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Intra-abdominal Solid Organ Injuries: An Enhanced Management Algorithm

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Abstract

The organ injury scale grading system proposed by the American Association for the Surgery of Trauma provides guidelines for operative versus nonoperative management in solid organ injuries; however, major shortcomings of the American Association for the Surgery of Trauma injury scale may become apparent with low-grade injuries, in which conservative management may fail. Nonoperative management of common intra-abdominal solid organ injuries relies increasingly on computed tomographic findings and other clinical factors, including patient age, presence of concurrent injuries, and serial clinical assessments. Familiarity with characteristic imaging features is essential for the prompt diagnosis and appropriate treatment of blunt abdominal trauma. In this pictorial essay, the spectrum of the American Association for the Surgery of Trauma organ injury scale grading system is illustrated, and a multidisciplinary management algorithm for common intra-abdominal solid organ injuries is proposed.

Résumé

Le système de gradation des lésions d'organes à l'aide d'une échelle, comme le propose l'American Association for the Surgery of Trauma, fournit des lignes directrices pour la prise en charge opératoire et non opératoire des lésions d'organes solides. Cependant, des lacunes importantes de l'échelle de l'American Association for the Surgery of Trauma pourraient se révéler manifestes dans les cas de lésions de faible grade pour lesquelles un traitement conservateur pourrait être voué à l'échec. La prise en charge non opératoire des lésions d'organes intra-abdominaux solides dépend de plus en plus des observations tomographiques informatisées et d'autres facteurs cliniques, notamment l'âge du patient, les lésions concomitantes et les évaluations cliniques réalisées en série. Il est essentiel de s'être familiarisé avec les éléments d'imagerie caractéristiques pour permettre un diagnostic rapide et offrir un traitement approprié dans les cas de traumatismes abdominaux contondants. Dans cet essai s'accompagnant d'images, le spectre du système de gradation des lésions d'organes à l'aide de l'échelle de l'American Association for the Surgery of Trauma est illustré et un algorithme de prise en charge multidisciplinaire dans les cas de lésions d'organes intra-abdominaux solides est proposé.

Key Words: Blunt abdominal trauma; Pitfalls; Liver; Spleen; Renal; Kidney; Hepatic; Pancreas: Computed tomography

Trauma is the leading cause of death in the population under the age of 45 years old [1]. In 2007, more than 180,000 people died of trauma, of which blunt abdominal trauma (BAT) had the highest incidence [1]. In patients who are hemodynamically stable (either in the absence of shock, or patients in shock who do respond to therapy), there has been a notable shift from routine surgical to nonoperative management (NOM) of BAT [2]. This change may be attributed to several factors, including increased availability of high-quality computed tomography (CT) scanners in most trauma centers in the industrialized nations. However, the traditional Organ Injury Scale (OIS) defined by the American Association for the Surgery of Trauma (AAST) has significant shortcomings [3], especially in the prediction of solid organ injuries amenable to NOM. In particular, the recognition of low-grade injuries that may fail with observation

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alone and thus must be recognized by radiologists and reported to trauma teams may not be consistently and successfully predicted when using the OIS.

Splenic and liver injuries are the most common solid organ injuries to occur as a consequence of BAT; in contrast, renal and pancreatic injuries are less common [2]. The partial or complete removal of these organs can greatly increase patient morbidity [2], and precise interpretation of the AAST OIS grading system is crucial to determining patient outcomes [3]. This pictorial essay reviews the AAST OIS grades for spleen, liver, kidney, and pancreas, and presents a simplified multidisciplinary management algorithm for each solid organ injury discussed.

Blunt Splenic Trauma

The spleen is the most commonly injured abdominal organ, which accounts for 49% of blunt abdominal injuries [4]. Formerly, splenectomy was the treatment of choice for most intermediate or high-grade splenic injuries, but infectious postsplenectomy complications have led to a preference for nonoperative management in these scenarios [5,6]. Splenic lacerations may be superficial ($\leq$3 cm in depth, grades I-II) or deep ($\geq$3 cm in depth, grade III). Subcapsular and intraparenchymal hematomas and lacerations are easily visible on contrast-enhanced CT. Subcapsular hematomas appear as elliptic collections of low-attenuation blood between the splenic capsule and the splenic parenchyma, whereas active bleeding appears on CT images as areas of contrast extravasation with high attenuation, which are typically larger and more irregular than contained injuries [4]. An intraparenchymal hematoma appears as a hypodense area within a normally perfused splenic parenchyma. Parenchymal laceration and capsular disruption appear as linear defects [7]. A laceration that devascularizes $\geq$25% of the spleen is defined as a grade IV injury; whereas, a shattered spleen or a hilar vascular injury is defined as grade V injury [8]. Published literature has shown a significant mortality rate (22.7%) from grade V injuries [8]. The AAST spleen injury grading system is summarized in Table 1; various splenic injury grades are illustrated in Figure 1. These provide a useful framework for the stratification of splenic injuries for the purposes of diagnostic and treatment decisions.

An important factor that affects management is the presence of active extravasation, which may be life threatening without intervention, regardless of the grade of the injury. Despite its importance, active extravasation is not taken into account in the AAST OIS. Previous studies have reported successful NOM of patients with large hemoperitoneum with no evidence of active extravasation [7,9]. Conversely, small extravasations, pseudoaneurysms, and arteriovenous fistulas may be managed successfully with embolization in hemodynamically stable patients [10]. Examples of various low-grade splenic injuries that required intervention due solely to active extravasation are depicted in Figure 2. Hemodynamic stability is key in deciding further diagnostic or therapeutic management. A simplified multidisciplinary management algorithm for various grades of splenic trauma is depicted in Figure 3.

Blunt Hepatic Trauma

The liver is the second-most commonly injured organ, with an incidence of injury that ranges from 1%-8%; however, it is the most common cause of BAT mortality [11]. Hepatic laceration may be superficial ($\leq$3 cm in depth, grades I-II) or deep ($\geq$3 cm in depth, grades III-V). On contrast-enhanced CT, lacerations appear as irregularly linear or branching areas of hypoattenuation [11]. Parenchymal hematomas on a contrast-enhanced CT may appear as low-attenuation areas with ill-defined margins in the liver parenchyma [11]. In contrast, subcapsular hematoma appears as an elliptic collection of low-attenuation blood between the liver capsule and liver parenchyma [11]. Parenchymal disruption of 25%-75% in 1 lobe defines a grade IV lesion. Parenchymal disruption of $\geq$75% in 1 lobe defines a grade V lesion. Grade VI injury consists of hepatic avulsion, which has a 91.5% mortality rate and requires urgent exploratory laparotomy [8]. The AAST liver injury grading system is summarized in Table 2. Grades I-V hepatic injuries are illustrated in Figure 4. Grade VI is often a surgical diagnosis

Table 1
American Association for the Surgery of Trauma organ injury scale: spleen injury scale[a]

Grade[b]	Injury type	Description of injury
I	Hematoma	Subcapsular, <10% surface area
	Laceration	Capsular tear, <1-cm parenchymal depth
II	Hematoma	Subcapsular, 10%-50% surface area; intraparenchymal, <5 cm in diameter
	Laceration	Capsular tear, 1-3−cm parenchymal depth that does not involve a trabecular vessel
III	Hematoma	Subcapsular, >50% surface area or expanding; ruptured subcapsular or parenchymal hematoma; intraparenchymal hematoma $\leq$5 cm or expanding
	Laceration	>3-cm parenchymal depth or involving trabecular vessels
IV	Laceration	Laceration that involves segmental or hilar vessels, producing major devascularization (>25% of spleen)
V	Laceration	Completely shattered spleen
	Vascular	Hilar vascular injury with devascularized spleen

[a] Adapted from Ref. 20.
[b] Advance 1 grade for multiple injuries up to grade III.