

# Prognostic Factors in Hepatic Trauma

Gülüm Altaca, Melih Kara<sup>1</sup>, Gürkan Telliöglu<sup>1</sup>, Ibrahim Berber<sup>1</sup>

Bakırköy Dr. Sadi Konuk Training and Research Hospital Department of General Surgery, Haydarpaşa  
Numune Training and Research Hospital Department of General Surgery<sup>1</sup>, İstanbul

## ÖZET

### Karaciğer yaralanmalarında prognostik faktörler

**Amaç:** Operatif olarak tedavi edilen karaciğer travmalı olgularda mortaliteye etki eden faktörlerin retrospektif olarak araştırılması planlandı.

**Gereç ve Yöntem:** Analiz edilen parametreler yaş, cins, yaralanmanın tipi, Injury Severity Score (ISS, yaralanma ağırlık derecesi), Abdominal Trauma Index (ATI, abdominal travma indeksi), yaralanan abdominal organların sayısı (NIAO, number of injured abdominal organs), yapılan ameliyatlara, hastanede yatış süresi ve mortaliteydi. Ameliyat endikasyonları hızlı resüsitasyon sonrası hemodinamik stabilitenin sağlanamaması, ek abdominal organ yaralanması kuşkusu, peritoneal iritasyon bulguları ve 2 üniteden fazla kan transfüzyonu gereksinmesiydi. Karaciğer ve diğer organ hasarları Abbreviated Injury Scale (Kısaltılmış Yaralanma Skalası, AIS) 1990 revizyonuna göre derecelendirildi. ISS ve ATI skorları her hasta için hesaplandı.

**Bulgular:** Yaş ortalaması 25±8 idi. Altı hastada künt, 11 hastada penetran travma mevcuttu. Grade III ya da daha ağır karaciğer yaralanmaları tüm seride %64.6 idi. Karaciğer yaralanmasının derecesi hastanede yatış süresiyle koreleydi (r:0.65, p=0.015). İlk gelişte 11 hastada şok mevcuttu. Onüç hastada (%76.5) ek intra- ya da extra-abdominal organ yaralanması vardı. Ölen ve sağ kalan hastalarda NIAO sırasıyla 1.8±0.9 ve 2.3±0.8 idi (p<0.05). NIAO≥3 olan olguların %40'ına karşılık NIAO <3 olanların %16.6'sı mortal seyretti. Karaciğere yönelik operatif işlemler hepatografi (n:8), perihepatik packing (n:4) ve sağ lobektomiydi (n:1). Tüm seride mortalite oranı %23.5 idi. Hastanede ortalama yatış süresi 11 gündü. Künt travmanın mortaliteyi arttırdığına dair bir eğilim saptandı (mortalite oranı künt travmada 3/6 ve penetran travmada 1/5, OR:10, p=0.05). Künt travma karaciğer hasarının derecesiyle (r:0.74, p=0.001) ve kan transfüzyonu sayısı ile (r:0.75, p=0.002) anlamlı olarak ilişkili bulundu. Karaciğer hasarının derecesi de aynı şekilde kan transfüzyonu sayısı ile ilişkili bulundu (r: 0.66, p=0.01). Şok varlığı hematokrit düzeyi ile (r:0.80, p=0.001), karaciğer hasarının derecesi ile (r:0.50, p=0.03) ve kan transfüzyonu sayısı ile (r:0.60, p=0.006) ilişkili bulundu. Ölen ve sağ kalan hastalarda ortalama ATI sırasıyla 39.2 ve 15.3 idi (p=0.001). Korelasyon analiziyle ISS ve ATI'nin her ikisinin de mortaliteyle anlamlı olarak korele olduğu gösterildi (ISS için r:0.74, p=0.0001 ve ATI için r:0.60, p=0.001).

**Sonuç:** Karaciğer hasarının derecesi ile ISS ve ATI'nin mortaliteyi anlamlı olarak etkilediği sonucuna varıldı. Bu göreceli olarak küçük travmalı hasta grubunda, künt ve penetran travmada ISS ve ATI'nin uygulanabilirliği ve prognostik etkileri gösterildi. ISS ve ATI birbirleriyle ve mortalite ile korelasyon gösterdiği için prognostik skorlama sistemleri olarak uygun yöntemlerdir.

**Anahtar kelimeler:** Karaciğer, yaralanma, travma, travma skorlama sistemleri, ISS, ATI

## ABSTRACT

### Prognostic factors in hepatic trauma

**Objective:** The aim of the study was to analyze retrospectively the factors affecting the mortality rate in patients with hepatic trauma who were treated operatively.

**Material and Methods:** Parameters analyzed were demographics, presence of shock, type of injury, grade of injury, Injury Severity Score (ISS) and abdominal trauma index (ATI), number of injured abdominal organs (NIAO), operative procedures, length of hospital stay and mortality. Indications for operation were hemodynamically instability after rapid initial resuscitation, suspected concomitant abdominal organ injury, signs of peritoneal irritation, and need for more than two units of blood transfusion. Liver and other organ injuries were graded according to Abbreviated Injury Scale (AIS) 1990 revision (AIS-90). ISS and ATI scores were calculated for each patient.

**Results:** Mean age was 25±8 years. Six patients had blunt and 11 had penetrating trauma. Grade III or more severe hepatic injuries consisted 64.6%. The grade of liver injury correlated significantly with length of hospital stay (r:0.65, p=0.015). A total of eleven patients suffered from shock at first presentation. Concomitant intra- or extra-abdominal organ injury was detected in 13 patients (76.5%). NIAO in patients who survived and who died were 1.8±0.9 and 2.3±0.8, respectively (p<0.05). Forty percent of patients with NIAO ≥3 and 16.6% of patients with NIAO <3 died. Operative procedures for liver injury were hepatorrhaphy (n:8), peri-hepatic packing (n:4) and right lobectomy (n:1). The overall mortality rate was %23.5. Mean hospital stay was 11 days. In patients with blunt trauma, there was a trend towards higher mortality (mortality rate was 3/6 in blunt trauma and 1/5 in penetrating trauma OR:10, p=0.05). Blunt trauma significantly correlated with grade of liver injury (r:0.74, p=0.001) and number of blood transfusions (r:0.75, p=0.002). Grade of liver injury also significantly correlated with number of blood transfusions (r: 0.66, p=0.01). Presence of shock correlated significantly with hematocrit level (r:0.80, p=0.001), grade of liver injury (r:0.50, p=0.03), and number of blood transfusions (r:0.60, p=0.006). Mean ISS in patients who died and survived were 32.5 and 12.4, respectively (p=0.0001), and mean ATI in patients who died and survived were 39.2 and 15.3, respectively (p=0.001). Correlation analysis demonstrated that both ISS and ATI correlated significantly with mortality (r:0.74, p=0.0001 for ISS and r:0.60, p=0.001 for ATI). ISS and ATI also correlated significantly with each other (r:0.83, p=0.0001).

**Conclusion:** Grade of liver injury, ISS and ATI were found to have a significant effect on mortality in this study. Applicability and prognostic effects of both ISS and ATI in blunt and penetrating abdominal trauma are validated in this relatively small group of trauma patients as they were found to be correlated with each other and mortality. Therefore they still stand as appropriate score systems to determine prognosis.

**Key words:** Liver, trauma, trauma scoring systems, ISS, ATI

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## INTRODUCTION

Liver injuries are seen in 20%, 30%, and 40% of patients operated on for blunt trauma, gunshot and

stab wounds, respectively (1). Severe hemorrhage from liver parenchyma in hepatic trauma remains a formidable challenge even for the most experienced trauma surgeons. Injury Severity Score (ISS) is the most widely used measure of injury severity in patients with trauma (2). Attempting to summarize the severity of injury in a patient with multiple traumas with a single number is difficult at best; therefore, multiple alternative scoring systems have been proposed, each with its own problems and limitations. The Abdominal Trauma Index

Yazışma adresi / Address reprint requests to: Gülüm Altaca  
Bakırköy Dr. Sadi Konuk EAH, Genel Cerrahi Kliniği, İstanbul

Telefon / Phone: +90-532-363-4349

Elektronik posta adresi / E-mail address: gulumaltaca@superonline.com

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(ATI) was designed to stratify patients with penetrating injuries; however it has also been used to classify patients with blunt trauma (3,4,5).

The factors effecting the mortality rate as well as correlation of ISS and ATI scores with mortality in patients with hepatic trauma who were treated operatively were analyzed.

## MATERIAL AND METHODS

Analysis involved a retrospective review of 17 consecutive patients with hepatic injury operated on at one center in the last three years. Parameters analyzed were demographics, presence of shock, type of injury, grade of injury, ISS and ATI scores, number of injured abdominal organs (NIAO), operative procedures, length of hospital stay and mortality.

Presence of shock at admission was diagnosed if systolic arterial blood pressure was less than 100 mmHg. Initial resuscitation consisted of rapid infusion of two liters of Ringer's Lactate. Ultrasonography (US), diagnostic peritoneal lavage (DPL) and/or computerized tomography (CT) were performed preoperatively whenever possible according to the clinical stability of the patients.

Indications for operation were hemodynamically instability after rapid initial resuscitation, suspected concomitant organ injury, signs of peritoneal irritation, and need for more than two units of blood transfusion. Liver and other organ injuries were graded according to Abbreviated Injury Scale (AIS) 1990 revision (AIS-90) (5). ISS and ATI scores were calculated for each patient.

Statistical analysis were performed by SPSS V11.5. Chi-square test, Student's T-test, and correlation statistics (Spearman's correlation test for categorical variables and Pearson's test for were numeric variables) were performed where applicable.  $p < 0.05$  was accepted as statistically significant.

## RESULTS

All but one patient were male. Mean age was  $25 \pm 13.8$  years (range:6-51years). Type of injury, presence of shock, grade of liver injury, concomitant organ injuries, and operations for liver trauma are presented in Table 1. Six patients had blunt trauma; 4 traffic accidents and 2 falls from a height. Eleven patients had

penetrating trauma; 6 had stab wound and 5 had gunshot wounds. Median packed RBC transfusion was 3.9 units (range: 0-17 units). Median hospital stay was 11 days (range: 1-50 days). Mean hospital stay of patients who survived was  $14 \pm 13$  days. The grade of liver injury correlated significantly with length of hospital stay ( $r:0.65$ ,  $p=0.015$ ).

Four patients were taken directly to the operating room without any diagnostic procedure due to severe persistent shock and/or obvious injury to intraabdominal organs (23.5%). A total of eleven patients suffered from shock at first presentation. Grade III or more severe hepatic injuries consisted 64.6% (Grade I:  $n=2$ , Grade II:  $n=4$ , Grade III:  $n=5$ , Grade IV:  $n=3$ , Grade V:  $n=3$ ).

Concomitant organ injury was detected in 13 patients (76.5%). Mean NIAO was  $1.94 \pm 0.8$ . NIAO in patients who survived and who died were  $1.8 \pm 0.9$  and  $2.3 \pm 0.8$ , respectively ( $p > 0.05$ ). Forty percent of patients with  $NIAO \geq 3$  compared to 16.6% of patients with  $NIAO < 3$  died. Organs injured were stomach ( $n=5$ ), colon ( $n=3$ ), spleen ( $n=2$ ), vena cava inferior ( $n=3$ ), small intestine ( $n=1$ ), duodenum ( $n=1$ ), mesentery ( $n=1$ ), cranium ( $n=2$ ) and lungs ( $n=5$ ). Six patients had more than one concomitant injury. All four patients died had at least one additional intra- or extra-abdominal organ injury.

Operative procedures for liver injury were hepatorrhaphy ( $n:8$ ), peri-hepatic packing ( $n:4$ ) and right lobectomy ( $n:1$ ). No hepatic bleeding was found in four patients during exploration; three of them had concomitant abdominal organ injuries. Intrahepatic balloon tamponade was applied with a Sengstaken-Blakemore tube in one patient in addition to packing. Patients with peri-hepatic packing were reoperated on 24-48 hours after the first operation. Right anterior branch of the portal vein was repaired after 24 hours in one patient in this group with a successful outcome. The overall mortality rate was 23.5%. Mortality occurred in one patient with hepatorrhaphy and in two patients with peri-hepatic packing, all of whom had concomitant multiple organ injuries.

In patients with blunt trauma, there was a trend towards higher mortality (mortality rate was 3/6 in blunt trauma and 1/5 in penetrating trauma; OR:10,  $p=0.05$ ). Blunt trauma significantly correlated with grade of liver injury ( $r:0.74$ ,  $p=0.001$ ) and number of blood transfusions ( $r:0.75$ ,  $p=0.002$ ). Grade of liver injury also significantly

correlated with number of blood transfusions ( $r: 0.66$ ,  $p=0.01$ ). Presence of shock correlated significantly with hematocrit level ( $r:0.80$ ,  $p=0.001$ ), grade of liver injury ( $r:0.50$ ,  $p=0.03$ ), and number of blood transfusions ( $r:0.60$ ,  $p=0.006$ ).

Mean ISS and ATI in the total series were  $20.9\pm 10.2$  and  $17.2\pm 11.4$ , respectively. ISS and ATI were significantly higher in patients who died compared to the patients who survived. Mean ISS in patients who died and survived were  $32.5\pm 2.1$  and  $12.4\pm 5.5$ , respectively ( $p=0.0001$ ), and mean ATI in patients who died and survived were  $39.2\pm 2.4$  and  $15.3\pm 4.7$ , respectively ( $p=0.001$ ). Correlation analysis demonstrated that both ISS and ATI correlated significantly with mortality ( $r:0.74$ ,  $p=0.0001$  for ISS and  $r:0.60$ ,  $p=0.001$  for ATI). ISS and ATI also correlated significantly with each other ( $r:0.83$ ,  $p=0.0001$ ).

## DISCUSSION

In the past 15 years, nonoperative management of hemodynamically stable patients with blunt abdominal trauma has gained worldwide acceptance. Still, there remains some 18-50% among the patients with blunt abdominal injury that have to be operated on immediately upon admission for reasons such as hemodynamically instability, suspected or documented viscus injury, and more than limited balanced salt solution and transfusion requirements (1,6,7). In addition, environment is also important in such decisions such as ability to access critical care services all the time, and presence of a special trauma team and trauma critical care facilities. Strict cooperation of multiple specialties such as radiology and intensive care units alongside the experience of surgical team is also precious. Nonoperative management of patients with penetrating abdominal trauma, and even of those with gunshot wounds is also emerging, though still controversial (8,9).

High grade liver injury is not a contraindication for nonoperative trauma; however, the patients that are initially not operated on but eventually require surgery generally have liver injuries of grade IV and V (1). Damage control surgery for multiply injured hemodynamically instable patients should be applied in a subset of those patients with proper indications. In our series, damage control surgery in terms of packing was applied in 4 patients with 50% survival rate.

In this study the risk factors and validity of ISS and ATI scores were analyzed in a group of patients who were treated operatively. The Abbreviated Injury Scale (AIS) is the basis for the ISS, which is the most widely used measure of injury severity in patients with trauma. It has some weaknesses that any error in AIS scoring increases the ISS error, a variety of different injury patterns might yield the same ISS score and injuries to different body regions are not weighted. ISS limits the total number of contributing injuries to only 3. Attempting to summarize the severity of injury in a patient with multiple traumas with a single number is difficult at best; therefore, multiple alternative scoring systems have been proposed, each with its own problems and limitations. The ATI was designed to stratify patients with penetrating injuries, and has also been used to classify patients with blunt trauma. The Penetrating Abdominal Trauma Index (ATI) is described as a method for quantifying the risk of complications following penetrating abdominal trauma, introduced in 1981 by Moore et al (3). ATI provided a useful means to investigate trauma and served as a tool in the decision-making process when managing penetrating abdominal trauma (3,4). The most appropriate use of trauma scoring systems might be field triage, research, and evaluating trauma care in centers or between centers rather than making decisions solely on scores for an individual patient.

Mortality was higher in blunt trauma in this study though not significant; however, a trend was found statistically. Blunt trauma, nevertheless, significantly correlated with grade of liver injury and number of blood transfusions which is concordant with the literature.

Concomitant organ injury had no statistical effect on mortality in our study. This might be due to the fact that a great majority of patients ( $n:13$ ) had additional organ injury. However, all four patients who died had at least one concomitant organ injury. We believe that the effect of concomitant organ injury showed itself in the effects of ISS and ATI on mortality in this series. NIAO, contradiction to its simplicity, seems to be another important factor determining prognosis in trauma patients. We found that 2/5 patients with  $NIAO\geq 3$  compared to 2/12 patients with  $NIAO<3$  died. The term NIAO and its effect in trauma was first analyzed by Sikic et al in 2001 and was found to be a significant predictor

of complications or mortality (10,11). The injuries with the greatest number of complications were of the duodenum, pancreas and kidney. The highest mortality rate was in patients with the injuries of the intraabdominal large blood vessels, duodenum and urinary bladder. An ATI higher than 22, an ISS higher than 26 and NIAO  $\geq 3$  were found to increase the complication rate in trauma patients (10).

ISS and ATI greater than 25 is generally accepted to increase complications and/or mortality in liver trauma (3,4,10,12). Mean ISS and mean ATI in patients who died were 32.5 and 39.2, respectively, and they were

significantly higher than that of the survivors in our study.

Grade of liver injury and ISS and ATI were found to significantly affect mortality in this study. Blunt trauma demonstrated a trend towards higher mortality. NIAO was higher in patients with poor outcome, though not significant. Applicability and prognostic effects of both ISS and ATI in blunt and penetrating abdominal trauma are validated in this relatively small group of trauma patients; they are correlated with each other and mortality; therefore they still stand as appropriate score systems to determine prognosis.

**Table 1: Characteristics of patients and liver injury, operative procedures and outcome**

Age (yrs)	Type of injury	Shock	Liver Injury Grade	Concomittant organ injury	Operative procedure for liver injury	Outcome
28	Gun shot	+	2	VCI, small intestine	none	Survived
45	Gun shot	+	3	stomach	hepatorraphy	Survived
6	Gun shot	-	2	mesentery	hepatorraphy	Survived
40	Stab wound	-	3	-	hepatorraphy	Survived
17	Stab wound	-	3	-	hepatorraphy	Survived
17	Fall	+	3	lungs	hepatorraphy	Survived
14	Traffic acc.	+	5	lungs	packing	Exitus
7	Traffic acc.	+	4	Duodenum	packing, baloon tamponade	Survived
24	Stab wound	+	2	stomach, colon	none	Survived
51	Gun shot	+	2	cranium, lungs, stomach, colon	hepatorraphy	Exitus
15	Traffic acc.	+	5	stomach, spleen	packing	Exitus
15	Stab wound	+	3	-	hepatorraphy	Survived
39	Stab wound	-	1	colon	none	Survived
23	Traffic acc.	+	5	VCI, spleen, lungs	hepatorraphy	Exitus
23	Stab wound	-	1	-	none	Survived
45	Fall	+	4	cranium	lobectomy	Survived
29	Gun shot	-	4	VCI, stomach, lungs	packing	Survived

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