with adrenal hemorrhage due to other causes, it is feasible that in survivors these lacerations may calcify. In the absence of an associated mass, however, adrenal calcifications in children are nonspecific.

7. Neonatal adrenal hemorrhage

Adrenal hemorrhage is more common in neonates than in older children or adults and is the most common adrenal mass in neonates. The reason for such a high incidence is its large size compared to weight and a unique vascular supply. The risk factors for neonatal adrenal hemorrhage include obstetric birth trauma, intrauterine hypoxia, sepsis, and hemorrhagic disorders. Neonatal adrenal hemorrhage may sometimes be the result of obstetric birth trauma owing to a difficult labor or delivery, particularly in infants of diabetic mothers or infants who are large for gestational age. Vaginal delivery of the macrosomic fetus may result in hemorrhage of the intra-abdominal organs. The most commonly affected organs are the liver and adrenal glands.

At birth, the adrenal gland is quite large and weighs 5–10 g because of fetal embryogenesis and homeostasis (the normal adult adrenal weighs about 5 g). Adrenal insufficiency may result in hemorrhage at birth as the result of regression of the fetal cortex, which occurs rapidly during the first 6 weeks of life. The vascular channels in the primitive cortex become markedly engorged and more susceptible to hemorrhage. In addition to the superior, middle and inferior adrenal arteries, an adrenal arterial supply arising from the gonadal arteries has been reported in 60% of fetal adrenal vascular dissections. If the hemorrhage is significant, a palpable flank mass, anemia, prolonged jaundice and hypovolemic shock due to blood loss may occur. A scrotal hematoma is an unusual clinical manifestation. Adrenal insufficiency is rare in neonates. Renal vein thrombosis in neonates is associated with adrenal hemorrhage. The presence of hematuria and azotemia suggests a diagnosis of coexistent renal vein thrombosis.

The differential diagnosis of a flank mass in the suprarenal area in the newborn includes adrenal hemorrhage, neuroblastoma, Wilms’ tumor and renal duplication of the upper segment.

Neuroblastoma is the most common solid malignant tumor in infants of less than 1 year. Adrenal hemorrhages in newborns are usually diagnosed by sonography. The differentiation between neonatal neuroblastoma and adrenal hemorrhage may be very difficult in the individual case. The most important follow-up criteria to sonographically differentiate adrenal malignoma from hemorrhage are significant reduction in size, loss of echogenicity as well as the formation of a capsule within the first 10 days of life. Otherwise—even with insignificant laboratory findings—malignoma, especially congenital neuroblastoma, has to be suspected.

Conventional color code Doppler sonography and power Doppler sonography are useful to diagnose a neuroblastoma (hemorrhage with a cystic appearance, and demonstrated vessels within the tumor). When morphological change, clinical appearance and follow-up do not allow differentiation of adrenal hemorrhage and neuroblastoma, MRI is indicated. An additional contrast application (gadolinium-DTPA) can aid in demonstrating vascular tumors. Unilateral adrenal hemorrhage should be differentiated from neuroblastoma. Measurement of vanilmandelic acid, homovanillic acid, and catecholamines is also useful.

8. Treatment of adrenal hemorrhage

Adrenal injuries are managed surgically or conservatively. The treatment of choice of adrenal gland injury is based on the severity of the damage, contralateral gland status, viability of residual tissue, patient’s general condition and hemodynamic stability, and associated injuries. Information regarding the size of the hematoma and the presence of extravasation, during an aortography and selective adrenal artery angiography, are useful for selecting the appropriate management of patients with traumatic adrenal hemorrhage.

Usually, patients undergo surgical intervention in the presence of major injuries to the spleen, liver, or one of the kidneys. In spite of Gomez et al reporting an approximately 50% rate of total or partial adrenalectomy in 1993, nowadays the incidence of post-traumatic adrenalectomy has decreased to approximately 2.5–3.1%. Adrenalectomy should be reserved for cases with extensive parenchymal damage to the gland and attempts at preserving residual adrenal tissue should always be made, especially in situations when the contralateral adrenal was resected. One operative option includes repair of the gland to preserve adequate adrenal function and prevent adrenal insufficiency; a second operative option is to resect the adrenal gland, which could potentially eliminate the source of delayed hemorrhage and infection and decrease the risk of inferior vena cava thrombosis from compression.

Commonly patients who undergo adrenalectomy also receive a coordinate nephrectomy. In situations where surgery is the only option, special attention should be given to the salvage of both organs (adrenal gland and kidney), if possible. The adrenalectomy must be performed once other maneuvers to obtain hemostasis have proved unsuccessful (e.g., packing and ligation of the adrenal vein). A few patients with isolated adrenal hemorrhages have been treated with embolization—Transarterial embolization—which is an accepted procedure in the management of traumatic hemorrhage due to neck, face, and retroperitoneal injuries and solid visceral trauma—is useful for treating patients with massive adrenal hemorrhage. For all that, in the pediatric population, although there is a possibility of significant adrenal hemorrhage requiring transfusion, adrenal trauma is typically self-limiting and does not require intensive care monitoring or operative intervention.
9. Conclusions

In the pediatric population, blunt adrenal injuries are probably more common than previously suspected but are rare, usually perceived as an incidental finding, and typically present as part of a multi-organ trauma. Vaginal delivery of a macrosomic fetus may result in traumatic adrenal hemorrhage. The right adrenal gland is more likely to be injured, with liver trauma as the most commonly associated injury, followed by ipsilateral renal injury. Isolated adrenal injury is exceedingly rare.

Unilateral adrenal injury is by itself of no clinical significance in children but identification of bilateral adrenal hemorrhage, despite being extremely rare in children, may theoretically lead to acute adrenal insufficiency. In children with bilateral adrenal hemorrhage, an extended hormonal insufficiency is only necessary in patients with bilateral adrenal hemorrhage showing signs of adrenal insufficiency. CT is the best diagnostic tool, and ultrasound is very useful in follow-up examinations.

The differential diagnosis of an adrenal neoplasm, especially in children with an isolated adrenal hemorrhage, must be considered. Although there is a possibility of significant adrenal hemorrhage requiring transfusion, adrenal trauma is typically self-limiting and does not require intensive care monitoring or operative intervention. The presence of adrenal hemorrhage in a child without a history of trauma should alert to the possibility of inflicted injury.

References
