Trauma and Toxicology

Traumatic Adrenal Injury in Children

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Key words: adrenal, adrenal hemorrhage, adrenal injury, adrenal insufficiency, abdominal CT

Abstract

Background: Multiple organ injury in children is an increasingly frequent phenomenon in the modern emergency room. Adrenal hemorrhage associated with this type of trauma has received little attention in the past.

Objectives: Using computed tomography, we sought to determine the rate and nature of adrenal gland injury in children following blunt abdominal trauma due to motor vehicular accident.

Methods: A total of 121 children with blunt abdominal trauma were examined and total body CT was performed in cases of multi-organ trauma or severe neurological injury.

Results: Of all the children who presented with blunt abdominal trauma over a 51 month period, 6 (4.95%) had adrenal hemorrhage. In all cases only the right adrenal gland was affected. Coincidental injury to the chest and other abdominal organs was noted in 66.7% and 50% of patients, respectively.

Conclusions: Traumatic adrenal injury in the pediatric population may be more common than previously suspected. Widespread application of the more sophisticated imaging modalities available today will improve the detection of damage to the smaller organs in major collision injuries and will help in directing attention to the mechanism of trauma.

Motor vehicle accidents are the most common cause of abdominal trauma in children. In most cases the visceral parenchymal organs are injured, but there may also be accompanying chest trauma. Relatively little attention has been focused, however, on the presence of adrenal hemorrhage in this subgroup of patients.

Adrenal hemorrhage due to abdominal trauma was first described in 1863 [1]. Sevitt [2], in a 1955 postmortem study of a series of young victims of fatal car accidents, reported a 28% rate of adrenal hemorrhage following severe abdominal trauma. Yet, as of 1992, only eight such cases had been documented in the literature among hospitalized pediatric patients [3]. 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 [4], and that in the past, injury of these tiny retroperitoneal organs (measuring only 2x1.5 cm in infants) was difficult to detect by imaging techniques during the acute phase. Until recently, it was routine practice to perform immediate abdominal ultrasonography at the bedside of car accident victims, followed by CT for complete evaluation of the abdominopelvic region, as needed. Late follow-up of surgical candidates consisted of ultrasonography only. With the recent introduction of more sensitive imaging modalities, such as high resolution CT and more recently the high speed spiral CT scanners, improved visualization is now available. In 1992, Taylor [5] delineated the high risk signs of abdominal injury and listed the clinical indications for emergency abdominal CT.

In our prospective study, state-of-the-art CT methods were used to examine children with blunt abdominal trauma, all of them following vehicular accidents, and the rate and nature of coincidental adrenal injury were determined.

Material and Methods

A total of 121 children admitted to Schneider Children's Medical Center from April 1993 to July 1997 (51 months) following blunt trauma were examined by emergency CT for suspected abdominopelvic visceral injury. A Twin spiral CT scanner or an Excel 1800 model (Elscint, Israel) was used. Contrast medium (Omnipaque 300, Winthrop, NY, USA) was administered by manual intravenous bolus injection at a dose of 2 ml/kg body weight, up to 120 ml. The abdomen was scanned from the lung bases through the symphysis pubis. Total body CT examinations were conducted in cases of multitrauma or severe neurological injury. Repeated CT studies in patients considered candidates for surgery, and follow-up ultrasonography in those whose clinical condition had stabilized or improved, were performed.
Results

Of the 121 patients with blunt abdominal trauma, 6 (4.95%) showed adrenal hemorrhage on CT examination [Figure 1A]. The demographic characteristics and medical findings of this subgroup are shown in Table 1. All adrenal injuries were on the right side. None of the children had laboratory or clinical signs of adrenal insufficiency, but one (16.67%) had adrenal gland calcification on follow-up ultrasonography. In four children (66.7%) an ipsilateral abdominal organ (liver and/or right kidney) was also injured [Figure 1B]. Four children had chest injuries — ipsilateral (contusion of the right lower lobe and pleural effusion) in three (50%) and contralateral (contusion of the left lower lobe) in one (16.67%) [Figure 1C]. Additional retroperitoneal hemorrhage was found in one patient (16.67%).

Discussion

The results of our study show that adrenal injury accompanies blunt abdominal trauma in almost 5% of pediatric cases. This figure is even higher than the 2% in adults [3] and 3% in children [4] reported previously. In most of the children the adrenal injury was accompanied by trauma to other abdominal organs, and in 50% by ipsilateral chest trauma. The literature reports injury rates of 61% [4] and 95% [3] to ipsilateral abdominal viscera. Research performed by automobile manufacturers has shown that individuals involved in car accidents are subjected to multiple vector forces, so that many organs may be injured simultaneously or successively. This factor is compounded in children by the higher energy transfer per body size coefficient.

All the adrenal injuries in our series were of the right gland, which concurs with earlier reports [3,4,6]. Several possible mechanisms of injury may explain this high right adrenal vulnerability. First, the proximity of the right adrenal gland to the inferior vena cava [7] may cause its mechanical compression during impact. Some authors have suggested a hydrodynamic theory involving the increased pressure in the right adrenal vein that drains directly into the inferior vena cava [6]. Furthermore, the venous lattice of the adrenal medulla may be susceptible to damage owing to its loose spongiform structure [2]. We suggest that at the moment of acceleration-deceleration, the liver, which is the heaviest abdominal parenchymal organ, moves to 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.

According to the current knowledge, unilateral adrenal injury is by itself of no clinical significance. The rare instances of bilateral adrenal injury may lead to some adrenocortical insufficiency, which compounds the burden of body trauma, stress and shock.

Table 1. Demographic characteristics and radiology findings in patients with traumatic adrenal injury

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Sex/Age (yr)</th>
<th>Abdominal injury</th>
<th>Chest injury</th>
<th>Adrenal injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M/5</td>
<td>None</td>
<td>None</td>
<td>Rt</td>
</tr>
<tr>
<td>2</td>
<td>M/5</td>
<td>Retroperitoneal bleeding</td>
<td>Rt, lower lobe contusion</td>
<td>Rt</td>
</tr>
<tr>
<td>3</td>
<td>M/3</td>
<td>Rt kidney, liver: Rt lobe</td>
<td>None</td>
<td>Rt</td>
</tr>
<tr>
<td>4</td>
<td>F/9.5</td>
<td>Liver: Rt lobe</td>
<td>Rt, lower lobe contusion, Rt, pleural effusion</td>
<td>Rt</td>
</tr>
<tr>
<td>5</td>
<td>M/4.5</td>
<td>Liver: Rt lobe</td>
<td>None</td>
<td>Rt</td>
</tr>
<tr>
<td>6</td>
<td>F/2.5</td>
<td>Liver: Rt &amp; Lt lobes; Rt kidney</td>
<td>Rt, &amp; Lt lower lobes contusion</td>
<td>Rt</td>
</tr>
</tbody>
</table>
We conclude that injury to the adrenal gland in children following blunt abdominal trauma is probably more common than previously suspected. The newer spiral CT scanners provide improved visualization of the smaller retroperitoneal organs, enabling identification of the more severely injured adrenal glands. The accurate diagnosis of adrenal hemorrhage may serve as an important index for identifying other coincidental injuries of the ipsilateral abdominal and chest organs.

References

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Interfering with TGF-beta

Unregulated cell growth results in tumor production, therefore it is important to identify developmental factors that regulate cell growth. Transforming growth factor-beta (TGF-beta) regulates cell growth and differentiation through receptor-mediated phosphorylation of Smad proteins. These Smad proteins in turn form protein complexes and enter the cell’s nucleus to activate the transcription of target genes. Stroschein et al. have identified a new player, SnoN, in TGF-beta signaling. In the absence of TGF-beta, the SnoN oncprotein binds to a Smad2/Smad4 complex and recruits a transcription co-repressor, thus inhibiting transcription activation. When TGF-beta is present, Smad3 triggers the degradation of SnoN and transcription activation resumes. Finally, a negative-feedback mechanism is present in which TGF-beta stimulates SnoN production, which then represses the transcription activation function of the Smad complex once again. SnoN is found in various carcinomas. Hence, the transforming activity of SnoN may be explained by its interference with the role of TGF-beta in inhibiting cell growth.

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