Journal of Experimental and Clinical Medicine
https://dergipark.org.tr/omujecm

**Research Article**

J Exp Clin Med
2022; 39(3): 670-674
**doi:** 10.52142/omujecm.39.3.15

# Liver trauma in children with Syrian Civil War: How should treatment management?

**Mehmet Emin ÇELİKKAYA*, Ahmet ATICI, İnan KORKMAZ, Çiğdem EL, Bülent AKÇORA**

Department of Pediatric Surgery, Faculty of Medicine, Mustafa Kemal University, Hatay, Türkiye

**Received:** 17.12.2021 • **Accepted/Published Online:** 06.06.2022 • **Final Version:** 30.08.2022

**Abstract**

Patients with liver injuries should be considered multidisciplinary cases, and the decision to operate should be made according to each patient's clinical and hemodynamic stability. In this study, we aimed to describe treatment management approaches and appropriate operation times for children with liver injuries resulting from the Syrian Civil War. A total 32 patients who were admitted to a pediatric surgery clinic between 2010 and 2020 with liver injuries resulting from Syrian Civil War were examined retrospectively. Patients were evaluated according to age, gender, type of injury, accompanying trauma, treatment modality, and mortality. A total of 21 patients were injured with shrapnel, while 11 patients suffered from blast effect injury. The mean pediatric trauma score of the patients was 5.2, while the mean pediatric trauma score of the six patients who died was 3.11. Liver suturing was performed in four patients due to bleeding. A segmentectomy was performed in one patient with active bleeding in segment 7. This bleeding was stopped by ligating the branches of the hepatic artery. Two patients who were operated on in Syria and to whom packing was applied due to uncontrolled bleeding were referred to Turkey. One patient with inferior vena cava injury died due to excessive blood loss and instability at the time of admission, and six patients died due to accompanying head trauma and/or multiple body trauma. The main purpose in emergency operations is to stop bleeding. Rarely, however, suturing or even segment resection in the bleeding area may be required.

**Keywords:** blast effect, liver, laceration, shrapnel, Syrian Civil War

## 1. Introduction

The liver is the most commonly injured intra-abdominal solid organ (1). Whether the trauma is penetrating or blunt, the most common cause of morbidity and mortality is bleeding (2). Most liver damage occurs in the posterior segment of the right lobe (3). The management of liver injuries is a clinical challenge for pediatric surgeons, especially in children with multiple traumas. Although penetrating traumas are uncommon, it remains a challenge to determine optimal surgical timing (4). Fortunately, isolated injuries of the extra hepatic bile ducts are rare. Moreover, long-term sequelae are infrequently seen due to the highly regenerative capacity of the liver (5).

While aggressive operative approaches were more popular at the beginning of the twentieth century, non-operative treatment was replaced by the surgical approach with the development of imaging modalities after World War II (6, 7). Thus, patients with liver injuries should be considered multidisciplinary, and the decision to operate should be made according to each patient's clinical and hemodynamic stability. Computed tomography (CT) the preferred imaging method for evaluating post-traumatic abdominal and pelvic injuries in children with stable hemodynamics.

Types of liver damage include laceration, hematoma (subcapsular or intraparenchymal), active hemorrhage, hepatic vascular injury, A-V fistula, and bile duct injury. Lacerations are the most common type of liver parenchymal injury and they are observed as hypodense areas that extend linearly or show branching on contrast-enhanced CT (8).

Since most bleeding that develops as a result of liver injury in children stop spontaneously without the need for operation (9), it is necessary to evaluate the patient's laboratory findings and CT findings together, and then the decision for the operation should be taken. While rapid physical examinations and further investigations are performed in stable patients, unstable patients, despite resuscitative efforts, should be taken for emergency laparotomy (10).

In this study, we aimed to describe treatment management and appropriate operation timing in children with liver injuries resulting from the Syrian Civil War.

## 2. Materials and Methods

### 2.1. Study design and patients

All patients with liver injuries due to the Syrian Civil War who were admitted to the Department of Pediatric Surgery between 2010 and 2020 were included the study. Patients who had already been operated on in Syria and who did not require

*Correspondence: eminctf@hotmail.com

further re-operation were excluded from the study. The permission of the ethics committee was granted with decision number 10 (dated May 02, 2019).

Patients were evaluated according to age, gender, type of injury, pediatric trauma score (11), accompanying trauma, treatment modality, and mortality. All patients who had firearms injuries and were brought to the emergency department received a rapid physical examination and appropriate fluid resuscitation.

The presence and degree of laceration were evaluated with CT imaging. The most important determinant of the decision to whether operative management or non-operative management was the assessment of hemodynamic stabilization. The most important determinant of the decision to operate was the lack of hemodynamic stabilization (12). The oral intake of the patients who were decided to be followed by non-operative treatment was discontinued, and appropriate fluid treatment and antibiotherapy were initiated. These patients were also immobilized.

### 2.2. Statistical method

The Statistical Package for the Social Sciences (SPSS, Chicago, IL, USA) version 18.0 for Windows was used for statistical analysis. Categorical variables were arranged by frequency (n, %), and scaled measurements were arranged with mean ± standard deviation. Since our data showed a normal distribution, the mean was used as a measure of central tendency, and the standard deviation was used to show the spread.

## 3. Results

The mean age of the patients was 8.1 years. A total of 25 (78%) patients were male, and 7 (22%) were female. While 21 patients had been injured with shrapnel, 11 patients had blast effect injury. The mean pediatric trauma score of the all patients was 5.2±2.94, while the mean pediatric trauma score of six patients who died was 3.11±1.86.

In terms of injury grading according to the Organ Injury Scale of the American Association for the Surgery of Trauma (13), four patients had grade 1 injuries, seven patients had grade 2, nine patients had grade 3, seven patients had grade 4, and five patients had grade 5 injuries. Further, eleven patients had contusions in the lung, eight patients had intestinal perforations, three patients had head trauma, two patients had right kidney lacerations, two patients had colon perforations, two patients had fractures in the ribs and extremities, two patients had splenic injuries, one patient had a pancreatic injury, one patient had diaphragm perforation (Fig. 1), and one patient had an inferior vena cava injury (Table 1 and Table 2).

All operated patients had grade 4 or 5 liver laceration. It was noted that liver segments 7 and 8 were damaged in all operated patients. Liver suturing was performed in four patients due to bleeding. A segmentectomy was performed in a patient with active bleeding in segment 7. Bleeding was stopped by binding the branches of the hepatic artery. Four patients who had been operated on in Syria and had packing applied due to unstoppable bleeding were referred to Turkey (Fig. 2).

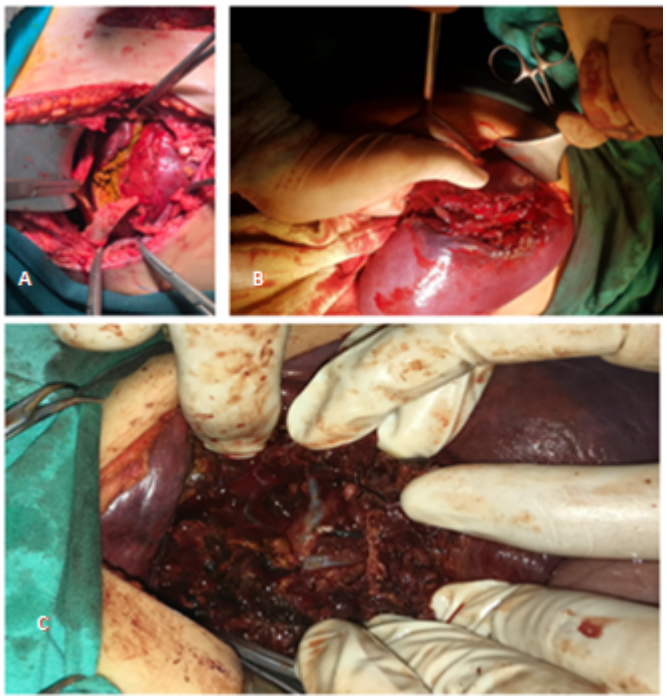


**Fig. 1. a:** Liver injury with diaphragm rupture and rib fracture places held by clamp are diaphragm edges **b:** Liver parenchymal laceration **c:** Intraoperative view after resection of the lacerated segment which active bleeding in the liver

**Table 1.** Clinical features of patients

| | n | % |
|---|---|---|
| Number of Patients | 32 | |
| Male | 25 | 78 |
| Female | 7 | 22 |
| Mean age all of the patients | 8.1 | |
| Male | 7.42 | |
| Female | 9.25 | |
| Type of injury | | |
| Penetrating | 21 | 65 |
| Blast | 11 | 35 |
| Grade of injury | | |
| Grade 1 | 4 | 12 |
| Grade 2 | 7 | 22 |
| Grade 3 | 9 | 28 |
| Grade 4 | 7 | 22 |
| Grade 5 | 5 | 15 |
| Accompanying injuries | | |
| Pulmonary laceration | 11 | 34 |
| Intestinal perforation | 8 | 25 |
| Head trauma | 3 | 9 |
| Right kidney laceration | 2 | 6 |
| Colon perforation | 2 | 6 |
| Fracture of the ribs and/or extremities | 2 | 6 |
| Spleen injury | 2 | 6 |
| Pancreatic injury | 1 | 3 |
| Diaphragm perforation | 1 | 3 |
| Vena cava inferior injury | 1 | 3 |

**Table 2.** Features of patients undergoing surgery

| | Age/Sex | Degree of liver injury | Treatment | PTS* | Type of injury | Hemoglobin** (g/dL) | Hematocrit** (%) | Survey |
|---|---|---|---|---|---|---|---|---|
| **Patient 1** | 4 years/male | 5 | Primer suturation | 5 | Shrapnel | 7.4 | 21.5 | Healing |
| **Patient 2** | 13 years/male | 4 | Primer suturation | 2 | Shrapnel | 13.6 | 39.7 | Healing |
| **Patient 3** | 12 years/male | 4 | Primer suturation | 1 | Blast | 10.1 | 30.2 | Healing |
| **Patient 4** | 11 years/male | 4 | Primer suturation | 4 | Blast+shrapnel | 8.8 | 25.1 | Healing |
| **Patient 5** | 7 years/male | 5 | Segmentectomy | 6 | Blast | 6 | 18.9 | Healing |
| **Patient 6** | 15 years/male | 4 | Packing removed | 11 | Shrapnel | 12 | 35 | Healing |
| **Patient 7** | 12 year/male | 4 | Relaparotomy | 10 | Blast+shrapnel | 10.2 | 32.7 | Healing |
| **Patient 8** | 13 years/female | 4 | Relaparotomy | 4 | Blast | 6 | 18.9 | Healing |
| **Patient 9** | 15 years/female | 4 | Laparotomy | 7 | Shrapnel | 8.1 | 24.6 | Healing |
| **Patient 10** | 8 years | 5 | Inferior vena cava repair+primer suturation | -1 | Shrapnel | 4 | 12.1 | Exitus |

*Pediatric Trauma Score

** Values of the patients on arrival who were taken into surgery

When the compressions were removed in relaparotomy, it was observed that active bleeding had stopped. Only one of the operated patients died. The patient with the inferior vena cava injury died due to excessive blood loss and instability at the time of admission. Six patients who followed by non-operative management died due to accompanying head trauma and/or multiple body trauma.

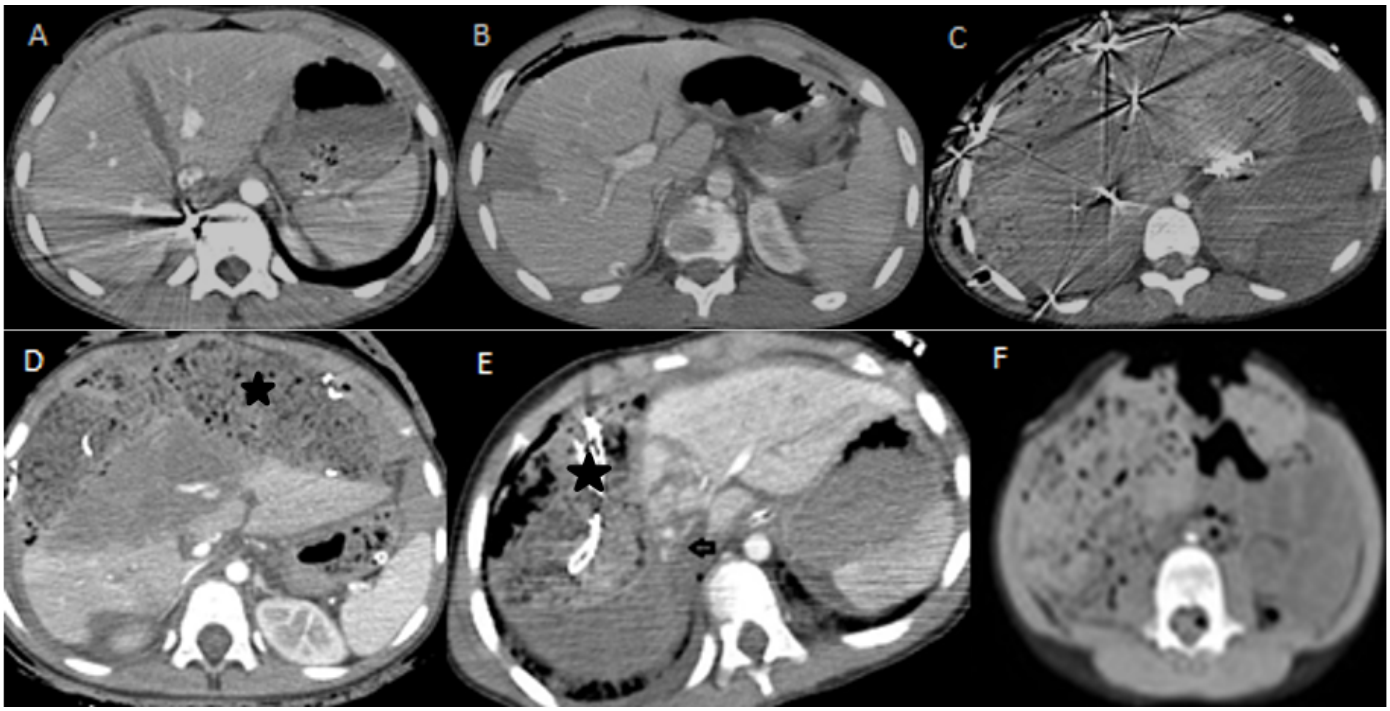


**Fig. 2.** Lesion patterns on CT images. **A.** A laceration with parenchymal extension of more than 3 cm, and shrapnel particle, **B.** Intraparenchymal hematoma with laceration, **C.** Multıple shrapnel particles in liver parenchyma, **D.** Oversized devascularized area and contrast extravasation, buffer placed in Syria for bleeding control (blackstar), **E.** Large devascularized area in the right lobe of the liver, hepatic vein injury (blackarrow) and buffer placed in Syria for bleeding control (black star), **F.** Packing with open abdomen

It was observed that bile drainage from the abdomen of the patient who underwent liver segment resection began on the fourth postoperative day. Bile leakage stopped spontaneously on the postoperatively 26th day. None of the patients developed late complications such as hemobilia, biliary peritonitis and ileus.

All ex-patients had comorbid organ damage. All these patients had thoracic injuries (6/6, %100), 3 patients (3/6, %50) had cranial injuries and 3 patients (3/6, %50) had abdominal trauma. One patient had major vascular injury. Interestingly, all of the ex-children had injured with blast effect (6/6, %100). The majority of patients (n=16, 80%) were brought to the hospital at night. Twelve patients (60%) did not have any family members at the time of admission. Two patients (40%) were brought from battlefield with injured other family members at the same time. Therefore, clear information and medical history about the injured children could not be obtained.

## 4. Discussion

According to the UN High Commissioner for Human Rights, more than 1,900,000 civilians were killed in the war in Syria between 2011 and 2014, and more civilian were injured due to

weapons and bombs. 85.1% of the dead civilians were males and 9.3% were females (14). Similar to the literature, in our study; 78% of the patients were male and 22% were female. The majority of patients are male, and extremity injuries in adolescent age group suggests that children are actively used in war.

Trauma surgery in war condition has many different features according to civil trauma surgery. Weapons have more energy, so more destructive (15). In a study, it was observed that 67% of ex children in battlefield had injured by blast effect (16).

Despite its not seen an external injury, blast trauma may be more mortal than penetrant trauma due to affects the whole body. Explosions, especially in closed areas, may be more lethal than in open areas. The determination of trauma related blast injuries is more difficult than the detection of penetrating trauma. Radiological examination is valuable in these patients (17). Invasive procedures should be avoided to save time, especially in injured children. CT scans should be the most preferred imaging method for patients with multisystemic injuries (18). CT shows intraabdominal extraperitoneal and intraperitoneal hemorrhages as well as solid organ injuries. In addition, intestinal perforation, bone damages, subcutaneous soft tissue damage, pulmonary injuries and central nervous system injuries within the image can be detected. In our study, 13 of our patients had shrapnel injury while 7 patients had blast effect injury. 6 patients (6/7, 86%) who had blast injuries were observed to be ex because of the accompanying multiple traumas.

Liver damage mostly occurs in the posterior part of the right lobe. Because the posterior right lobe is fixed by the coronary ligaments so when the liver is exposed to trauma, the movement of this segment is restricted while the rest of the liver is free to move (10). In our study, similar to literature, liver segments 7 and 8 were damaged in all operated patients.

Accompanying injuries are one of the most important obstacles to the success of the treatment. It has been reported that cranial injury, thoracic injuries and major vascular injuries increase morbidity and mortality significantly. In addition, retroperitoneal organ injuries, such as duodenum, cause high mortality (6). According to Iraq and Afghanistan war, it was observed that there was relationship between thoracic trauma, head trauma, severity of trauma, large vessels trauma and mortality (19, 20). In our study, among dead patients, all of these had lung contusion, 3 patients had cranial injury, 1 patient had major vascular injury, 1 patient had non-functioning spleen and 1 patient had pancreatic laceration. And also, severe trauma (pediatric trauma score<6) was seen in all these patients. These results were similar to findings of Iraq and Afghanistan war.

Transfer time of the injured from the battlefield to the hospital is closely related to mortality. The first sixty minutes are known as “golden hours” (19). Almost all of our patients were not brought in this first hour. These patients were brought to the emergency service at night.

Approximately 80-90% of hepatic injuries can be managed safely without operation (21, 22). Hemodynamic stability is the main factor in determining whether or not conservative treatment can be applied (23). In a study reported that in children, organ injury scales are not determinative factor for operative management. Because regardless of the severity of trauma bleeding generally stops spontaneously so most frequently liver injuries can be successfully managed nonoperatively (10). Conservative treatment is possible in patients with blood pressure greater than 80 mmHg, heart rate less than 120/min, blood transfusion requirement less than half the blood volume. Bleeding stops spontaneously in more than half of liver traumas. The liver has an incredible post-traumatic self-healing capacity. The most important among the non-surgical management criteria are; hemodynamic stability is the absence of other abdominal organ injuries. Grade I and grade II liver injuries should be observed with hematocrit follow-up and bed rest. More severe injuries should be followed up in the intensive care unit if hemodynamics are stable. In some studies, it has been reported that 92% of patients with grade IV and grade V liver injury will develop complications that will require intervention. Interventional radiology may be required to embolization with angiogram for stop bleeding or to percutaneously drainage for biloma or abscess (6, 24). Many surgical approaches such as simple hemostasis, liver suturing, segment resection, lobe resection and abdominal packing have been described in liver injuries. It has also been reported that hepatic resection whether anatomic or nonanatomic has a high mortality rate when performed under emergency conditions (25, 26). In a study, the operative mortality rate of trauma patients who operated for grade 4 and grade 5 liver injury was reported as 66% (21). In the majority of recently studies in the literature, the mortality rate in grade 4 and grade 5 liver injury has been reported to 15% (6). In our study, nearly 70% of the patients were followed conservatively. Since all our patients were brought under war conditions and at night, open surgery was performed for all operated patients. Segmentectomy was performed in a patient who already had avulsion injury. In spite of being an old method, packing can be applied in unstoppable hemorrhages in such desperate situations as war environment. Compressions filled in the bleeding area should be removed with a second laparotomy after 48-72 hours. In our study, packing had performed on two patients and it was observed that hemorrhages stopped spontaneously in the laparotomy.

As a result; the widespread use of high-quality radiological imaging systems has been an important support in non-operative management. Noninvasive imaging methods provide an important and noninvasive assessment of the severity of the injury, as well as valuable information in the patient's follow-up. Patients should be hemodynamically stable and have no

signs of peritonitis in order to perform nonoperative management (27).

Careful physical examination and vital signs should be followed in patients who are decided to undergo nonoperative management (26). Patients who have firearm injury of the liver to be treated nonoperatively should be selected very well. The main purpose in emergency operations is stopping the bleeding. Rarely though, suturing or even segment resection in the bleeding area may require. Reducing the transfer time from the battlefield to the hospital and knowing the applied first medical interventions especially in the medical center close to the battlefield will reduce the mortality, thus it can be avoided from unnecessary operation and cost.

**Conflict of interest**

The authors declare that they have no conflict of interest to the publication of this article.

**Funding**

The authors declare that there is no funding.

**Acknowledgments**

None to declare.

**Authors' contributions**

Concept: M.E.Ç, A.A, Design: M.E.Ç, Ç.E, Data Collection or Processing: M.E.Ç, İ.K., B.A, Analysis or Interpretation: M.E.Ç, B.A., A.A, Literature Search: M.E.Ç, İ.K., Writing: M.E.Ç, Ç.E.

**References**

1. Cywes S, Bass DH, Rode H, Millar AJ. Blunt liver trauma in children. Injury. 1991 Jul;22(4):310-4.
2. van As AB, Millar AJ. Management of paediatric liver trauma. Pediatr Surg Int. 2017 Apr;33(4):445-453.
3. Stalker HP, Kaufman RA, Towbin R. Patterns of liver injury in childhood: CT analysis. AJR Am J Roentgenol. 1986 Dec;147(6):1199-205.
4. Dicker RA, Sartorelli KH, McBrids WJ, Vane DW. Penetrating hepatic trauma in children: operating room or not? J Pediatr Surg. 1996 Aug;31(8):1189-91; discussion 1191-3.
5. Kim RD, Kim JS, Watanabe G, Mohuczy D, Behrns KE. Liver regeneration and the atrophy-hypertrophy complex. Semin Intervent Radiol. 2008 Jun;25(2):92-103.
6. Kaptanoglu L, Kurt N, Sikar HE. Current approach to liver traumas. Int J Surg. 2017 Mar;39:255-259
7. Poletti PA, Mirvis SE, Shanmuganathan K, Killeen KL, Coldwell D. CT criteria for management of blunt liver trauma: correlation with angiographic and surgical findings. Radiology. 2000 Aug;216(2):418-27
8. David Richardson J, Franklin GA, Lukan JK, Carrillo EH, Spain DA, Miller FB, et al. Evolution in the management of hepatic trauma: a 25-year perspective. Ann Surg. 2000 Sep;232(3):324-30
9. Ruess L, Sivit CJ, Eichelberger MR, Taylor GA, Bond SJ. Blunt hepatic and splenic trauma in children: correlation of a CT injury severity scale with clinical outcome. Pediatr Radiol. 1995;25(5):321-5.
10. Sivit CJ. Imaging children with abdominal trauma. AJR Am J Roentgenol. 2009 May;192(5):1179-89.
11. Tepas JJ 3rd, Mollitt DL, Talbert JL, Bryant M. The pediatric trauma score as a predictor of injury severity in the injured child. J Pediatr Surg. 1987 Jan;22(1):14-8.
12. Peitzman AB, Richardson JD. Surgical treatment of injuries to the solid abdominal organs: a 50-year perspective from the Journal of Trauma. J Trauma. 2010 Nov;69(5):1011-21.
13. Tinkoff G, Esposito TJ, Reed J, Kilgo P, Fildes J, Pasquale M, et al. American Association for the Surgery of Trauma Organ Injury Scale I: spleen, liver, and kidney, validation based on the National Trauma Data Bank. J Am Coll Surg. 2008 Nov;207(5):646-55.
14. Price M, Gohdes A, Ball P. Updated statistical analysis of documentation of killings in the Syrian Arab Republic. Human Rights Data Analysis Group, Geneva. 2014. Aug;14-15
15. Holcomb JB, McMullin NR, Pearse L, Caruso J, Wade CE, Oetjen-Gerdes L, et al. Causes of death in U.S. Special Operations Forces in the global war on terrorism: 2001-2004. Ann Surg. 2007 Jun;245(6):986-91.
16. Aharonson-Daniel L, Waisman Y, Dannon YL, Peleg K; Members of the Israel Trauma Group. Epidemiology of terror-related versus non-terror-related traumatic injury in children. Pediatrics. 2003 Oct;112(4):e280.
17. Giannou C, Baldan M, Molde A. War Surgery. 2nd edt. Geneva, Switzerland: International Committee of the Red Cross; 2013.
18. Naaman O, Yulevich A, Sweed Y. Syria civil war pediatric casualties treated at a single medical center. J Pediatr Surg. 2020 Mar;55(3):523-529
19. Newgard CD, Meier EN, Bulger EM, Buick J, Sheehan K, Lin S, et al.; ROC Investigators. Revisiting the "Golden Hour": An Evaluation of Out-of-Hospital Time in Shock and Traumatic Brain Injury. Ann Emerg Med. 2015 Jul;66(1):30-41, 41.e1-3.
20. Creamer KM, Edwards MJ, Shields CH, Thompson MW, Yu CE, Adelman W. Pediatric wartime admissions to US military combat support hospitals in Afghanistan and Iraq: learning from the first 2,000 admissions. J Trauma. 2009 Oct;67(4):762-8.
21. Duane TM, Como JJ, Bochicchio GV, Scalea TM. Reevaluating the management and outcomes of severe blunt liver injury. J Trauma. 2004 Sep;57(3):494-500.
22. Carrillo EH, Platz A, Miller FB, Richardson JD, Polk HC Jr. Non-operative management of blunt hepatic trauma. Br J Surg. 1998 Apr;85(4):461-8.
23. Meredith JW, Young JS, Bowling J, Roboussin D. Nonoperative management of blunt hepatic trauma: the exception or the rule? J Trauma. 1994 Apr;36(4):529-34; discussion 534-5.
24. Ochsner MG. Factors of failure for nonoperative management of blunt liver and splenic injuries. World J Surg. 2001 Nov;25(11):1393-6.
25. Coburn MC, Pfeifer J, DeLuca FG. Nonoperative management of splenic and hepatic trauma in the multiply injured pediatric and adolescent patient. Arch Surg. 1995 Mar;130(3):332-8.
26. Bond SJ, Eichelberger MR, Gotschall CS, Sivit CJ, Randolph JG. Nonoperative management of blunt hepatic and splenic injury in children. Ann Surg. 1996 Mar;223(3):286-9.
27. Pal KM, Khan A. Nonoperative management of penetrating liver trauma. Injury. 2000 Apr;31(3):199-201.