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Research Article

The Factors that Determine the Mortality in Chest Trauma, and in the Determination of Mortality, Comparision of Sufficiency of Injury Severity Score and New Injury Severity Score

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Abstract

Background: Localized thorax and generalized body trauma can be turned into a potentially life-threatening situation for the patients.

Aim: Specific numerical values can be given to the data obtained by close follow-up of the changes in the clinical status of the trauma patient. In this way, the necessary approach or transfer process can be previously predicted to reduce the patients' mortality and morbidity.

Methods: Four hundred fourteen patients were inspected due to thorax trauma and hospitalized for six years. In our hospital was used therapy of patients. Those patients were divided into three groups retrospectively. They were classified as Group I (n = 64) patients with blunt trauma but without rib fracture, group II patients (n = 220) with blunt trauma and rib fracture, and group III patients (n = 130) with penetrating injury. The relation between the mortality and Injury Severity Score (ISS), New Injury Severity Score (NISS), and age were analyzed in these three groups. I used ROC and χ^2 test for statistical evaluation in the SPSS program. If the results were $p < 0.05$, I accepted the value as significant.

Results: For this patients it's found that 68 % (n = 284) hospitalized for blunt thorax trauma, 32 % (n = 130) penetrating trauma. Also, 55% (n = 156) of the blunt trauma group were in the vehicle unit, 23% (n = 65) of their cars crashed, and 22% (n = 63) of them were observed to fall. After the penetrating injury, tube thoracostomy was applied to 77.2 % (n = 78) of patients with hemopneumothorax. After blunt trauma, tube thoracostomy was applied to 79,9 % (n = 143) of patients with hemopneumothorax. 8.9% (n = 16) were operated on after penetrating injury 20,4 % (n = 20) of patients with hemopneumothorax. The ratio of operations applicated in our clinic between Group II-III and Group I-III was significantly longer ($p < 0.05$).

6,7 % (n = 19) of blunt trauma and 3.1 % (n = 4) penetrating trauma resulted in mortality. For the patients who died in the penetrating trauma group, ISS points were a maximum of 26 points, a minimum of 16 points, and NISS points were a maximum of 35 and minimum of 22 points. Although in the blunt trauma group, ISS points were maximum of 45 points, minimum of 9 points, and NISS points were a maximum of 57 points and minimum of 34 points.

Conclusions: The complexity of trauma and relation with more than one system were significant risk factors for mortality. The mortality risk in chest trauma increased in patients over 45 years old and had ISS or NISS of more than 16 points. According to our statistical results, we found that NISS is more reliable than ISS.

Keywords: Thoracic Trauma; ISS and NISS; Mortality

Introduction

Traffic accidents are involved in the etiology of 17% injuries and 60% of deaths while maintaining the first rank among the causes in our country's data [1]. It is estimated that 30% of these deaths can be prevented by providing out-of-hospital first aid and transportation quickly and under appropriate conditions. Rapid transport of seriously injured and calculated the Abbreviated Injury Scale(AIS) high with patients to a suitable center minimizes the time lost until the initiation of primary treatment [2,3].

The Injury Severity Score (ISS) and the New Injury Severity Score (NISS) are two commonly used trauma severity scores that are used to assess the severity of injury in trauma patients. Both scores are calculated based on the AIS, which is a standardized system for describing the severity of injuries. The ISS is calculated by adding the AIS scores of the three most severely injured body regions. The NISS is calculated by adding the squares of the AIS scores of the three most severely injured body regions [4-6]. This study discussed the treatment approach we applied to patients with thoracic trauma admitted to our clinic and the factors affecting mortality in thoracic trauma. We compared the adequacy of the ISS and NISS systems, which are anatomical scoring systems, in determining chest trauma mortality using the AIS in trauma patients. Thus, it was aimed to determine high-risk groups for patients with thoracic trauma.

Patients and Method

I collected age, gender, pathological finding, ISS, and NISS data. Four hundred fourteen patients with thoracic trauma treated in our clinic for six years were retrospectively analyzed. Patients with blunt trauma without a rib fracture were classified as Group I, patients with blunt trauma with a rib fracture were classified as Group II, and patients with penetrating injuries were classified as Group III. The patients were evaluated regarding age and gender distribution, clinical findings, extrathoracic injuries accompanying thoracic trauma, and applied conservative and surgical treatment methods. ISS and NISS values were calculated in three groups (Table 1). The relationship between age and trauma scores with mortality was evaluated. The χ^2 test was used for comparisons between groups. The effectiveness of the ISS and NISS tests in determining trauma results was evaluated with the "Receiver-Operating Characteristic Curve" (ROC). All statistical operations were performed using SPSS 25.0 for the Windows program.

Results

Four hundred fourteen patients with thoracic trauma were followed up in our clinic over six years. Of these patients, 83,1% were male (n = 344) and 16,9% were female (n = 70) (Table 1). The youngest of our patients was four years old, and the oldest was 84 years old. While blunt traumas were more common, especially in adults over 30 years of age, penetrating injuries were prevalent in young people under 30 years of age (Table 1).

	Group I (n = 64) 16%		**Group II (n = 220) 52%**		**Group III (n = 130) 32%**	
Sex	**M (%)**	**F (%)**	**M (%)**	**F (%)**	**M (%)**	**F (%)**
	52 (%81.3)	12 (%18.7)	177 (%80.5)	43 (%19.5)	115 (%88.5)	15 (%11.5)
Age	Nusmber	%	Number	%	Number	%
0-14	4	6.3	0	0	4	3.1
15-29	26	40.6	37	16.8	64	49.2
30-44	17	26.6	59	26.8	39	30
45-59	10	15.6	65	29.6	18	13.8
≥60	7	10.9	59	26.8	5	3.8

Table 1: Distribution number of patients by gender, age, and number of groups.

68.6% (n = 284) of the cases were admitted to our clinic because of blunt trauma and 31.4% (n = 130) of penetrating trauma. Of 284 patients exposed to blunt trauma, 220 had rib fractures. Forty-two patients were placed under clinical observation due to pathologies without rib fracture (Table 2). Rib fractures were most common on the left and in the fifth rib.

	Group I (n = 64)		Group II (n = 220)		Group III (n = 130)	
Pathological Findings	**Number**	**%**	**Number**	**%**	**Number**	**%**
Hemothorax	13	20.3	52	23.6	38	29.2
Pneumothorax	15	23.4	36	16.4	21	16.2
Hemopneumothorax	9	14.1	54	24.5	42	32.3
Subcutaneous emphysema	6	9.4	38	17.3	16	12.3
Sternal fracture	3	4.7	2	0.9	1	1.5
Parenchymal contusion	2	3.1	4	1.8	25	19.2
Fail chest	0	0.0	19	8.6	1	0.8
Heart injury	0	0.0	20	9.1	1	0.8
Diaphragmatic laceration	0	0.0	2	0.9	3	2.3
Esophageal laceration	2	3.1	2	0.9	4	3.1
Scapula fracture	0	0.0	22	10.0	4	3.1
Clavicle fracture	3	4.7	28	14.1	4	3.1
Vertebral fracture	4	6.3	15	6.8	4	3.1
Cerebral injury	6	9.4	30	13.6	0	0.0
Eye injury	2	3.1	17	7.7	4	3.1
Abdominal injury	3	4.7	11	5.0	9	6.9
Extremity injury	13	20.3	34	15.5	11	8.5

Table 2: Pathologies seen in the chest wall and inside the thorax in trauma patients.

The incidence of hemothorax and/or pneumothorax in the patients was statistically significantly higher in Group III compared to other groups ($p < 0.001$). The difference between Group I and Group II was not statistically significant ($p > 0.05$).

In the statistical analysis performed between the three groups in terms of subcutaneous emphysema, the difference was statistically significant ($p < 0.05$).

Flail chest was seen in 14 of the patients. 7 of them were admitted to our clinic due to in-vehicle traffic accidents, 4 of them due to non-vehicle traffic accidents, two to assault, and one due to injuries with a firearm. The flail chest was present in the left hemithorax in 10 patients, in the right hemithorax in 3 patients, and bilateral in 1 patient. All of the cases had accompanying intrathoracic and extrathoracic organ injuries. These patients were followed up for 11.6 days (Table 2).

One hundred eleven extrathoracic injuries were detected in 190 (45%) of 414 patients (Table 2). Quadriplegia developed in 2 of 15 patients with vertebral fracture, and paraplegia in 7 patients. Cerebral injury was seen in 20 patients (9 had a cranial bone fracture, 4 had a hemorrhage, and 8 had edema). Abdominal injuries were seen in 15 patients. Damage to the liver in 10 patients, spleen in 5 patients, stomach in 3 patients, colon in 3 patients, small intestine in 1 patient, and kidney in 1 patient was detected. Liver and spleen injuries were present in 2 of the patients with liver injury. No abdominal surgery was performed in 4 patients who were followed up in our clinic due to thoracic trauma and additionally had the liver injury. Of the patients with limb fractures, 11 had humerus, 9 had hand bones, 8 had pelvis, and 8 had foot bone fractures (Table 2).

The difference between the operations performed by our clinic between the groups was statistically significant between Groups II and III and between Groups I and III ($p < 0.05$). The difference between all blunt trauma patients and penetrating trauma patients was statistically significant when thoracotomy was taken as a baseline. No statistical difference was found between Group I and Group II.

The hospital stay of patients with chest tubes was 28 ± 8.2 days in Group I, 10 ± 1.4 days in group II and 7.4 ± 3.2 days in Group III. Group I had more extended hospital stays due to extremity, pelvis, vertebral, abdominal, and cerebral injuries. Patients hospitalized due to penetrating injury were followed up in our clinic for a minimum of 1 day and a maximum of 122 days.

While mortality in penetrating injuries developed due to extensive vessel injuries, it was seen due to flail chest and other organ injuries in blunt traumas (Table 3). No mortality was observed in Group I. While mortality in Group II was 10.5% above the age of 45, 6.3% under the age of 45. Mortality in Group III was 8.7% above 45 years of age and 1.9% under 45 years of age (Table 4).

	A) Penetrating		B) Blunt
1.	Vena cava injury	1.	Multiple rib fractures, intraparenchymal contusion
2.	Cardiac injury	2.	Flail chest, Multiple rib and extremity fractures
3.	Pulmonary vein injury, flail chest	3.	Flail chest, cardiac arrest
4.	Pulmonary artery injury,	4.	Cerebral injury, bilateral multiple rib fracture, hemothorax and pneumothorax
		5.	Flail chest, multiple rib and cervical vertebra fracture
		6.	Flail chest, intraparenchymal contusion, multiple rib fractures, subarachnoid hemorrhage
		7.	Flail chest, multiple rib fractures, cerebral contusion
		8.	Flail chest, cervical fracture
		9.	Flail chest, cardiac contusion
		10.	Flail chest, intraparenchymal contusion, pelvic fracture
		11.	Multiple rib fractures, intraparenchymal contusion, cardiac arrest
		12.	Hemothorax, Liver laceration, pelvic fracture, bladder rupture
		13.	Cerebral injury, Hemopneumothorax
		14.	Flail chest, bilateral hemopneumothorax, diffuse intraparenchymal contusion
		15.	Multiple rib fractures, intraparenchymal contusion, hemopneumothorax, splenic rupture
		16.	Cerebral injury, hemopneumothorax
		17.	Cerebral injury, hemopneumothorax
		18.	Cerebral injury, abdominal injury, hemopneumothorax
		19.	Cerebral injury, flail chest, hemothorax

Table 3: Death causes.

When all trauma patients were taken into account, the mean age was 37, while the mean age of the patients with mortality was 51. There were nineteen deaths in group II and four deaths in Group III (Table 4).

	Group I (n = 64)			Group II (n = 220)			Group III (n = 130)		
Age	Number	Mortality	%	Number	Mortality	%	Number	Mortality	%
0-44	47 (%73.4)	0	0	96 (%43.6)	6	6.3	107 (%82.3)	2	1.9
≥45	17 (%26.6)	0	0	124 (%56.4)	13	10.5	23 (%17.7)	2	8.7

Table 4: Mortality numbers of groups by age groups.

Mortality development rate over 45 years of age in Group II and Group III was statistically significant compared to the Group below 45 years of age ($p < 0.005$). When all patients were evaluated, 8 out of 250 patients under 45 years of age died, while 15 mortality occurred in 164 patients over 45 years of age. The difference was statistically significant ($p < 0.01$) (Table 4).

Trauma scores

While the mean ISS of all trauma patients was 11 and the mean of NISS was 19, the mean ISS of our patients with mortality was 21, and the mean of NISS was 36. In penetrating traumas with mortality, the smallest ISS score was 16 points, the highest ISS score was 26 points, and the smallest NISS score was 22 points, while the highest NISS score was 35 points. In blunt trauma, the smallest ISS score was 9 points, the highest ISS score was 45 points, and the smallest NISS score was 34 points, while the highest NISS score was 57 points (Table 5).

		Group I (n = 64)		Group II (n = 220)		Group III (n = 130)	
		Number	Mortality	Number	Mortality	Number	Mortality
ISS	0-15	39	0	152	1	101	1
	16-24	13	0	41	7	15	1
	>24	12	0	27	11	14	2
NISS	0-15	32	0	73	0	60	0
	16-24	13	0	56	0	41	1
	>24	19	0	91	19	29	3

Table 5: Number of injuries and mortality in groups according to ISS and NISS score groups.

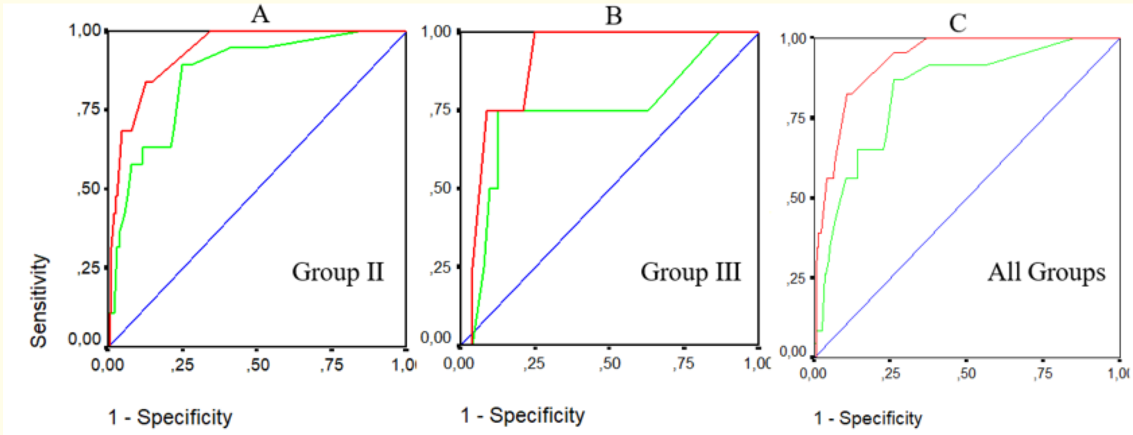
No mortality was observed in. Group I. While seven mortality was observed with ISS scores 16-24 points in Group II and Group III was observed one mortality (Table 5).

In Groups II and III, the difference in mortality between patients with an ISS score below 15 and patients with an ISS score above 15 was found to be statistically significant ($p < 0.05$).

According to NISS scoring, nineteen mortality in Group II was seen in those more than 24. In Group III, three mortality were seen in those more than 24, and one was observed between 16-24 scores (Table 5).

In Group II, the difference in mortality was statistically significant between patients with NISS scores less than 24 and more than 24 ($p < 0.005$). No statistically significant difference was found in Group III.

The ISS and NISS data of the groups were compared with the ROC curve. The resulting graph is presented below. The closer the ROC curve is to 1,00 values, the more significant. The measured value of NISS values is closer than ISS values. Therefore, NISS values showed better mortality than ISS (Graph 1A-C).



Graph 1: ROC curve of ISS and NISS data of patients with Group II-III and all Groups.

The ROC curve was calculated as ISS: 0.86 and NISS: 0.93 for patients with blunt trauma. (Graph 1A). The ROC curve was calculated as ISS:0.62 and NISS:0.85 for penetrating injuries (Graph 1B). The ROC curve of all patients followed up in our clinic revealed NISS: 0.88, ISS: 0.64 ($p < 0.05$) (Graph 1C). Cut off value for blunt traumas ISS:15, NISS:30.5, for penetrating injury ISS: 19.5, NISS:20.5, and for all traumas ISS: 16.5 (0.79), NISS: It was calculated as 31.5(0.91) (Graph 1C).

Discussion

Thorax traumas are most common in men and grades 2-5. It is observed in decades (mean age of 40 years) [1]. Men constituted 83,1% of the patients who applied to our hospital, and they were in grades 2-3. decade patients were in the majority (49.2%). This is due to the large population of young people in our country.

Non-penetrating chest injuries are more common in developed societies. The most common type of trauma among blunt traumas is traffic accidents, with a rate of 70-80% [1]. 66% of blunt and 34% of penetrating injuries were seen in our clinic. 78% of blunt traumas were developed after traffic accidents. Also in 57% of all traumas additional system injuries were present.

Flail chest and contusion coexistence are a serious problem that can cause respiratory failure. Voggenreiter reported 10.4% of flail chest in a study of 405 patients [7]. In my series, flail chest was seen in 9.4% of all patients, 8.6 % of patients with blunt trauma, and 0.8% of patients with penetrating injuries. In Beg., *et al.*'s series of 100 patients with flail chest, two cases developed flail chest due to penetrating injury [8]. Patients with flail chest mortality varies between 10-40% in various studies [9,10]. Mortality is 50% in the patients with flail chest in our clinic.

Mortality increases due to serious extrathoracic injuries accompanying the event. The patients with flail chest in our series had severe head trauma, and 4 of these patients died. Clark., *et al.* and Relihan., *et al.* reported that mortality rates increased in thoracic traumas with head trauma and were 39% and 86%, respectively [9,11]. Nine of our 20 patients' deaths were due to the coexistence of head trauma and thoracic trauma.

The increase in mortality depends on the type of trauma, associated organ injuries, and the patient's age [1]. Studies have reported that the mortality rate in blunt trauma is 1-8% [1,6,12]. In our clinic, the mortality rate in patients with blunt multi-trauma was 0.08%, The cause of mortality in patients with penetrating injuries was the heart and great vessel injury.

It is accepted that another factor affecting mortality is age. Liman., *et al.* reported that mortality increased in patients over 60 years of age and that there was no relationship between mortality and the nature of trauma. Ziegler., *et al.* reported that elderly patients had a high mortality rate even if the ISS score was low [1,13]. These findings suggest that even less severe trauma can result in lethal outcomes for the elderly. In our series, the mortality rate was found to be significantly higher in cases aged over 45 years.

It has been reported the risk of mortality increases in traumas with an ISS value of 15 points and above [4]. In our series, mortality was significantly higher in patients with ISS value above 15 points and NISS values above 24 points. However, it has been suggested that the ISS is insufficient in traumas with more than one injury in a system [14,15], especially in penetrating injuries [16]. In their study, Osler., *et al.* compared NISS and ISS using Oregon region data (n = 3449) and Albuquerque data (n = 3136) in 1997. When ROC analysis was applied to the results, they found NISS: 0.896, ISS: 0.869 ($p < 0.001$) for Albuquerque data, NISS: 0.907, ISS: 0.896 ($p < 0.004$) for Oregon data, and they claimed that NISS was superior to ISS [6]. Brenneman., *et al.* reported a 68% difference between the data in the two scoring systems in their study conducted in 1998 using data from 2328 patients [17]. When ROC analysis was performed, NISS was calculated as 0.852, ISS: 0.799 ($p < 0.001$), and it was estimated that NISS was superior to ISS. Again, a similar study result was obtained by Balogh., *et al.* and Tamim H., *et al.* [18,19]. The ROC curve of all patients followed up in our clinic revealed NISS was calculated as 0.91, ISS: 0.79 ($p < 0.05$). The NISS has been shown to be more accurate in predicting mortality than the ISS as in our study in both penetrating injuries and blunt traumas.

Conclusion

Over 45 years of age and the complexity of the trauma and its involvement in more than one system are important factors that increase mortality risk. Intrathoracic great vessel and heart injuries in penetrating traumas, other system injuries in blunt traumas, and flail chest and contusion coexistence are the most important causes of mortality.

Studies with scoring systems are generally valid for multi-trauma patients. The ISS is insufficient, especially if multiple injuries are in a single system. In the retrospective analysis performed in our clinic, considering the data obtained, it was seen that NISS gave more accurate results than ISS. Therefore, NISS should be regarded as a more reliable scoring system, especially in the presence of isolated thoracic trauma. However, every trauma scoring system inevitably has some handicaps. The data obtained by minimizing these handicaps will increase the quality of treatment and clinical success in trauma patients.

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