BJGH Brazilian Journal of Global Health
Revista Brasileira de Saúde Global

Liver trauma in ultrasound and computed tomography exams

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ABSTRACT

OBJECTIVE

To identify the main imaging findings in the occurrence of liver trauma by ultrasonography (USG) and computed tomography (CT) exams.

METHODS

Literature review of radiological images to identify anatomical morphology with studies published in the last 17 years (2007-2024). The search strategy included the PubMed and Scielo databases, with the descriptors, ((hepatic trauma) AND (ultrasonography) OR (computed tomography)). The inclusion criteria included literature review studies that addressed the topic of liver trauma, that had images of the diagnostic methods sought (USG and CT), and that were in accordance with the objective of the research and available online in full text.

RESULTS

Among the findings of blunt and penetrating abdominal trauma, case reports with hepatic hematomas and lacerations, bilomas and abscesses were found. The most common injury grades were I, II and III. It occurs more frequently in young men, in agreement with other studies, because men are more susceptible to traumatic events due to risk behaviors.

CONCLUSIONS

With the advancement of imaging exams such as CT and USG, conservative treatment has become possible for stable patients with blunt hepatic trauma, which reduces unnecessary laparotomies. Patients undergoing surgical treatment are those with greater severity of trauma and associated injuries.

DESCRIPTORS

Hepatic trauma; Ultrasonography; Computed tomography.

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DOI: https://doi.org/10.56242/globalhealth;2024;4;15;47-51

INTRODUÇÃO

Abdominal trauma is of great importance due to the risk to life present in these cases, and can be classified into two distinct types: penetrating (open) or blunt (closed). Blunt trauma is usually caused by accidents involving motor vehicles, falls, explosions and sports injuries. Penetrating trauma can be caused by a sharp weapon or a firearm projectile.[1]

Among the organs most affected by blunt abdominal trauma is the liver, representing between 35% and 45%, while in penetrating trauma, its involvement represents 40%, according to epidemiological data.[1] The liver is an organ whose size makes it susceptible to penetrating trauma and its position in the abdominal cavity exposes it to blunt trauma, by direct injury and by deceleration.[2]

The diagnosis is based on serial physical examination and subsidiary tests. However, because the physical examination is neither sensitive nor specific, and can be positive, in insignificant injuries, or negative, in important injuries, in 43% of cases, it is important to perform tests such as ultrasound (USG) and computed tomography (CT).[3]

Patients with penetrating abdominal trauma (gunshot wound or perforating injury) will probably be undergoing direct exploratory laparotomy, since there is no immediate way to know which organs have been violated until an intraoperative assessment of the viscera is performed. Patients with blunt trauma, including falls from a height, motor vehicle collisions, or assaults, are likely to have injuries to a solid organ, which may or may not be immediately evident.[3]

The use of CT in patients with blunt abdominal trauma is essential because it can characterize the presence of liver injury, its extent and severity, in addition to excluding associated injuries, avoiding unnecessary surgeries.[4] In addition, CT has become an important diagnostic method because it is more accessible to patients.[5]

USG, on the other hand, despite the need for a good equipment and correct handling by the professional, is a significant diagnostic option due to the practicality of performing the exam. The FAST (Focused Assessment With Sonography in Trauma) protocol of POCUS (Point of Care Ultrasonography) has advantages because it is fast (up to 3 minutes), portable, and can be repeated at the bedside, especially in cases of high clinical suspicion. This aspect is particularly important considering that approximately one-third of hemodynamically stable trauma patients may have significant intra-abdominal injuries even in the absence of free fluid on initial FAST.[6]

In abdominal trauma involving the spleen, liver, kidney, and pancreas, partial or complete removal of these organs can greatly increase patient morbidity, and accurate interpretation of the American Association for the Surgery of Trauma (AAST) classification system is crucial to determining patient outcomes.[7]

In 1989, the AAST organized a uniform and objective classification of liver trauma, allowing comparison between different trauma centers regarding treatment efficacy and outcomes. This classification was most recently revised in 2018, in which it was described throughout this work.[7]

Liver lacerations can be superficial (3 cm deep, grades I-II) or deep (3 cm deep, grades III-V). On contrast-enhanced CT, lacerations appear as irregularly linear or branched areas of hypoattenuation. Parenchymal hematomas on contrast-enhanced CT may appear as low-attenuation areas with poorly defined margins in the liver parenchyma. In contrast, a subcapsular hematoma appears as an elliptical collection of low-attenuation blood between the liver capsule and the liver parenchyma. A 25%–75% parenchymal rupture in 1 lobe defines a grade IV injury. A 75% parenchymal rupture in 1 lobe defines a grade V injury. A grade VI injury consists of hepatic avulsion, which has a mortality rate of 91.5% and requires urgent exploratory laparotomy.[7]

A nonoperative approach can produce a 90% success rate in the treatment of liver trauma. This approach is clinically more favorable because it has decreased mortality and other infectious complications frequently encountered after surgery.[7]

Published literature has shown a significant mortality rate with grades IV, V, and VI injuries (23.9%, 61.7%, and 91.5%, respectively). Active extravasation is a significant finding that should be sought and promptly reported to the trauma team. Similar to splenic injury, active extravasation is not accounted for based on the current AAST.[7]

The AAST scale cannot predict the need for surgical treatment in liver injuries, and the treatment of liver injuries with active extravasation largely depends on the hemodynamic stability of the patient's liver injury.[7]

Contrast-enhanced CT scans can accurately detect damage to the liver parenchyma. Lacerations, contusions, and hematomas appear as areas without contrast. Active hemorrhage can be assessed based on the collection of extravasated contrast material.[8]

Abdominal trauma is a notable cause of morbidity and mortality worldwide. Deaths related to these injuries are classified as external causes, which in Brazil represent the second leading cause of mortality, especially in the working-age population. Notably, trauma is strongly related to car accidents, the rates of which have been increasing in recent years. In these cases, multiple traumas occur, with the abdominal region being prevalent.[9]

Regarding the factors associated with deaths associated with abdominal trauma, car accidents (59.31%) and the use of weapons (30.09%) stand out. These results are due to the high morbidity and mortality related to the traumatic events involved. Traffic accidents cause multiple traumas resulting from the high kinetic energy involved, responsible for injuries and fractures that are difficult to treat clinically. Regarding the use of weapons, they result in penetrating injuries whose course has a high lethal risk, given the possibility of serious hemorrhages, causing significant volume loss, in addition to allowing infections to the victim.[9]

Therefore, the research aims to identify the main imaging findings in the occurrence of liver trauma through USG and CT exams.

METHODOLOGY

This is a literature review focusing on the collection of radiological images to identify their alterations in trauma. The health descriptors used were: ultrasound; tomography; Trauma-Focused Sonographic Assessment; trauma; liver. The search strategy was ((liver trauma) AND (ultrasonography) OR (computed tomography)).

The databases were PubMed and Scielo. The search generated 501,836 articles, and 27 articles that met the criteria described below were selected.

Initially, articles published in the period 2007-2022 were selected, characterizing the last 15 years of publication on the subject. Subsequently, two more years of studies were added to capture a larger volume of studies. Thus, the search period for this research was 2007-2024. The inclusion criteria included literature review studies that addressed the topic of liver trauma, that had images of the diagnostic methods sought (USG and CT, images being necessary, since the objective of the study is to identify radiological findings), and that were in accordance with the objective of the research and available online in full text. The exclusion criteria used were disagreement with the criteria mentioned above.

RESULTS AND DISCUSSION

After selecting 27 articles for the composition of the work, it was found that the main types of liver injuries were grades I, II and III according to the AAST classification, and among the main findings were the presence of free fluid in the cavity and hemoperitoneum due to trauma. These findings were demonstrated in figures 1 to 5, represented throughout this section.

FAST USG is a highly sensitive exam for the diagnosis of free fluid in the abdominal cavity in hemodynamically unstable patients, as well as for the identification of liver injuries. One of the great advantages of this exam is that it can be performed at the bedside (Point of Care), without the need to move the patient from the emergency room. On the other hand, when the patient is hemodynamically stable, contrast CT is the method of choice in patients with blunt abdominal trauma. CT allows determining the extent of the liver injury, documenting the presence of active hemorrhage and detecting associated injuries. It is very useful in defining the severity of liver injury and in deciding on conservative treatment.[10]

Through imaging exams, unnecessary laparotomies can be avoided, reducing their morbidity. Therefore, conservative treatment has shown other advantages over surgical treatment, such as a lower rate of complications, less need for blood transfusions, shorter hospital stay, especially in Intensive Care Units, and lower mortality rate.[10]

Abdominal ultrasound is generally used for patients who do not tolerate CT, which is the most commonly used method for diagnosing intra-abdominal solid organ injury. For small occult liver damage, enhanced CT can reveal the wound and assess bleeding. Enhanced CT combined with ultrasound is considered the most valuable method for evaluating abdominal trauma.[10]

Liver trauma occurs more frequently in men aged 20 to 40 years. Blunt mechanisms are more frequent than penetrating mechanisms. 11 This incidence of trauma in young male adults is associated with increased risk behavior due to exposure to alcohol and illicit drugs. 1 However, in patients undergoing surgical treatment, the penetrating mechanism is the most common (78.5%).[11]

A study showed that the right hepatic lobe was affected in 51.2% of cases, the left in 32.6%, and both in 16.3%. The degree of liver injury was assessed in 172 individuals, and of these, the most common injury was grade III (31.4%). Damage control surgery was required in 21.7% of patients and thoracotomy with thoracic aortic clamping in 5.3%. During the same surgical procedure, 59 individuals required other surgical procedures to treat injuries to other organs.[10]

The most commonly used surgical techniques are: hepatorrhaphy (38.5 - 80%), damage control (6.54 - 26.9%), electrocautery (28% - 8.9%), intrahepatic balloon (6.8%) and hepatectomy (0.9 - 3.8%). The indication for surgical treatment of patients was related to hemodynamic instability at admission or the need to address other associated injuries, as seen in other series.[11]

Liver trauma accounts for approximately 5% of admissions to emergency rooms, with the abdomen being the most frequently injured in trauma victims, with a wide variation in aspects related to the characteristics of each group of victims and also due to the fact that different countries and samples have particular epidemiological aspects.[2]

The literature shows a preponderance of low-grade injuries (grades I, II and III), with a proportion of 73% in a study with 154 patients with liver trauma and 84% in a study with 783 patients with trauma of the same origin.[12]

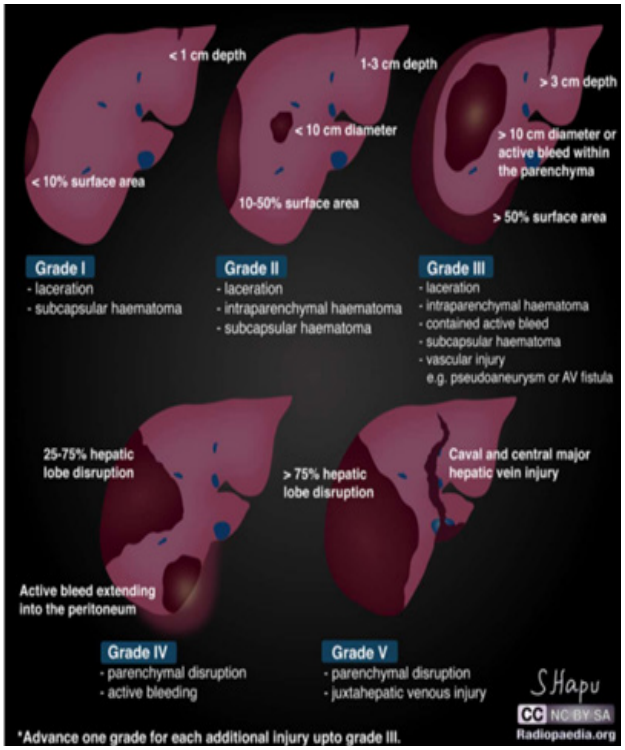
Non-operative therapy has been increasingly used with the development of conservative treatment in the medical field.[10] Asfar *et al.*[10] revealed that approximately 80% of blunt liver injuries can be treated by non-operative therapy, especially in hemodynamically stable patients. The reasons for this change are as follows: (1) in about half of the patients with blunt liver trauma, bleeding was stopped before exploratory laparotomy; (2) the liver has a great capacity for autohemostasis after injury; (3) CT has been improved and minimally invasive surgery has been developed; (4) medical treatment in an intensive care unit is provided. Figures 1 and 2 show the images from the study by these authors:

Figure 1 - Translated AAST scale, imaging criteria (CT findings) liver injury scale 2018 revision.

LIVER TRAUMA SCALE (2018 REVISION) THE AMERICAN ASSOCIATION FOR THE. SURGERY OF TRAUMA (AAST)		
AAST Grade	abbreviated injury scale	imaging criteria (CT scan findings)
I	2	subcapsular hematoma <10% of surface area
		parenchymal laceration < 1cm deep
II	2	subcapsular hematoma with surface area of 10-50%; intraparenchymal hematoma with diameter <10cm
		laceration 1-3 cm in depth and length
III	3	subcapsular hematoma >50% of surface area; ruptured subcapsular or parenchymal hematoma
		intraparenchymal laceration > 10 cm
		laceration > 3 cm deep.
		any lesion in the presence of hepatic vascular injury or active bleeding contained within the hepatic parenchyma.
IV	4	parenchymal rupture involving 25-75% of a hepatic lobe.
		active bleeding that extends beyond the liver parenchyma into the peritoneum.
V	5	parenchymal rupture >75% of the hepatic lobe, juxtahepatic venous injury to include retrohepatic vena cava and main central hepatic veins.

Source: Authors (2024)

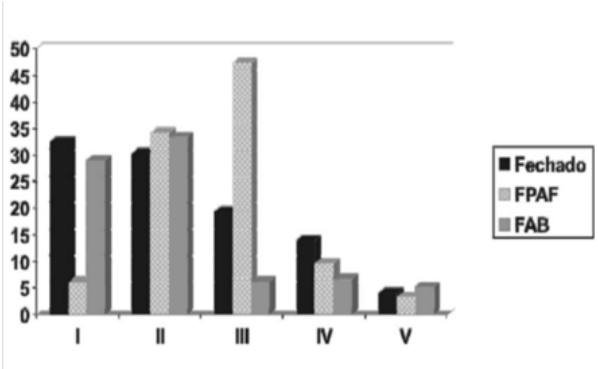
Figure 2 - Illustrative representation of the AAST liver injury scale.[25].



Source: Authors (2024)

In the study by Diório *et al.*[2], a prevalence of patients suffering from penetrating trauma was observed (437 cases - 68.4%), of which 299 (46.8%) suffered FPAF (gunshot wound) and 138 (21.6%) FAB (stab wound). Two hundred and one patients (31.6%) were victims of TF (blunt/blunt trauma), of which 103 were motor vehicle accidents, 57 were run over, 15 were motorcycle accidents and 26 were other injury mechanisms, as shown in Figure 3:

Figure 3 - Percentage of patients according to the severity of liver injury and the trauma mechanism.[2].



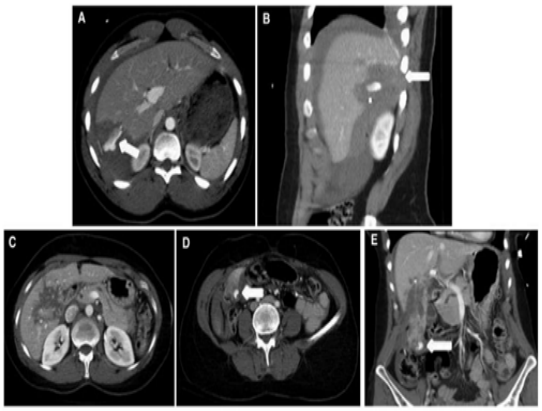
Legend: *Fechado* = blunt trauma
Source: Authors (2024)

Over the past twenty years, there has been a fundamental change in the surgical management of hepatic trauma. First, it was recognized that most liver injuries stop bleeding spontaneously, they are self-limited. In addition, CT has become a more accessible diagnostic method. As a consequence, these changes promote a current trend toward non-surgical management of patients who have suffered blunt hepatic trauma but remain hemodynamically stable. This strategy can also be used in selected patients who were initially unstable but responded to fluid or blood administration.[5]

Conservative treatment of blunt hepatic trauma has advantages over surgical treatment, such as: there is less need for blood transfusion, less occurrence of intra-abdominal sepsis and lower mortality. To achieve this, the patient must be maintained in an intensive care unit, must not show signs of

peritonitis and must be hemodynamically stable without the need for a significant volume of blood transfusion.[4] Figures 4 and 5 show the authors' findings:

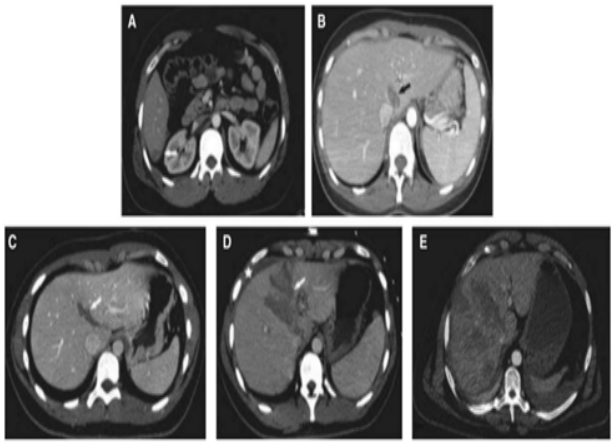
Figure 4. Liver lesions.



(A, B) Axial and sagittal views of a grade II liver lesion with active extravasation (arrows). (C-E) Two axial and 1 coronal view of grade II liver extravasations (arrows). Both lesions were successfully treated with intra-arterial embolization.[7]

Source: Authors (2024)

Figure 5 - Liver lesions.



(A) Grade I, subcapsular hematoma <1 cm and <10% surface area (white arrow). (B) Grade II, intraparenchymal hematoma <10 cm (black arrow). (C) Grade III, 5 cm parenchymal laceration (white arrow). (D) Grade IV, parenchymal rupture of segments 5 and 8 and approximately 25% of the liver parenchyma (white arrow) and small subcapsular hematoma (star). (E) Grade V, parenchymal rupture of >75% of the right hepatic lobe.[7]

Source: Authors (2024)

CONCLUSION

Liver trauma occurs more frequently in men (over 80%), in agreement with other published studies and with the paradigm that men are more susceptible to traumatic events. Blunt trauma is the most frequent, and among penetrating traumas, injuries caused by the use of weapons had the greatest proportion. The most frequent cause of death was polytrauma. The liver is the most injured organ.

Studies have shown a predominance of grades I, II and III injuries. In addition to findings such as the presence of free fluid in the cavity and hemoperitoneum. Patients undergoing surgical treatment are commonly hemodynamically unstable patients with complications from the trauma, while stable patients are preferably treated conservatively.

REFERENCES

1. Kalil M, Amaral IMA. Epidemiological evaluation of hepatic trauma victims undergoing surgery. Rev Col Bras Cir [Internet]. 2016Jan;43(1):22-7. DOI: 10.1590/0100-69912016001006.
2. Diório AC, Fraga GP, Dutra Júnior I, Joaquim JL de GC, Mantovani M. Predictive factors of morbidity and mortality in hepatic trauma. Rev Col Bras Cir [Internet]. 2008Nov;35(6):397-405. DOI: 10.1590/S0100-69912008000600010.
3. Warhadpande S, Lionberg A, Cooper KJ. Clinical Interventional Radiology - Pocketbook: a concise guide to radiology. Thieme Brazil; 2019.
4. Zago TM, Pereira BM, Calderan TRA, Hirano ES, Rizoli S, Fraga GP. Blunt liver trauma: comparison between surgical and nonoperative treatment. Rev Col Bras Cir [Internet]. 2012Jul;39(4):307-13. DOI: 0.1590/S0100-69912012000400011
5. Smaniotto B, Bahten LCV, Nogueira Filho DC, Tano AL, Thomaz Junior L, Fayad O. Liver trauma: analysis of treatment with intrahepatic balloon in a university hospital in Curitiba. Rev Col Bras Cir [Internet]. 2009Jul;36(3):217-22. DOI: 10.1590/S0100-69912009000300007.
6. Flato UAP, Guimarães HP, Lopes RD, Valiatti JL, Flato EMS, Lorenzo RG. Use of FAST-Extended (EFAST-Extended Focused Assessment with Sonography for Trauma) in intensive care. Rev bras ter intensive [Internet]. 2010Jul;22(3):291-9. DOI: 10.1590/S0103-507X2010000300012.
7. Kokabi N, Shuaib W, Xing M, Harmouche E, Wilson K, Johnson JO, Khosa F. Intra-abdominal solid organ injuries: an enhanced management algorithm. Can Assoc Radiol J. 2014 Nov;65(4):301-9. DOI: 10.1016/j.carj.2013.12.003. Epub 2014 Jun 12. PMID: 24931047.
8. Okumura S, Usui A, Kawasumi Y, Odagiri H, Funayama M, Kaneta T. Diagnostic Accuracy of Liver Damage Based on Postmortem Computed Tomography Findings in High-Energy Trauma. Tohoku J Exp Med. 2022 Jul 22;257(4):327-332. DOI: 10.1620/tjem.2022.J046. Epub 2022 Jun 10. PMID: 35691914.
9. Aliseda MM, Sabec-Pereira DK, Leite J, Pereira KF. Profile of deaths associated with abdominal trauma submitted to the legal medical institute of the municipality of toledo - PR. Arq. Ciênc. Saúde Unipar [Internet]. 2024 Sep 6 [cited 2024 Nov 9];28(2):1-17. Available from: https://revistas.unipar.br/index.php/saude/article/view/11028.
10. Yu WY, Li QJ, Gong JP. Treatment strategy for hepatic trauma. Chin J Traumatol. 2016 Jun 1;19(3):168-71. DOI: 10.1016/j.cjtee.2015.09.011. PMID: 27321299; PMCID: PMC4908222.
11. Trintinalha Pdo, Cirino Eri, Marcante Rfr, Jabur Gr, Buso Pl. Surgical treatment in hepatic trauma: factors associated with hospitalization time. Rev Col Bras Cir [Internet]. 2021;48:e20202784. Available from: DOI: 10.1590/0100-6991e-20202874.
12. Zago TM, Pereira BM, Nascimento B, Alves MSC, Calderan TRA, Fraga GP. Hepatic trauma: a 21-year experience. Rev Col Bras Cir [Internet]. 2013Jul;40(4):318-22. DOI: 10.1590/S0100-69912013000400011.
13. Hassan R, Abd Aziz A. Computed tomography (ct) imaging of injuries from blunt abdominal trauma: a pictorial essay. Malays J Med Sci. 2010 Apr;17(2):29-39. PMID: 22135535; PMCID: PMC3216157.
14. Cartu D, Margaritescu D, Sandulescu S, Bratiloveanu T, Ramboiu S, Bica M, Georgescu E, Dudu C, Patrascu S, Bordu S, Goganau A, Surlin V, Marinescu D. Nonoperative treatment of abdominal trauma involving liver and spleen. Surgery (Bucur). 2021 Dec;116(6):689-699. DOI: 10.21614/chirurgia.116.6.689. PMID: 34967714.
15. Cañete Gómez, Jesús *et al*.Biloma secondary to liver trauma. Cirugía Española, v. 85, no. 6, p. 379-380, jun. 2009. Available at: DOI: 10.1016/j.ciresp.2008.04.005.
16. Casado Maestre, María Dolores *et al*. Complications in the conservative management of blunt liver trauma: biliary fistula, hemobilia and biloma. Cirugía Española, v. 91, no. 8, p. 537-539, Oct. 2013. DOI: 10.1016/j.ciresp.2013.02.023.
17. Queiroz HMC, Costa F de A, Campos Junior MM de, Aquino RL de, Linhares Filho FA de C, Otoch M. Arterial embolization in the treatment of hemobilia after liver trauma: case report. Radiol Bras [Internet]. 2012Jan;45(1):63-4. DOI: 10.1590/S0100-39842012000100015.
18. Fonseca-Neto OCL da, Ehrhardt R, Miranda AL de. Study of morbidity and mortality in patients with liver trauma. ABCD, arq bras cir dig [Internet]. 2013Apr;26(2):129-32. Available from: DOI: 10.1590/S0102-67202013000200012
19. Betancourth, J. *et al*. 59th Congress of the Spanish Pediatric Surgery Society held on. 2021.
20. Pérez-Alonso, A.Operative management of a patient with moderate blunt liver trauma. Magazine of Gastroenterology

of Mexico, v. 85, no. 4, p. 486-490, Oct. 2020. DOI: 10.1016/j.rgmx.2019.10.005.
21. Mzoughi Z, Djebbi A, Bayar R, Frahat LB, Gharbi L, Khalfallah MT. Open liver trauma causing hepatic caval fistula successfully treated by embolization. Trauma Case Rep. 2017 Jan 18;7:3-6. DOI: 10.1016/j.tcr.2017.01.002. PMID: 30014024; PMCID: PMC6024110.
22. Stalhschmidt CMM, Formighieri B, Marcon DM, Takejima AL, Soares LGS. Liver trauma: five-year epidemiology in an emergency department. Rev Col Bras Cir [Internet]. 2008Jul;35(4):225–8. DOI: 10.1590/S0100-69912008000400004.
23. Farzaneh N, Stein EB, Soroushmehr R, Gryak J, Najarian K. A deep learning framework for automated detection and quantitative assessment of liver trauma. BMC Med Imaging. 2022 Mar 8;22(1):39. DOI: 10.1186/s12880-022-00759-9. PMID: 35260105; PMCID: PMC8905785.
24. Takahashi MS, Yamanari MGI, Suzuki L, Pedrosa ÉFNC, Lopes RI, Chammas MC. Use of contrast-enhanced ultrasound in pediatrics. Radiol Bras. 2021 Sep-Oct;54(5):321-328. DOI: 10.1590/0100-3984.2020.0167. PMID: 34602668; PMCID: PMC8475167.
25. Hapugoda S, Liver trauma grading (diagrams). Case study, Radiopaedia.org (Accessed on 28 Oct 2024) DOI: 10.53347/rID-51390.
26. Abib SDCV, Perfect JAJ. Trauma Guide. Manole Publishing; 2012.
27. Velasco IT, Alencar JCGD, Petrini CA. Ultrasound procedures in the emergency room. Editora Manole; 2020.
28. Orozco F, Quiroga AN, Bernardo F, Crego N, Insausti A, Stork GM. Minimally invasive management of blunt hepatic trauma complications. Rev Argent Cir [Internet]. 2022 May 31 [cited 2024 Nov. 13];114(2):155-61. Available from: https://revista.aac.org.ar/index.php/RevArgentCirug/article/view/548.
29. Fretes Dario, Insfran Sergio, Aguilera Panambi. Surgical acute hemorrhagic abdomen due to subcapsular hepatic hematoma of the right lobe. Clinical case report. Cir. parag. [Internet]. 2021 Dec [cited 2024 Nov 09] ; 45(3):30-31.Available from: http://scielo.iics.una.py/scielo.php?script=sci_arttext&pid=S2307-042020 21000300030&lng=en. Doi: 10.18004/sopaci.2021.diciembre.30.