Blunt liver trauma- brief review and computed tomography role

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Learning objectives

- Discuss the importance of CT in diagnosis and management of the patients with blunt liver trauma;
- Review CT features of blunt liver trauma;
- Expose the liver injury grading system based on computed tomography (CT), documented by the American Association for The Surgery of Trauma (AAST).

Background

In blunt abdominal trauma, the liver is one of the most frequently injured organ [1,2] and represents about 15-20% of all blunt injuries to the abdominal viscera [2].

Blunt liver trauma is still associated with an important morbidity and mortality (described mortality rate 4.1%-11.7%) but in recent years there has been a shift from routine surgical to nonsurgical management of these injuries. A surgical approach is often associated with more blood transfusions and complications than nonoperative managements [1,2]. Hence, nonsurgical treatment has become the standard of care in hemodynamically stable patients with blunt liver trauma. CT ability to diagnose and monitor hepatic injuries, has made this imaging method the great responsible in this treatment change.

In this poster we will review the literature about CT based liver injury grading system established by the AAST. We will also expose the most common CT features of blunt liver trauma, which include lacerations, subcapsular or parenchymal hematomas, active hemorrhage, juxtahepatic venous injuries, periportal low attenuation, and a fat inferior vena cava [1]. CT is also helpful in the evaluation of delayed complications related to this kind of trauma, which include delayed hemorrhage, hepatic or perihepatic abscess, posttraumatic pseudoaneurysm, hemobilia, and other biliary complications such as biloma and bile peritonitis [1,5].

Findings and procedure details
The major CT features of blunt liver trauma are:

**Hepatic Laceration:**

- the commonest type of parenchymal liver injury [1,3];
- CT reveal irregular linear or branching hypodense areas, frequently traveling along vessels and fissures [3], surrounded by enhancing liver parenchyma [1-4];
- can be further classified as superficial (<3 cm in depth) or deep (>3 cm) [1];
- multiple parallel lacerations have been called "bear claw" lacerations [3];
- lacerations that extend to the hepatic bare area may be associated with hemothorax and adrenal hematoma [1,4];
- lacerations that extend to the porta hepatis are commonly associated with major vessels and bile duct injuries, thus likely to lead to the development of bilomas.
- a liver fracture is a laceration extending through the entire liver and possible leading to an avulsion of a part of liver parenchyma [3].

**Subcapsular or intraparenchymal hematomas:**

- also one of the most common liver injuries;
- acute hematomas are characteristically hyperattenuating (40-60 HU) in comparison to the normal liver parenchyma at unenhanced CT;
- Subcapsular hematomas: CT reveal an elliptic blood collection beneath a intact capsule, compressing the normally enhancing hepatic parenchyma, and assuming a lenticular form which deform the liver contour [3]. They are most commonly found anterolateral to the right lobe.
- Intraparenchymal hematomas: contrast-enhanced CT show round to oval focal low-attenuation areas, that may persist for several weeks.

**Active Hemorrhage:**

- The detection of active contrast extravasation after blunt liver trauma is important, as it is associated with an ongoing, potentially life-threatening hemorrhage, and it is a strong predictor of failure of nonsurgical management. This condition may manifest as bleeding either into a parenchymal hematoma or freely, as a "jet" into the peritoneal space [1];
• During the portal venous phase, CT shows focal high-attenuation areas, in comparison with the normally hepatic parenchyma. The bleeding area may reach a similar (generally within 10 HU) attenuation value to an adjacent major artery [2];
• Attenuation values may help differentiating clotted blood from an active arterial extravasation area. Hence, attenuation values between 91 to 274 HU (mean, 155 HU) are in favor of active bleeding, whereas values between 28 to 82 HU (mean, 54 HU) are in favor clotted blood [1].

Major Hepatic Venous Injury:

• May be suspected if CT reveals lacerations or hematomas that extend along one or more major hepatic veins or IVC. These lesions are a strong indication for surgical treatment, as they can be life-threatening;
• Also these findings may be an indirect sign of arterial hemorrhage, as these injuries were 3.5 times more frequently associated with hepatic arterial bleeding than injuries without major hepatic venous involvement;
• Injuries extending to the retrohepatic vena cava are particularly lethal, with mortality rates reaching about 80-100%, due to the difficulty in exposing this area, and controlling this hemorrhage [2].

Periportal Low Attenuation

• This may be the only sign of liver injury [1,3];
• CT shows low attenuation areas that parallel the portal vein and its principal branches, and also when seen next to a hepatic laceration, it may represent a hemorrhage dissecting periportal connective tissue.
• we should keep in mind that this finding can be related to vigorous IV fluid administration or other causes of elevated central venous pressure [1,3].

Flat IVC

• It happens if the inferior vena cava below the level of the renal vein, has an anteroposterior width that is less than one-fourth of its lateral width and the change is not caused by external compression. At CT, conditions like hypovolemia, poor fluid resuscitation, or shock may present as a attenuated IVC.
To overcome the difficulty in establishing a systematic approach to these lesions, also due to the wide variety of terms used to describe liver injuries, a liver injury classification scale was created by the American Association for the Surgery Trauma (AAST) [4].

We should keep in mind that, even when using this grading scale, surgeons should not determine whether to manage surgically or conservatively that patient, solely on the basis of CT criteria, since even high-grade injuries have responded favorably to nonsurgical treatment. Hence, in patients with blunt liver trauma, it is suggested that the best predictor for the necessity of surgical intervention is the loss of hemodynamic stability [1].

<table>
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<th>Grade</th>
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| I     | **Hematoma:** subcapsular, < 10% surface area  
       | **Laceration:** capsular tear, <1 cm in parenchymal depth |
| II    | **Hematoma:** subcapsular, 10%-50% surface area intraparenchymal, <10 cm in diameter;  
       | **Laceration:** 1-3 cm in parenchymal depth, <10 cm in length |
| III   | **Hematoma:** subcapsular, > 50% surface area of ruptured subcapsular or parenchymal hematoma; intraparenchymal, > 10 cm or expanding;  
       | **Laceration:** > 3 cm in parenchymal depth |
| IV    | **Laceration:** parenchymal disruption involving 25%-75% of a hepatic lobe or one to three Couinaud segments |
| V     | **Laceration:** parenchymal disruption involving > 75% of a hepatic lobe or more than three Couinaud segments within a single lobe **Vascular:** juxtahepatic venous injuries (ie, retrohepatic vena cava or central major hepatic veins) |
| VI    | Vascular hepatic avulsion |

*Table 1- represents AAST liver injury scale (reviewed in 1994).*
*High-grade injuries grades IV-V; Advance one grade for multiple injuries up to grade III. Source- reference [1]

CT FEATURES OF DELAYED COMPLICATIONS

CT play an important role monitoring conservative treatment, as this method can effectively detect delayed liver complications in patients with blunt liver trauma. If the patient remains asymptomatic, a follow-up CT is generally taken as unnecessary in patients with low-grade injury. The optimal timing for a follow-up CT in patients with high-grade injuries fits between 7 and 10 days (from the original injury).

Delayed complications may happen in about 10-25% of patients with hepatic injuries [2] and are more common in patients with severe, complex liver injuries [1].

Such complications can arise weeks to months after injury [1,5]. As more and more patients with grade IV/V liver injuries have been treated nonsurgically [5], the prevalence of delayed complications detected at follow-up CT has increased [1]; However some authors still defend that liver-related complications appear to be less frequent in patients managed without operation than in those managed surgically[5].

The most common complications are delayed hemorrhage, hepatic abscess and bilomas.

Delayed Hemorrhage:

- Is seen in about 1.7 to 5.9% - the most frequently described complication on nonsurgically managed patients with these injuries [1,2,5];
- may be related to either an initially small injury which has expanded, or to a biloma-induced pseudoaneurysm and may ultimately originate an expanding hematoma or cause a free intraperitoneal rupture [1,5].

Abscess:

- develops in about 0,6 to 4% of the patients with hepatic injury [1,2];
• there's still matter of debate about the contribution of nonsurgical management to this complications [2,5];
• these complications present on follow-up CT as focal areas of #uid attenuation with or without gas bubbles/air-#uid level [1].

Biliary Complications:

• This group of complications (which includes biloma, biliary #stula, bilhemia, and bile peritonitis) [1] arise either as a result of direct liver trauma such as bile duct disruptions [5], and has been seen in 2.8-7.4% of patients with blunt liver trauma [1].
• Bile leakage from a hepatic laceration is common but in most cases it is limited and temporary, with no adverse sequelae. In fact many peripheral bile duct injuries go unrecognized by current imaging techniques and heal without complications[5]. This leakage, when free into the peritoneal cavity, may also result in bile peritonitis, although signi#cant bile duct injury that requires de#nite treatment is relatively rare.
• Biloma (reported with an incidence ranging from 2 to 12%) [5] presents at CT as a well-circumscribed intraparenchymal or perihepatic collection, with low attenuation and progressive growth - this is in fact strongly suggestive of biloma in a patient with history of blunt liver trauma. We should keep in mind that most traumatic bilomas usually resolve spontaneously, without intervention, over weeks to months [1,2].
• Bile peritonitis: Persistent or increasing amounts of free #uid in the peritoneal cavity, which presents at CT with low-attenuation and enhancing thickening of the peritoneum [1]. Although bile may leak into the peritoneal cavity and result in bile ascites and bile peritonitis, it is more common that an induced inflammatory response to the intraperitoneal bile results in bile being walled-off in bilomas with CT attenuation close to water, unless bleeding or infection supervenes [4].

Finally the CT follow-up can document the tissue healing process as a hemoperitoneum usually resolves within 1 week, subcapsular hematomas within 6-8 weeks, and lacerations within 3 weeks . Parenchymal homogeneity is usually restored in 4-8 weeks, although hematomas and bilomas may persist for years.

Images for this section:
**Fig. 1:** Axial contrast material-enhanced CT scan shows hepatic lacerations.
Fig. 2: Coronal contrast material-enhanced CT scan shows hepatic lacerations.
Fig. 3: Axial contrast material-enhanced CT scan shows hepatic hematomas, contusion, hemoperitoneum and devascularized right kidney.
**Fig. 4:** Axial contrast material-enhanced CT scan shows hepatic lacerations around portal veins and inferior vena cava.
Fig. 5: Image courtesy of MD Woong Yoon. Contrast-enhanced CT scan shows a laceration that extends into the IVC and cutoff of right hepatic venous drainage (arrow). Hemorrhagic fluid is seen around the IVC. Surgery revealed a laceration of the right hepatic vein.
Fig. 6: Image courtesy of MD Woong Yoon. Contrast-enhanced CT scan shows low-attenuation areas around the portal vein and its branches (arrowheads); laceration that extends into the porta hepatis (arrow). Marked distention of the IVC may indicate vigorous fluid replacement.
Fig. 7: Image courtesy of MD Pierre P. Goffette. Axial unenhanced CT scan from a conservatively treated grade-III liver injury. Eight days after trauma an emergent control CT shows a markedly increased and hyperdense perihepatic hematoma.
Fig. 8: Image courtesy of MD Pierre P. Goffette. Axial contrast-enhanced CT scan from the post-operative period after emergent hepatorrhaphy and suture of a right colonic injury. The image shows intra and perihepatic bilomas (star).
Conclusion

Liver is one of the most commonly injured organs in blunt abdominal trauma, and it is related with an significant morbidity and mortality. CT has an important role on the assessment of hemodynamically stable patients.

Personal information

References


