ORIGINAL ARTICLE

Analysis of trauma scoring system for patients with abdominal trauma

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ABSTRACT

BACKGROUND: This study investigated the correlations between several trauma scoring systems, including the injury severity score (ISS), clinical abdominal scoring system (CASS), new injury severity score (NISS), and clinical outcomes, including laparotomy, in-hospital mortality (IHM), and long hospital stay (LS) in patients with abdominal trauma.

METHODS: Data of 749 patients with abdominal trauma between January 2009 and December 2019 were reviewed retrospectively. Data from medical records included age, sex, initial vital signs, type and mechanism of trauma, hospital stay, laparotomy, and IHM. Injured organs and grades were collected using computed tomography. Correlations between the scoring system and clinical outcomes were analyzed using the area under Curves (AUC) of the receiver operating characteristic (ROC) curve.

RESULTS: The mean age of the patients was 40.14±19.47 years. Blunt trauma was the most common type of trauma in 704 patients (94.0%), and traffic accident was the most common mechanism in 475 (63.4%). Injured organs included liver (45.1%) and spleen (25.1%). A total of 179 patients (23.9%) underwent laparotomy and IHM was reported in 35 (4.6%). The AUC of ROC for ISS, NISS, and CASS was significantly associated with laparotomy (0.682; p=0.001, 0.713; p=0.001; 0.845; p=0.001). The AUCs showed significant for IHM (0.606; p=0.034, 0.626; p=0.012, 0.701; p=0.001). The AUCs for LS were 0.554 (p=0.041), 0.549 (p=0.062), and 0.581 (p=0.002).

CONCLUSION: The CASS is excellent for predicting laparotomy, IHM, and LS in patients with abdominal trauma. The NISS is more appropriate than the ISS for predicting laparotomy and IHM.

Keywords: Clinical abdominal scoring system; in-hospital mortality; injury severity score; new injury severity score; trauma scoring systems.

INTRODUCTION

The abdomen is the third most injured region of the body after the extremities and head, and abdominal trauma accounts for approximately 10% of trauma.[1] The abdomen is a fairly wide region in the center of our body, containing many organs. Therefore, there are many secondary internal organ injuries caused by blunt trauma, and blunt trauma has been reported in up to 80% of abdominal trauma.[2] In addition, unlike the extremities, abdominal trauma is often accompanied by trauma in other regions. In abdominal trauma, various clinical presentations caused by polytrauma often delay accurate diagnosis and clinical judgment.[3] More than 50% of abdominal trauma cases have reversible prognostic factors, and appropriate laparotomy and intervention can significantly reduce the mortality rate.[4] Hence, many trauma surgeons focus on abdominal trauma, and many trauma scoring systems are needed to predict intervention and mortality in abdominal trauma.

To provide objective information for predicting morbidity and mortality in trauma, a trauma scoring system was implemented.[5] Since the trauma scale must be accurate and reliable, various efforts have been made to revise the trauma scoring system according to the population and involved regions of the body. In trauma, particularly abdominal trauma, the

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scoring system frequently uses anatomical and physiological parameters.[6] The injury severity score (ISS), which collects the abbreviated injury scale (AIS) based on anatomical parameters,[7] has been used as a pivotal trauma scoring system for a long time and is still commonly used. The post-traumatic process is so dynamic that it was necessary to introduce physiological data into the trauma scoring system, which led to the development of the trauma injury severity score (TRISS) and the introduction of the clinical abdominal scoring system (CASS) in the abdomen.[8]

This study investigated the correlations between several trauma scoring systems and clinical outcomes, including laparotomy, in-hospital mortality (IHM), and long hospital stay (LS) in patients with abdominal trauma. In this study, the ISS of anatomical scale and the CASS of physiological scale were initially adopted as trauma scoring systems. In a preliminary study, it was necessary to separately reflect injuries of various organs in abdominal trauma, and the new injury severity score (NISS)[9] was added and eventually adopted.

MATERIALS AND METHODS

To identify patients with abdominal trauma, we searched the institutional medical data repository with the codes S35-37 and K66 of the Korean National Health Insurance Service. The data of 898 patients with abdominal trauma between January 2009 and December 2019 were reviewed retrospectively. Young patients under 18 years of age, patients with suspected head trauma on the Glasgow coma scale (GCS) score of <12, patients with asystole at admission, and patients with moderate injury to body regions other than the abdomen were excluded from the study. Only patients with minor injury (AIS score: 1) in the head, face, chest, extremities, and external regions were included in this study. The final cohort included 749 patients with abdominal trauma.

Data collected from medical records included age, sex, type and mechanism of trauma, injured organs, hospital stay, laparotomy, and IHM. The injured organs were determined using computed tomography and operative findings. If the patient was stable or the possibility of bowel injury was low, laparoscopy was performed before open laparotomy, and it differed depending on the surgeon on duty. The small bowel of the injured organ was defined as the jejunum, ileum, and mesentery. Data regarding the time of presentation after the trauma, pulse rate, systolic blood pressure, GCS, and abdominal clinical findings at admission were collected for the CASS. The AIS scores of intra-abdominal organs were also collected through the official readings of initial abdominal computed tomography by radiologists in a single medical center. Involved organs, including the abdominal vessel and extent, were divided according to the AIS[10] and reclassified by an author (HJ) if they were not classified or were insufficient. LS was defined as hospitalization for >30 days.

Correlations between trauma scoring systems (the ISS, CASS, and NISS) and clinical outcomes (laparotomy, IHM, and LS) were analyzed using the area under curves (AUC) of the receiver operating characteristic (ROC) curve. All statistical analyses were performed using the Statistical Package for the Social Science software version 25 (IBM Corp, Armonk, NY, USA). Statistical significance was set at $p<0.05$.

RESULTS

Of the 749 patients included in this study, 553 were men (71.2%). The mean age of the patients was 40.14±19.47 years.

Table 1. Baseline characteristics of patients with abdominal trauma

Characteristics, n (%)	Total (n=749)
Age	40.14±19.47
Male	553 (71.2)
Diabetes	48 (6.4)
Hypertension	84 (11.2)
Type of trauma	
Blunt	704 (94.0)
Penetrating	44 (5.9)
Mixed	1 (0.1)
Mechanism of trauma	
Traffic accident	475 (63.4)
Fall down	162 (21.6)
Assault	42 (5.6)
Self-inflicted	23 (3.1)
Other	47 (6.3)
Injured organs*	
Liver	349 (46.6)
Spleen	217 (29.0)
Kidney	103 (13.8)
Pancreas	55 (7.3)
Stomach & Duodenum	20 (2.7)
Small bowel & Mesentery**	120 (16.0)
Colon & Rectum	42 (5.6)
Abdominal vessel	14 (1.9)
ISS	5.75±4.98
CASS	6.62±1.44
NISS	6.57±5.45
Hospital stay***, days	20.70±23.95
Laparotomy	179 (23.9)
In-hospital mortality	35 (4.7)

ISS: Injury Severity Score; NISS: New Injury Severity Score; CASS: Clinical Abdominal Scoring System. *Injured Organs were determined by computed tomography and operative findings. **Small bowel included jejunum, ileum and its mesentery. ***Hospital stay is limited to first admission. Data are expressed as numbers (%) and means±SDs.

Table 2. Predictive Powers of ISS, CASS and NISS for laparotomy and in-hospital mortality in patients with abdominal trauma

Characteristics	C-statistic	95% CI	p-value
For Laparotomy			
ISS	0.682	0.639–0.726	0.001
CASS	0.845	0.813–0.876	0.001
NISS	0.713	0.671–0.756	0.001
For In-hospital mortality			
ISS	0.606	0.505–0.707	0.034
CASS	0.701	0.602–0.800	0.001
NISS	0.626	0.519–0.732	0.012
For Long hospital stay*			
ISS	0.554	0.502–0.605	0.041
CASS	0.581	0.530–0.632	0.002
NISS	0.549	0.497–0.601	0.062

ISS: Injury Severity Score; CASS: Clinical Abdominal Scoring System; NISS: New Injury Severity Score; CI: Confidence interval. *Long hospital stay was defined as hospitalization for more than 30 days.

Blunt trauma was the most common type of trauma in 704 patients (94.0%), followed by penetrating trauma observed in 44 patients (5.9%). Traffic accidents were the most common mechanism, with 475 (63.4%) accidents, followed by falls with 162 (21.6%). Injured organs included the liver in 349 patients (46.6%), spleen in 217 patients (29.0%), kidney in 103 patients (13.8%), pancreas in 55 patients (7.3%), stomach and duodenum in 20 patients (2.7%), small bowel and mesentery in 120 patients (16.0%), colon and rectum in 42 patients (5.6%), and abdominal vessels in 14 patients (1.9%). The mean ISS, CASS, and NISS scores of 749 patients were 5.75±4.98, 6.62±1.44, and 6.57±5.45, respectively. A total of 179 patients (23.9%) underwent laparotomy during the first hospitalization, and open laparotomy after laparoscopy or laparoscopic surgery was performed in 42 cases (23.4%). The mean hospital stay was 20.70±23.95 days. IHM was reported in 35 patients (4.6%) (Table 1).

The AUC of the ROC for ISS, CASS, and NISS showed significant values for laparotomy (0.682, 95% confidence interval [CI], 0.639–0.726; p=0.001, 0.845, 0.813–0.876; p=0.001, 0.713, 0.671–0.756; p=0.001). The AUC of ISS, NISS, and CASS showed significant association with IHM (0.606, 95% CI, 0.505–0.707; p=0.034, 0.701, 0.602–0.800; p=0.001, 0.626, 0.519–0.732; p=0.012) (Fig. 1 and Table 2). The predictive powers for laparotomy and IHM were statistically significant in the order of CASS, NISS, and ISS. The AUC of ROC for ISS, CASS, NISS for LS was 0.554 (95% CI, 0.502–0.605; p=0.041), 0.581 (0.530–0.632; p=0.002), and 0.549 (0.497–0.601; p=0.062), respectively (Table 2). The CASS was moderately predictive of LS in patients with abdominal trauma.

DISCUSSION

History of Trauma Scoring System

As industrialization progresses, interest in automobile accidents in trauma is increasing. The AIS was developed in 1971 through efforts to objectify injuries. The AIS included 73 main injuries with severity measures, varying from minor to fatal. [11] Introduced in 1972, the ISS is an anatomical scoring system that facilitates the overall scoring of multiple traumas. Each injury is assigned an AIS for every six regions of the body, and

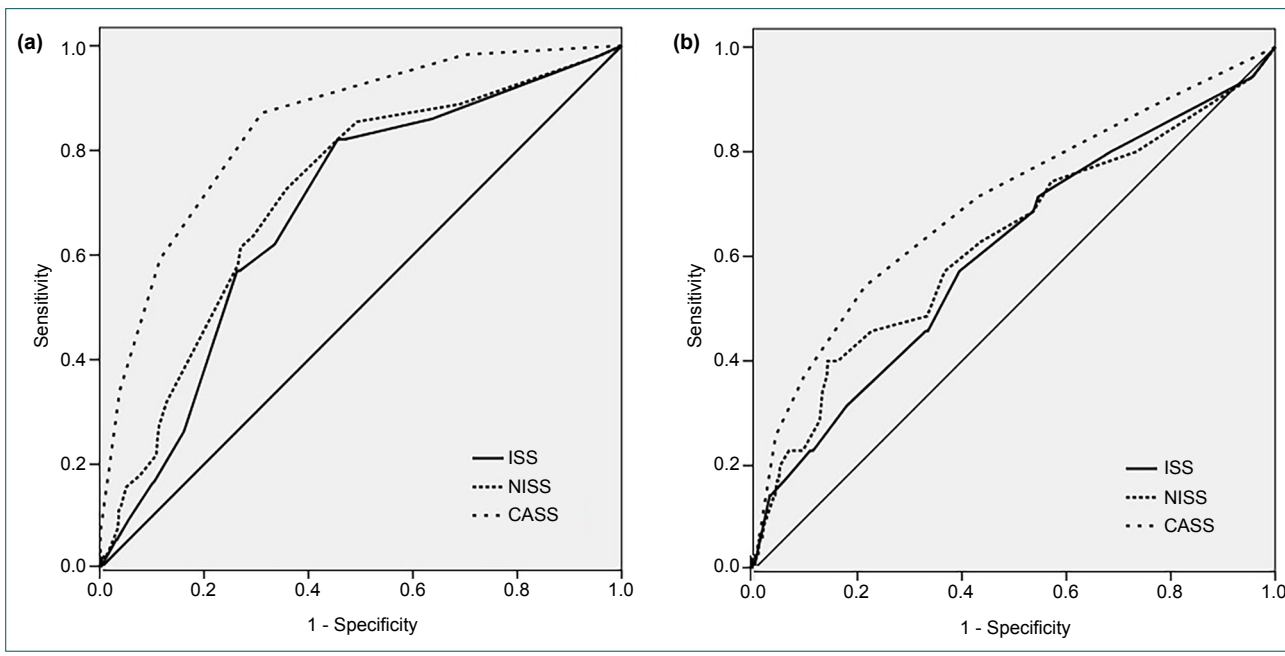

Figure 1. Receiver operating characteristics curves of the injury severity score, clinical abdominal scoring system, new injury severity score for laparotomy **(a)** and in-hospital mortality **(b)**.

the highest AIS for each region is used.[6,7] Understanding the post-traumatic physiological process is important, and with the development of the TRISS in 1981, data were integrated into the trauma scoring system and widely used.[8] Since then, efforts have been made to revise the trauma scoring system according to the population and involved regions of the body. The NISS, introduced in 1997 as a modification of the ISS, is the sum of AIS scores of the three most severe injuries, regardless of region, and has been widely used to predict post-traumatic multiple organ failure.[9,12] Recently, the CASS, made of five items, including time of presentation after the trauma, systolic blood pressure, pulse rate, GCS, and abdominal clinical findings, reflects the prognosis after abdominal trauma and helps predict the need for laparotomy.[13]

Characteristics of Trauma Scoring System in Abdominal Trauma

The abdomen is a wide region in the center of the body, and it contains many organs including the liver, spleen, stomach, small bowel, and colon. Therefore, abdominal trauma is often accompanied by various organ injuries and clinical manifestations.[3] The ISS is limited to only one injury in each of the three most injured regions, and having more than one serious injury in a region may result in an underestimated degree of trauma.[14] The NISS uses the AIS scores of the three most severe injuries regardless of region; hence, it is often used in penetrating trauma or multiple organ failure, which inflicts multiple injuries in a region. In this study of abdominal trauma, the NISS was found to be more suitable than the ISS for predicting laparotomy and IHM. For LS, only the CASS showed predictive power in abdominal trauma. The CASS was proposed to predict the prognosis after abdominal trauma.[13] The authors discussed that physiological parameters had more influence than anatomical parameters for LS affected by the patient's condition and complications.

This study had some limitations. This study was retrospective and relied on medical records from several medical staff for subjective manifestations and history of trauma. Although there are many scoring systems for assessing trauma, only a few representative systems have been compared. Most of the laparotomies were decided by the surgeon on duty, and the decision criteria for laparotomy could be slightly different depending on the surgeon. This is a limitation in that the results of negative laparotomy cannot be accurately reported because data on abdominal injuries that do not require laparotomy are not separately collected. Nepative laparotomy is associated with post-operative complications,[15] and another purpose of the research of trauma scoring system is to reduce negative laparotomy, and further studies are needed. In trauma localized to the abdomen, the authors found it important to compare individual organs. However, this could not be performed because of the limitations of the study plan and data. Unlike the past, which relied heavily on the scoring system, CT scan has recently become routine, so it is important to make decisions on a case-by-case basis. However, prompt decision-making and prognosis in the field of trauma are always important.

Conclusion

The CASS, a physiological scale, is excellent for predicting laparotomy, IHM, and LS in patients with abdominal trauma. For predicting laparotomy and IHM, the NISS is more appropriate than the ISS on an anatomical scale. The predictive scales of abdominal trauma should reflect both anatomical and physiological conditions, and each organ injury should be reflected separately.

Ethics Committee Approval: This study was approved by the Institutional Review Board of Ilsan Paik Hospital (2021-05-017).

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Conflict of Interest: None declared.

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ORİJİNAL ÇALIŞMA - *ÖZ*

Abdominal travmalı hastalar için kullanılan travma skor sistemlerinin analizi

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AMAÇ: Bu çalışmada, abdominal travması olan hastalarda Yaralanma Şiddet Skoru (ISS), Klinik Abdominal Skorlama Sistemi (CASS), Yeni Yaralanma Şiddet Skoru (NISS) dahil olmak üzere çeşitli travma skor sistemleri ile laparotomi, hastane içi mortalite (IHM) ve uzun hastanede kalış süresi (LS) dahil klinik sonuçlar arasındaki korelasyonlar araştırılmıştır.

GEREÇ VE YÖNTEM: Ocak 2009 ile Aralık 2019 tarihleri arasında abdominal travma geçiren 749 hastanın verileri geriye dönük olarak incelendi. Tıbbi kayıtlardan elde edilen veriler arasında yaş, cinsiyet, başlangıç yaşamsal bulgular, travma tipi ve mekanizması, hastanede kalış süresi, laparotomi ve hastane içi mortalite (IHM) yer almaktadır. Yaralanmış organlar ve derecelerine ait bilgiler bilgisayarlı tomografi kullanılarak toplandı. Skor sistemi ile klinik sonuçlar arasındaki korelasyonlar, Alıcı Çalışma Karakteristikleri (ROC) eğrisinin Eğri Altındaki Alanı (AUC) kullanılarak analiz edildi.

BULGULAR: Hastaların ortalama yaşı 40.14±19.47 yıldı. Yedi yüz dört hastada (%94.0) en sık travma tipi künt travma, 475 hastada (%63.4) ise trafik kazası en sık görülen nedendi. Yaralanmış organlar arasında karaciğer (%45.1) ve dalak (%25.1) mevcuttu. Toplam 179 hastaya (%23.9) laparotomi uygulanmış ve 35 hastada (%4.6) IHM bildirilmişti. ISS, NISS ve CASS için ROC'nin AUC'si laparotomi ile anlamlı şekilde ilişkiliydi (0.682; p=0.001, 0.713; p=0.001; 0.845; p=0.001). AUC'ler, IHM için istatistiksel olarak anlamlılık gösterdi (0.606; p=0.034, 0.626; p=0.012, 0.701; p=0.001). Uzun hastanede kalış süresi (LS) için AUC'ler 0.554 (p=0.041), 0.549 (p=0.062) ve 0.581 (p=0.002) idi.

TARTIŞMA: Klinik Abdominal Skorlama Sistemi (CASS), abdominal travmalı hastalarda laparotomi, IHM ve LS'yi öngörmek için mükemmeldir. Yeni Yaralanma Şiddet Skoru (NISS), laparotomi ve IHM'yi öngörmek için ISS'den daha uygundur.

Anahtar sözcükler: Hastane içi mortalite; klinik abdominal skorlama sistemi; travma skor sistemleri; yaralanma şiddet skoru; yeni yaralanma şiddet skoru.

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