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CLINICAL RESEARCH

Objective Assessment of the Severity of Patients Suffering from Fall from Height with Combined Injuries of the Abdominal Parenchymal Organs

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Abstract

In recent years, fall from a height (FFH) has been a relatively frequent cause of injury and death in the urban environment. ***The purpose of this study*** was to optimize the risk stratification of FFH victims with combined injuries of the abdominal organs by using Injury Severity Score (ISS) scale. The study included 111 patients (aged between 15 and 80 years) injured by FFH. All the falls were accidental and occurred mainly among males (82%). The height of the fall ranged from 2 to 5 meters. Combined injuries were found in 98 patients and isolated injuries in 13 patients. The combination of the 6 injured body regions was identified in 5 patients, 5 regions in 17, 4 in 35, 3 in 23, and 2 in 18. The abdomen trauma was most commonly associated with the following injured body regions: head and neck-chest-extremities and pelvis (13.3%), head and neck-chest-extremities (12.2%), and head and neck-chest-pelvis (9.2%). Among the combined injuries of the abdomen, ruptures of parenchymal organs (liver, spleen and kidneys) were predominant. To assess the severity of the injury, the ISS scale was applied. The injuries of abdominal parenchymal organs were evaluated according to the AAST (American Association for the Surgery of Trauma) classification. Comparative analysis of the assessment of the severity of a patient's condition according to the traditional scale and the ISS scale showed that the ISS scale promotes the active and timely detection of the extremely severe and terminal condition in patients with injuries due to FFH with combined trauma of the abdominal organs. Objective assessment of the severity of trauma and the dominant injury region allows determining the optimal treatment algorithm and predicting the outcome of the injury.

Keywords: *fall from a height; combined injuries; abdominal trauma*, *Injury Severity Score; severity of a patient's condition.*

Introduction

In recent years, fall from a height (FFH) has been a relatively frequent cause of injury and death in the urban environment [1,2]. Injuries due to FFH are characterized by severe associated injuries of different organs and systems, including severe abdominal trauma. The high frequency and prevalence of multiple injuries of abdominal organs determine the importance of this problem in emergency medicine [3-7]. The combination of abdominal trauma with injuries of other anatomical regions complicates the severity of injured patients and diagnosis of injuries that worsen the prognosis [4,5,8]. At equal severity of the injury and pathophysiological changes, the severity of a patient's condition depends on the functional reserves and adaptive capacities of the organism. In this regard, an objective assessment of the severity of a patient's condition presents certain difficulties [3,9-11].

A traditional classification of the severity of a patient's condition lacks clear criteria and unity of interpretation [12]. This classification is widely used in everyday practice and describes a patient's condition as satisfactory, moderate, severe, extremely severe or terminal. To assess the severity of a patient's condition, various scales and indices are suggested, which are based on a score of the clinical symptoms or laboratory indicators [11-13]. An objective assessment of a patient's condition at admission to hospital allows maximum avoidance of diagnostic and tactical mistakes, and improves the accuracy of decisions [9,14,15]. At the same time, a number of authors have noted that the integrated systems are not reliable and have suggested possible ways to improve them.

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Thus, the MFS-AC scale (MFS - military field surgery, A - admission, C - condition) developed by EK Gumanenko et al [16] is focused on the clinical signs. Calculations are based on a score of 12 of the most important and easily identifiable clinical signs. Among these are the color of the skin and condition of the respiratory system, central nervous system, circulatory system, and gastrointestinal tract, as well as the magnitude of blood loss. In many countries, an assessment of the severity of a patient's condition at admission is performed by using the ISS (Injury Severity Score). This scale best meets the requirements of emergency surgery and scientific analysis. The ISS scale is easy to use and requires no additional equipment. Among anatomical severity scores, the ISS scale created by Baker et al. in 1974 [10], has been considered for over 40 years to be the gold standard to classify trauma injuries, both blunt and penetrating [3,4,10,11,16]. The ISS is based upon the Abbreviated Injury Scale (AIS). AIS is one of the most common anatomic scales for traumatic injuries. The first version of the scale was published in 1969 [17] with major updates in 1976, 1980, 1985, 1990, 1998, 2005, and 2008. The AIS is a consensus-derived, anatomically based system of grading injuries on an ordinal scale ranging from 1 (minor injury) to 6 (lethal injury) [18]. The ISS is obtained by summing the square value of the 3 highest AIS scores, identifying the severity of patients and enabling stratification of them. Six body regions are defined, as follows: head and neck, face, chest, abdomen, extremities (including pelvis), and external structures. Only one injury per body region is allowed. The ISS ranges from 1 to 75, and an ISS of 75 is assigned to anyone with AIS of 6.

Despite the numerous advantages of the ISS, it has some limitations [19,20]. The most obvious limitation is its inability to account for multiple injuries to the same body region; therefore, the ISS scale is rarely used to assess the severity of injury in victims of FFH with combined injuries of the abdominal organs.

The purpose of this study is to optimize the risk stratification of FFH victims with combined injuries of the abdominal organs by using ISS.

Material and Methods

The study included 111 patients (aged between 15 and 80 years, mean age 34.46±5.92 yrs) injured by FFH. All the falls were accidental and occurred mainly among males (82%). The height of the fall ranged from 2 to 5 meters. All patients were treated in the Republican Scientific Center of Emergency Medicine (RSCEM) between 2010 and 2013. The study was approved by the RSCEM Ethics Committee. Written informed consent was obtained from each patient.

Combined injuries were found in 98 patients and isolated injuries in 13 patients. The combination of the 6 injured body regions was identified in 5 patients, 5 regions in 17, 4 in 35, 3 in 23, and 2 in 18. The abdomen trauma was most commonly associated with the following injured body regions: head and neck-chest-extremities and pelvis (13.3%), head and neck-chest-extremities (12.2%), head and neck-chest-pelvis (9.2%), head and neck-chest (9.2%), head and neck-chest – extremities and pelvis-spine (5.1%), chest (5.1%), head and neck-chest–spine (4.1%), pelvis (4.1%), head and neck-extremities and pelvis (3.1%), head and neck- extremities (3.1%), chest-pelvis –spine (3.1%), and chest–spine (3.1%). The remaining 25 percent included other rare combinations.

Among the combined injuries of the abdomen, ruptures of parenchymal organs were predominant (Table 1). Spleen injuries were observed in 30 (27%) of cases, liver injuries in 28 (25.2%) cases, and combined injuries of spleen and liver were observed in 6 (5.4%) cases. Isolated injuries of spleen and liver occurred in 17 (15.3%) and 14 (12.6%) cases, respectively. In other cases, the traumatic injuries of abdominal parenchymal organs (liver, spleen and kidneys) had a multiple character. Traumatic injuries of hollow organs were observed in 12(12.8%) patients. Retroperitoneal hematoma occurred in 19(17.1%) cases.

To assess the severity of the injury, the ISS scale was applied [10]. The injuries of abdominal parenchymal organs were evaluated according to the AAST (American Association for the Surgery of Trauma) classification [21]. According to this classification, the following injuries were diagnosed: Grade I splenic injury was in 1(3%) patient, Grade II in 2(7%) patients, Grade III in 11(37%) patients, and Grade IV in 16(53%) patients. Grade V splenic injury was not identified. Grade I hepatic injury was observed in 5 patients, Grade II in 8 patients, grade III in 11 patients, and grade IV in 4 patients. Grade V hepatic injury was not identified. The distribution of patients into groups depending on the degree of injury of parenchymal organs was carried out based on the data of clinical-instrumental methods of investigation and intraoperative findings. An ISS score was obtained by summing the square value of the 3 highest AIS scores: from 1 (minor injury) to 6 (lethal injury). Major trauma was defined using an ISS threshold of 13.

Statistical analysis was performed using the SPSS 10.0 software package (SPSS, Chicago, IL, USA). The mean (M) and standard error of the mean (SEM) were deduced. Student's unpaired and paired t-tests were used to compare two groups for data with normal distribution. We also used the Chi-square test to compare observed data. P values of <0.05 were considered statistically significant.

Results and Discussion

Assessment of the severity of a patient's condition according to the traditional scale and the ISS scale is presented in Table 2. The severity of the injuries depended on the combination of the anatomical regions involved. In our studies, the isolated injuries of the abdominal organs were mainly assessed as satisfactory and moderate severity; when the involvement of other anatomical regions increased, the number of patients with a severe, extremely severe and terminal condition also increased. The maximum score, ISS of 75, was assigned to 4 patients; 2 of them died within the first hour. The severity of these patients with traumatic cerebral injury had an AIS score of 6. The remaining 2 patients died on the first day; in these patients, we found a dominant combination of three anatomical regions with AIS of 5, which resulted in an ISS of 75.

Table 1.
The frequency of the abdomen trauma in FFH victims

№	Combined Injuries of the Abdominal Organs	Abs	%
1.	Contusion and hematoma of anterior abdominal wall	41	36.9
2.	Injuries of internal organs. Hemoperitoneum.	3	2.7
3.	Splenic capsular tear	1	0.9
4.	Splenic capsular tear + hepatic hematoma	1	0.9
5.	Splenic rupture	17	15.3
6.	Splenic rupture + retroperitoneal hematoma	1	0.9
7.	Splenic rupture + kidney rupture	1	0.9
8.	Splenic rupture + kidney rupture + retroperitoneal hematoma	1	0.9
9.	Splenic rupture + kidney rupture + rupture of the pancreatic capsule + retroperitoneal hematoma	1	0.9
10.	Splenic rupture + hepatic rupture/hepatic capsular tear	2	1.8
11.	Splenic rupture + hepatic rupture + retroperitoneal hematoma	1	0.9
12.	Splenic rupture + hepatic rupture + rupture of the small-intestinal mesentery + retroperitoneal hematoma	1	0.9
13.	Splenic rupture + gallbladder avulsion + retroperitoneal hematoma	1	0.9
14.	Splenic rupture + bladder rupture + deserosation of colon + retroperitoneal hematoma	1	0.9
15.	Splenic rupture + ovarian apoplexy + deserosation of colon + retroperitoneal hematoma	1	0.9
16.	Hepatic hematoma	2	1.8
17.	Hepatic capsular tear	2	1.8
18.	Hepatic rupture	10	9.0
19.	Hepatic rupture + retroperitoneal hematoma	2	1.8
20.	Hepatic rupture + contusion of the pancreatic head	1	0.9
21.	Hepatic rupture + contusion of the pancreatic head + hepatoduodenal ligament hematoma	1	0.9
22.	Hepatic rupture + ovarian apoplexy + deserosation of colon	1	0.9
23.	Hepatic rupture + rupture of the small intestine + diffuse serofibrinous peritonitis	1	0.9
24.	Hepatic rupture + rupture of the small intestine + tear in the stomach wall + diffuse serofibrinous peritonitis	1	0.9
25.	Kidney rupture + colon rupture + diffuse serofibrinous peritonitis	1	0.9
26.	Rupture of the small Intestine + diffuse serofibrinous peritonitis	2	1.8
27.	Rupture of the small Intestine + rupture of the small-intestinal mesentery + rupture of the pancreatic capsule + hepatic capsular tear + tear in the stomach wall + deserosation of colon + diffuse serofibrinous peritonitis	1	0.9
28.	Rupture of the small-intestinal mesentery + retroperitoneal hematoma	1	0.9
29.	Rupture of the small-intestinal mesentery + contusion of the pancreatic head + retroperitoneal hematoma	1	0.9
30.	Gastrointestinal ligament hematoma + retroperitoneal hematoma	1	0.9
31.	Retroperitoneal hematoma	6	5.4
32.	Penetrating abdominal trauma without injuries of abdominal organs	1	0.9
33.	Penetrating abdominal trauma with injuries of colon	1	0.9
34.	Penetrating abdominal trauma with injuries of the small intestine	1	0.9
Total		111	100

Table 2.
The severity of a patient's condition with combined injuries according to the traditional scale and the ISS scale

Traditional scale			ISS scale		
Severity of a patient's condition	total (n=98)	death rate	ISS range	total (n=98)	death rate
Satisfactory	1.0%	0	< 13 points	18.4%*	0
Moderate severity	22.4%	0	14-21 points	17.3%	0
Severe	62.2%	17.3%	22-32 points	30.6%*	7.1%*
Extremely severe	8.2%	7.1%	33-46 points	21.4%*	12.2%*
Terminal	6.1%	6.1%	46 -66 points	8.2%*	7.1%
Lethal			75 points	4.1%*	4.1%*
Total	100.0%	30.5%	Total	100.0%	30.5%

P<0.05 vs Traditional scale.

Table 3.
Types of surgical procedures on abdominal organs in FFH victims

№	Types of surgical procedures	Abs	%
1.	Laparoscopic microwave coagulation for hepatic rupture	2	3.4
2.	Laparoscopic microwave coagulation for splenic rupture	1	1.7
3.	Laparoscopic appendectomy	1	1.7
4.	Laparotomy, splenectomy	17	28.8
5.	Laparotomy, splenectomy + cholecystectomy	1	1.7
6.	Laparotomy, splenectomy + coagulation / suturing the hepatic rupture	3	5.1
7.	Laparotomy, splenectomy + suturing the kidney rupture	1	1.7
8.	Laparotomy, splenectomy + nephrectomy	2	3.4
9.	Laparotomy, splenectomy + suturing the bladder rupture + suturing the colon rupture	1	1.7
10.	Laparotomy, splenectomy + coagulation for hepatic rupture + suturing the small-intestinal mesentery rupture	1	1.7
11.	Laparotomy, splenectomy + suturing the colon rupture + suturing the ovarian rupture	1	1.7
12.	Laparotomy, APC the splenic rupture	1	1.7
13.	coagulation for splenic capsular tear + coagulation for hepatic rupture	1	1.7
14.	Laparotomy, suturing and/or coagulation for hepatic rupture	12	20.3
15.	Laparotomy, suturing the hepatic rupture + removal of retroperitoneal hematoma	1	1.7
16.	Laparotomy, removal of retroperitoneal hematoma, inspection of the retroperitoneal area	1	1.7
17.	laparotomy, suturing the small-intestinal/colon mesentery rupture	2	3.4
18.	Laparotomy, suturing the colon rupture	1	1.7
19.	Laparotomy, suturing the colon rupture + suturing the ovarian rupture + coagulation for hepatic rupture	1	1.7
20.	Laparotomy, coagulation for hepatic rupture, side-to-side entero-entero anastomosis and sigmastoma (due to co-morbidity, a pelvic tumor)	1	1.7
21.	Laparotomy, resection of the part of the descending colon with end-to-end colo-colonic anastomosis on the metallic frame + suturing the left kidney rupture with nephrostomy	1	1.7
22.	Laparotomy, suturing the small-intestinal wall and mesentery rupture, suturing the stomach tear and sigmoid colon + coagulation for the tears of the left hepatic lobe	1	1.7
23.	Laparotomy, suturing the small intestine rupture	2	3.4
24.	laparotomy, suturing the hepatic rupture + suturing the small intestine rupture	1	1.7
25.	Laparotomy, suturing the mesentery defect and deserosation of the small intestine part	1	1.7
26.	Laparotomy, suturing the tears of the anterior and posterior walls of the stomach + coagulation for the hepatic rupture + suturing the small intestine rupture	1	1.7
Total		59	100

We found differences in the number of patients with varying degrees of severity determined by the traditional grading scale and the ISS scale. These differences were most significant in groups of patients whose condition at admission was determined as moderate, severe, and extremely severe. Thus, the number of patients with combined injuries and a high degree of severity on the ISS scale was 2 times less than the traditional classification, but the number of patients with an extremely severe and terminal condition was 4.15 and 12.35 times greater, respectively. At the same time, the patients admitted with fatal injuries according to the traditional scale were not allocated separately, whereas, 4(4.1%) patients were given the highest ISS score (75). As shown in Table 2, the severe condition according to the traditional scale was identified in 64 patients and extremely severe and terminal condition in only 8 and 6 patients, respectively. According to the ISS scale, among the admitted patients, the severe condition was determined in 30 patients, extremely severe condition in 21 patients, terminal condition in 8 patients, and a lethal injury in 4 patients. We found a direct correlation between the clinical outcome and severity of the condition at admission. No deaths have been noted among the patients with satisfactory and moderate severity of condition at admission. In the patient group with a severe condition, according to the ISS scale the number of deaths was 2.4 times less than the same group according to the traditional scale. Conversely, in the patient group with the extremely severe and terminal condition according the ISS scale, the number of deaths was 1.72 and 1.16 times greater, respectively.

Active surgical tactics were used in 94 cases: a diagnostic laparoscopy was performed in 35 cases, laparoscopic surgery in 4 patients, conversion to laparotomy in 27 patients, and the initial laparotomy in 28 patients (Table 3). Three (2.7%) patients with Grade I or II splenic injury were subjected to argon plasma coagulation (APC); splenectomy was performed at Grade III or IV in 27(24.3%) patients. Electrocoagulation

and/or APC were performed at Grade II hepatic injury in 34.8% cases; suturing the liver rupture in combination with coagulation was carried out at Grade III or IV hepatic injury. The ruptures and tears of the hollow organs were sutured in 12(12.8%) cases; suturing the kidney rupture and nephrostomy was performed on 2 patients, nephrectomy in 2 patients. The diagnostic and treatment procedures in patients with injuries due to FFH with the combined trauma of the abdominal organs were carried out with the participation of surgeons of different specialties. The choice of treatment policy was determined by the severity of a patient's condition, features of injury (the combined or multiple injuries), the severity of the injuries of the abdominal parenchymal organs, and a number of other factors. Overall mortality was 30.5%. Causes of deaths were pneumonia, cerebral edema, and multiple organ failure.

In conclusion, the use of the ISS scale optimizes the analysis of clinical material. Comparative analysis of the assessment of the severity of a patient's condition according to the traditional scale and the ISS scale showed that the ISS scale promotes the active and timely detection of the extremely severe and terminal condition in patients with injuries due to FFH with combined trauma of the abdominal organs. Objective assessment of the severity of trauma and the dominant injury region allows determining the optimal treatment algorithm and predicting the outcome of the injury.

Competing interests

The authors declare that they have no competing interests.

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