Effects of additional intra-abdominal organ injuries in patients with penetrating small bowel trauma on morbidity and mortality

Penetran ince bağırsak yaralanmalarında ek organ yaralanmasının morbidite ve mortalite üzerine etkisi

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BACKGROUND

We aimed to evaluate the effects on morbidity and mortality of additional organ injuries obtained concurrently with penetrating small bowel injuries.

METHODS

Between January 2000 and March 2005, patients in whom penetrating small bowel injuries occurred as a result of abdominal injuries were allocated into two groups and assessed. The first group included patients with isolated small bowel injuries, while those in the second group had small bowel injuries together with other intra-abdominal organ injuries.

RESULTS

Small bowel injury was identified in 38 patients (34 M, 4 F) with an average age 38.1±8.86 (17-53) years (Group I: 20 patients; Group II: 18 patients). The PATI (penetrating abdominal trauma index) values of the first and second groups were 6.2±2.58 and 17±6.36, respectively, and the difference was statistically significant ($p<0.001$). Complication rates were 23.68% for the whole group, 5% in group I and 44.8% in group II. The rate was significantly higher in group II ($p<0.01$). Mortality was 2.63% and it was not related to intestinal injury.

CONCLUSION

Isolated penetrating small bowel injuries are amenable to treatment with lower complication rates. Additional organ injury increases the development of complications. Injury severity score (ISS) and PATI may be useful for estimating the risk of development of complications.

Key Words: Complication; penetrating injury; small bowel injury; trauma; trauma scoring system.

AMAÇ

İnce bağırsak yaralanmalarında ek organ yaralanması varlığının komplikasyon ve mortalite üzerine etkileri değerlendirildi.

GEREÇ VE YÖNTEM

2000-2005 yılları arasında kliniğimizde penetran karın yaralanması sonucu ince bağırsak yaralanması olan hastalar iki gruba ayrılarak değerlendirildi. Grup I'de izole ince bağırsak yaralanmaları, grup II'de diğer karın organları ile birlikte ince bağırsak yaralanması olan hastalar toplandı. Bu iki gruptaki hastaların verileri karşılaştırıldı.

BULGULAR

Yaş ortalaması 38,1±8,86 (dağılım 17-53) olan 38 hastada (34E, 4K) ince bağırsak yaralanması saptandı; olguların 20'si grup I'de, 18'i grup II'de yer aldı. İki grubun sırası ile PATI (penetrating abdominal trauma index) değerleri 6,2±2,58, 17±6,36 idi, grup II'de anlamlı olarak daha yüksekti ($p<0,001$). Toplam komplikasyon oranı %23,68 bulundu; grup I'de %5, grup II'de %44,8 olup anlamlı olarak yüksekti ($p<0,01$). Yatış süresi grup II'de anlamlı olarak yüksekti (grup I: 5,95±4,63 gün, grup II: 9,38±3,8 gün) ($p<0,01$). Mortalite oranı %2,63 olup, ince bağırsak yaralanmasına bağlı değildi.

SONUÇ

İzole ince bağırsak yaralanmaları düşük komplikasyon oranları ile tedavi edilebilir. İnce bağırsak yaralanmalarında ek organ yaralanmasının varlığı komplikasyon gelişimini arttırmaktadır. Yaralanma Şiddeti Ölçeği (ISS) ve PATI skorları komplikasyon gelişimi riskini tahmin etmede kullanılabilir.

Anahtar Sözcükler: Komplikasyon; penetran yaralanma; ince bağırsak yaralanması; travma; travma skorlama sistemleri.

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The small bowel is an organ that takes up a large part of the abdomen and is the most often injured.[1,2] While small bowel injury occurs in 60-80% of patients with gunshot injuries penetrating the abdomen, injury occurs in only 30% of patients involved in stabbings.[3-5] However, small bowel injuries may occur with various abdominal injuries and are dependent on injury type and severity. Morbidity and mortality rates are also influenced by other injuries.[6-8]

In our study, we compared clinical situations and severity of injury by the trauma score system of cases treated in our clinics. In intestinal injuries, we evaluated the effects of additional intra-abdominal organ injuries on complications and mortality and the factors related to development of complications.

MATERIALS AND METHODS

Data from patients with small bowel injuries due to penetrating abdominal injury occurring between January 2000 - March 2005 and treated in our clinic were retrospectively assessed. Patients with small bowel injuries were evaluated by allocating them into two groups. The first group included patients with isolated small bowel injuries, while those in the second group had small bowel injuries and other intra-abdominal injuries additionally (nonisolated). Age, gender, type of injury, ISS (injury severity score),[9] PATI (penetrating abdominal trauma index),[10] preoperative period (time between injury and surgery), presence of preoperative hypotension (systolic blood pressure under 90 mmHg despite the replacement therapy), other wounded body parts, operation time, abdominal complications, mortality, and the length of hospital stay of the patients in these groups were compared. Additionally, in patients with and without complications, age, type of injury formation, preoperative time, presence of preoperative hypotension, operation time, colon injury, additional organ injury, ISS, PATI, and length of hospital stay were compared.

An ISS of 15 and below was considered a minor trauma and above 15 as a major trauma. Patients with PATI scores above and below 15 were compared with respect to the development of complications.

Patients with a gunshot injury, hemodynamic instability, peritoneal irritation symptoms or evisceration in omentum or intestines were taken into mandatory laparotomy after emergency room treatment. In the first two years of the study, all patients with stab injuries were explored. In the last three years, patients with injuries due to stabbing with abdominal penetration, but without clinical signs and hemodynamic instability, were taken into observation and operated when the positive clinical signs and laboratory findings appeared (selective approach).

To compare the data, Mann-Whitney U test and Fisher's exact test were used. A value of $p<0.05$ was accepted as significant.

RESULTS

During this period, at least one abdominal organ injury was found following a penetrating abdominal injury in 90 patients. A total of 142 abdominal organ injuries occurred. The commonly injured organs

Table 1. Distribution and statistical comparison of group properties

	Group I (n: 20)	Group II (n: 18)	Total (n: 38)	p
Age (y)	30.45±8.45 (17-53)	33.94±9.19 (19-48)	32.1±8.87 (17-53)	0.188
Gender (F / M ratio)	4 / 16	0 / 18	4 / 34	0.107
Injury mechanism (SW / GSW)	3 / 17	9 / 9	12 / 26	0.035
Associated extra-abdominal injury (yes / no)	3 / 17	5 / 13	8 / 30	0.44
Presurgery time (hours) <6 h / >6 h	12 / 8	15 / 3	27 / 11	0.160
Preoperative hypotension (yes / no)	2 / 18	9 / 9	11 / 27	0.011
Surgery time (hours)	2.3±0.47 (2-3)	2.8±0.67 (2-4)	2.54±0.62 (2-4)	0.014
ISS	10.9±6.02 (4-29)	14.5±7.65 (4-34)	12.6±6.99 (4-34)	0.75
PATI	5.9±2.2 (2-10)	17±6.36 (6-28)	11.16±7.25 (2-28)	0.001
Complications (yes / no)	1 / 19	8 / 10	9 / 29	0.007
Mortality (yes / no)	1 / 19	0 / 17	1 / 37	1
Hospital stay (days)	5.95±4.64 (0-24)	9.39±3.82 (3-18)	7.58±4.56 (0-24)	0.001

SW: Stab wound; GSW: Gunshot wound; ISS: Injury severity score; PATI: Penetrating abdominal trauma index.

Table 2. Clinical signs of patients and diagnostic radiological procedures

	Group I (n: 20)	Group II (n: 18)	Total (n: 38)
Hemodynamic instability	2 (10%)	9 (50%)	11 (28.94%)
Peritoneal irritation			
Yes (%) / No (%)	17 (85) / 3 (15)	14 (77.77) / 4 (22.22)	31/38 (81.57)
Bowel evisceration			
Yes (%) / No (%)	3 (15) / 17 (85)	1 (5.55) / 17 (94.45)	4 (10.53) / 34 (89.47)
Omental evisceration			
Yes (%) / No (%)	2 (10) / 18 (90)	1 (5.55) / 17 (94.45)	3 (7.89) / 35 (92.11)
CT			
Yes (%) / No (%)	2 (10) / 18 (90)	1 (5.55) / 17 (94.45)	3 (7.89) / 35 (92.1)
USG			
Yes (%) / No (%)	1 (5) / 19 (95)	3 (16.67) / 15 (83.33)	4 (10.53) / 34 (89.47)

were the small bowel [38 (43.8%)], colon [30 (33.3%)], liver [24 (26.66%)], and stomach [14 (15.55%)]. There were other organ injuries but at much lower frequencies. The average age of the 38 patients (34 M, 4 F) in whom small bowel injury was determined was 38.1±8.86 (17-53). Groups I and II included 20 and 18 cases, respectively. The distributions of group properties are summarized in Table 1. Clinical signs of patients and diagnostic radiological procedures are shown in Table 2. Peritoneal irritation was found in 31 of the 33 patients who cooperated and were examined abdominally. Intestinal evisceration was identified in two other patients without irritation signs. Five patients chose not to cooperate, so hemodynamic instability for irritation was not assessed completely. In these cases, irritation findings were considered as absent. Abdominal computed tomographic (CT) scans were performed in three patients. Intra-abdominal free fluid was observed in two of them, one of whom also had pneumoperitoneum. No pathological finding was determined in the other patient. Abdominal ultrasonography (USG) was performed in four cases. Intra-abdominal free fluid was determined in two of four cases, and a non-compressed, non-motile intestinal loop was determined in one case in USG. There were no pathological findings in the other patient. In the second group, there were 23 additional intra-abdominal organ injuries. The distribution of the injuries is presented in Table 3. Additional body part injury was determined in eight patients, and the resulting data is summarized in Table 4. There were two body part injuries in a patient from the second group. Multiple small bowel injuries were determined in nine patients included in the study. Primary repair was applied to five of these, and resection and anastomosis were applied to four. In the other 29 patients, a single small bowel injury was identified. Primary repair was applied to 20, and resection and anastomosis were applied to the remaining nine. Resection-anastomosis and primary repair were all applied manually and on two layers.

No significant differences between the two groups were determined with respect to age, gender, ISS or preoperative duration ($p>0.05$). Operative time was 2.3±0.47 h in the first group and 2.8±0.67 h in the second group. The operative time in group II was significantly higher ($p<0.05$), due to the neces-

Table 3. Distribution of the additional organ injuries in group II

Injury	No. of patients
Colon	13
Stomach	4
Duodenum	1
Ureter	1
Common iliac artery	1
Common iliac vein	1
Colonic mesentery	2
Total	23

Table 4. Distribution of the injured additional extra-abdominal body parts

Associated extra-abdominal injury	Group I (n: 20)	Group II (n: 18)
Head		1
Neck		1
Chest	1	2
Lower extremity	2	2
Total	3	6

Table 5. Distribution of the complications

Complications	Group I (n: 20)	Group II (n: 18)
Intra-abdominal abscess	1	2
Wound infection	1	7
Total	2	9

sary repair of additional organs in this group. PATI values were 6.2±2.58 and 17±6.36, in groups I and II, respectively, and the difference was statistically significant (p<0.001). Gunshot injury was significantly higher in the second group (p<0.05). Additional organ injury occurred in 75% of gunshot injuries and 34.6% of stab injuries. The preoperative presence of hemodynamic instability was significantly higher in the second group (p<0.05).

The complication rates were 23.68%, 5% and 44.8% in the whole group, group I and group II, respectively, and the difference between the two study groups was significant (p<0.01). The distribution of complications is given in Table 5. In total, 11 complications occurred in nine patients, and there were two complications in two patients from group II. There was no leakage from the site of intestinal repair, and no anastomosis was applied in patients with complications. The length of the hospital stay was significantly higher in group II (p<0.01). Mortality occurred in one case (2.63%), but it was not related to the small bowel injury.

When patients with and without complications were compared, gunshot injury (p<0.05), additional organ injury (p<0.01), PATI (p<0.05), ISS (p<0.05), and length of hospital stay (p<0.001) were all significantly higher in patients with complications (Table 6).

DISCUSSION

Penetrating abdominal injuries are a major urban problem. While small bowel injuries are mostly seen, colon or liver injuries follow according to the various series.[5,11-15] The distribution of injured organs in our current abdominal injury cases corresponded to the distribution rates in the literature. Among these injuries, those of the small bowel were the most common. This indicates that in the management of trauma patients who have sustained penetrating abdominal injury, trauma personnel should have high suspicion regarding the presence of small bowel injury.

Table 6. Comparison of data between patients with and without complication

	Complication (yes) (n: 9)	Complication (no) (n: 29)	p
Age (y)	32.78±7.68	31.90±9.3	0.543
(min-max)	(20-48)	(17-53)	
Injury mechanism	3 / 6	23 / 6	0.016
SW / GSW	33.3% / 66.7%	79.3% / 20.7%	
Extra-abdominal injury (yes / no)	5 / 4	25 / 4	0.41
	55.6% / 44.4%	86.2% / 13.8%	
Presurgery time (hours) <6 h / >6 h	8 / 1	19 / 10	0.237
Preoperative hypotension (no / yes)	5 / 4	22 / 7	0.41
	55.6% / 44.4%	75.9% / 24.1%	
Surgery time (hours)	2.78±0.67	2.47±0.67	0.197
	(2-4)	(2-4)	
Colonic injury (no / yes)	4 / 5	21 / 8	0.226
	44.4% / 55.6%	72.4% / 27.6%	
Associated intra-abdominal injury (yes / no)	8 / 1	10 / 19	0.007
ISS	2 / 7	21 / 8	0.016
<15 / >15	22.2% / 77.8%	72.4% / 27.6%	
PATI	4 / 5	24 / 5	0.036
<15 / >15	44.4% / 55.6%	82.8% / 17.2%	
Hospital stay (days)	13.66±4.8	5.89±2.06	0.0001
	(8-24)	(2-11)	

SW: Stab wound; GSW: Gunshot wound.

In this study, PATI score, rate of gunshot injury, rate of preoperative hypotension and operation time were significantly higher in the group with additional organ injury. PATI increased with the increases in intra-abdominal injury intensity and number of organs injured.[10,16,17] In this respect, this higher score in additional organ injury was an anticipated situation. Although the ISS score was higher in the group with additional organ injury, there was no statistical difference between the groups. Even if more than one abdominal organ had been injured, we think the lack of significant differences between their ISS values can be attributed to the fact that the organ with the highest injury score had already been taken into account and the injuries of other body parts were similar between the two groups. In the study conducted by Hackam et al.,[7] ISS was determined to be significantly higher in the group with additional organ injury. This significance was attributed to the head and orthopedic injuries of this group. We think that the level of preoperative hypotension in group II is related to the increased severity of intra-abdominal injury due to the other organ injuries. The level of the PATI score in this group supports this idea.

In our study, 75% of gunshot injuries were placed in the group with additional organ injury, while 25% were in the group with isolated small bowel injury. There were isolated injuries in 65.4% of patients with stab injuries. In gunshot injury, there was more risk of intra-abdominal injury related to the kinetic energy that forms the injury.[7] In 53 to 78% of gunshot injuries, there were intra-abdominal injuries that needed to be treated.[14,18,19] Multiple organ injuries were identified in 75% of these patients.[5,20]

Although it was reported that USG and CT decreased the negative laparotomy percentage in penetrating abdominal injuries,[12] clinical assessment is a specific and fairly advantageous indication of laparotomy.[8,19,21] In selective treatment of penetrating abdominal injuries with accurate, careful and recurrent clinical examination, excellent results were reported.[14,19,22] In our study, clinical evaluation was the first approach, with the exception of two cases in whom intestinal evisceration was clinically appraisable. Peritoneal irritation findings occurred in all other cases.

While 5-13% mortality was reported in all small bowel injuries, most of the fatalities were due to other additional injuries.[6-8,23-26] However, in contrast to other studies in the literature, our study found a lower rate of mortality (2.6%) was not related to small bowel injury like in other studies. This might be due to our evaluation of only small bowel injury among patients surgically treated for penetrating abdominal injury, as patients who were dead on arrival, who expired before the operation, or in whom intestinal injury was determined were not included in this study.

Abdominal complication rates of 23% were reported in penetrating small bowel injuries.[7,8] In our study as well, the abdominal complication rate was 23.7%, with a rate of 5% in group I and 44% in group II. In the latter group, the complication rate was significantly higher. Additionally, in this group, length of hospital stay was significantly higher in relation to the level of complication rates. In our opinion, this situation was related to the higher intensity of injury due to the injury of other organs. Hackam et al.[7] also reported significantly higher complication rates in the group with additional organ injuries.

Borlase et al.[27] indicated that PATI was the scoring system to be used for the prediction of intra-abdominal sepsis risk in both penetrating and blunt abdominal trauma. In Croce et al.'s[28] study, PATI was found to correlate closely with development of abdominal septic complications in blunt trauma, but it performed less well with respect to penetrating trauma. However, for the more severely injured patients (ISS>15), ISS correlated well with the development of intra-abdominal infection.[28] In a study conducted by Öztürk et al.[15] in children with penetrating abdominal injury, they identified both PATI and ISS as major independent factors in the estimation of complications. In our study, the PATI score was significantly higher both in patients with additional organ injuries and in patients with complications. Although the ISS score was similar between the two groups, it was significantly higher in patients with complications.

In penetrating abdominal injuries, many risk factors other than ISS and PATI affect the development of complications. For example, age, gender, trauma mechanism, number of injured organs, and the presence of colon injury were all identified as risk factors using multivariate analysis.[29,30] Many studies reported that preoperative shock didn't have significant effects on development of complications.[8,15,16,30] In our study, although the presence of hypotension

was significantly higher parallel to injury severity within the second group, with respect to complication development, a significant effect was not determined, as found in other studies.

In small bowel injuries, many studies have indicated that in delays of less than 24 hours, the complication rate did not increase, but in delays of more than 24 hours, the risk of developing complications increased significantly.[23,25] Further, Bensard et al.[31] reported that in children, complications did not increase in delays up to 56 hours. Our study supports the idea that a limited delay does not affect the development of complications. This is most likely due to the fact that although the complication rate was high in patients with additional organ injuries, 83.3% of these patients were surgically treated within six hours of injury occurrence. However, only 60% of patients in the isolated intestinal injury group, where the complication rate was apparently low, were surgically treated within the initial six hours.

In some studies, no effect of injury type on development of the complications was determined by multivariate analysis.[15,30] In our study, complication development was significantly higher following a gunshot injury. Based on our findings, gunshot injury increases the likelihood of complications by causing multiple organ injuries, higher intra-abdominal trauma intensity and destructive effects on tissues.

The type of treatment (primary or resectional anastomosis) and manual or staple applications did not significantly influence the development of complications.[6,8,31-33]

Consequently, mortality is generally related to additional organ injuries, rather than to the intestinal injuries. Isolated intestinal injuries can be treated with lower complication rates. In intestinal injuries, the presence of additional organ injuries increases the development of complications. Gunshot injury may increase the complication risk by frequently causing additional organ injuries. The presence of additional organ injuries also extends the period of the hospital stay by making the injury more complex and increasing the risk of complication development. Additionally, we conclude that ISS and PATI scores may be useful parameters in indicating the risk of complication development. Especially high ISS and PATI scores should be monitored closely to gauge the risk of complication development.

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