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## Treatment of colorectal injuries in the civil war and the factors affecting mortality

**AIM:** Colorectal injuries are one of the most common causes of mortality in war. Mainstay treatment of these injuries include primary repair or stoma creation.

**METHODS:** Clinical data of the patients were evaluated retrospectively. Time from injury to hospital admission, method of treatment, the colorectal area affected, injury severity score ISS, hemodynamic instability, and mortality rate were determined.

**RESULTS:** Of the 61 patients included in the study. Mean time from injury to hospital admission was 160±19 minutes. The injury was in the right colon in 24 patients 39.3%, in the left colon in 18 29.5%, and in the rectum in 19 31.2% patients. Median ISS value of 61 patients was 16, IQR 5. Mortality and complication rates were higher in patients with hemodynamic instability and stoma requirement was also higher in this group  $p<0.05$ . Total mortality occurred in 15 24.5% patients. Of these, 10 66.6% patients had hemodynamic instability.

**DISCUSSION:** Hemodynamic instability is the most important factor affecting the mortality and the treatment method in wartime colorectal injuries.

**CONCLUSION:** We believe that in victims of war with colorectal injuries, surgical intervention before the development of hemodynamic instability may reduce the rate of mortality and stoma requirement.

**KEY WORDS:** Colorectal injury, Firearm injury, Hemodynamic instability, Stoma

## Introduction

Despite the improvements in diagnostic and therapeutic techniques, colorectal injuries caused by high-velocity firearms are still an important source of morbidity and mortality<sup>1,2</sup>. Mainstay treatment of colorectal injuries is the surgical control of the injury. However, the surgical techniques described in the literature have changed in recent decades. In the past, stoma creation was the primary surgical treatment method, whereas today primary repair techniques have become highly popular. There are numerous factors that have led to this change. Of the

se, the most important ones include improved triage and resuscitation procedures, effective use of anesthesia techniques and agents, improvements in antibiotics, improvements in the transfusion of blood and blood products, and improved transportation techniques used in the medical evacuation of the victims to out of the battle zone<sup>3,4</sup>.

The aim of this study was to evaluate the treatment methods performed in colorectal traumas caused by high-velocity firearms in a medical center close to the battle zone and to determine the factors affecting mortality.

## Methods

The retrospective study included 68 patients who were admitted to our general surgery clinic due to colorectal injuries that occurred in a civil war in a neighboring country between 2010 and 2016. Of the

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68 patients, 64 had been injured by high-velocity firearms, 3 with a cutting-piercing instrument, and 1 with a low-velocity firearm. Since the aim of our study was to determine the surgical technique and morbidity and mortality in colorectal injuries caused by high-velocity firearms, the four patients who were injured by cutting-piercing tools and low-velocity firearms and the three patients who were injured in war and operated on in our hospital but were transferred to other health centers for various reasons were excluded from the study. The remaining 61 patients were the patients that had colorectal injuries caused by high-velocity firearms in the war zone or by shrapnel resulting from bomb explosions. Age, gender, mechanism of injury firearm or shrapnel, time from injury to hospital admission, systolic pressure, and the organs affected were recorded for each patient. Trauma scores were evaluated using Abbreviated Injury Scale and Injury Severity Score ISS<sup>5,6</sup>. The patients that retained a systolic blood pressure of less than 90 mmHg despite receiving 2000 cc ringer lactate or transfusion of blood and blood products were accepted as hemodynamically unstable. The surgical procedure employed stoma or primary repair, the amount of erythrocyte suspension administered, complications and mortality rate were also recorded. The study was approved by Local Ethics Committee.

#### STATISTICAL ANALYSIS

Data were analyzed using SPSS 21.0 for Windows SPSS Inc., Chicago, IL, USA. Student's t-test was used to analyze the demographic data of the patients. Two-way analysis of variance for repeated measures was used to analyze the changes that developed over time. To analyze ordinal data, Mann-Whitney U test and 2 test were used with appropriate corrections. Continuous variables were presented as mean $\pm$ SD or median range. A *p* value of <0.05 was considered significant.

#### Results

The 61 patients included 7 11.5% women and 54 88.5% men with a mean age of 27.3  $\pm$  8.3 years. Mean time from injury to hospital admission was 160  $\pm$  9 minutes. Forty-two 68.9% patients were injured by firearms and nineteen 31.1% with shrapnel.

The injury was localized in the right colon in 24 39.3%, in the left colon in 18 29.5% and in the rectum in 19 31.2% patients. Of the 42 patients injured by firearms, 39 63.9% patients underwent stoma creation and 22 36.1% patients underwent primary repair. Of the 19 patients injured by shrapnel, 7 36.8% patients underwent primary repair and 12 63.2% underwent stoma creation. No statistical difference was found between the groups in terms of mechanism of injury and treatment

methods *p*=0.321. The mean time from injury to hospital admission was 186  $\pm$  9 minutes in the stoma group and 144  $\pm$  17 minutes in the primary repair group and a significant difference was found between the two groups *p*=0.047.

Twenty-four patients had right colon injuries. Of these, 12 50% patients underwent primary repair and 12 50% underwent stoma creation. Eighteen patients had left colon injury, of which 8 44.4% patients underwent primary repair and 10 55.6% patients underwent stoma creation. Nineteen patients had rectal injuries, of which 2 10.6% patients underwent primary repair and 17 89.4% patients underwent stoma creation. Stoma creation was the most commonly performed method in rectal injuries.

Median ISS value of 61 patients was 16 IQR 5, 19 IQR 5 in the stoma group and 14 IQR 4 in the primary repair group. Median ISS value in the patients with rectal injuries was 18, IQR 5 with left colon injuries was 16, IQR 11 with right colon injuries was 15, IQR 5. Of the 46 patients who survived postoperatively, no complication occurred in 30 65.2% patients but the remaining 16 34.8% patients had various complications including anastomotic leakage *n*=2; 4.3%, wound site infection *n*=8; 17.3%, and intra-abdominal abscess *n*=6; 13.2%. Of the 16 patients with complications, 11 patients had hemodynamic instability. Postoperative complications were more common in the stoma group but no significant difference was found between the groups *p*=0.078. Complications occurred in 12 30.7% patients in the stoma group as opposed to 6 27.2% patients in the primary repair group.

Mortality occurred in 15 24.5% patients. No significant relation was observed between age and injury site and mortality *p*=0.318, *p*=0.957, whereas a significant relation was found between time from injury to hospital admission and mortality *p*=0.04. Mean time from injury to hospital admission was 195  $\pm$  28 minutes in the mortality group and 146  $\pm$  13 minutes in the survival group. Median ISS value was 17, IQR 11 in the mortality group and 16, IQR 5 in the survival group. The median count of the transfused erythrocyte suspension units in the patients was 5, IQR 2 in the mortality group and 1 IQR 2 in the survival group. The mortality group received significantly higher numbers of erythrocyte suspension units compared to the survival group *p*=0.001. Hemodynamic instability was present in 24 patients, with 10 66.6% patients in the mortality group and 14 30.4% patients in the survival group, and the difference was statistically significant *p*=0.001.

In the 24 patients with hemodynamic instability, mean time from injury to hospital admission was 198  $\pm$  20 minutes, median ISS value was 19, IQR 5 and the mean number of erythrocyte suspension units transfused was 6.4 units. These values were significantly higher compared to hemodynamically stable patients *p*=0.002, 0.001, and 0.001, respectively.

## Discussion

The results indicate that high ISS value, prolonged time from injury to hospital admission time, and hemodynamic instability were found to be important factors affecting the mortality in colorectal injuries caused by high-velocity firearms. It was also determined that the same factors were effective on the treatment method as well. Until the beginning of the last century, the inevitable end for the patients with colorectal trauma caused by firearms was absolute death. With the introduction of fecal diversion operations in later years, the mortality rates significantly decreased. Therefore, during the World War II, military surgeons were instructed to perform fecal diversion operations in victims with colorectal trauma. Over the last 50 years, primary repair or resection-anastomosis techniques have become highly popular and their mortality rates have been found to be similar to those of fecal diversion operation<sup>3,7</sup>.

The factors affecting the treatment methods for colorectal injuries have been extensively investigated in the literature. With the development of technological vehicles, it has become possible to transport victims from the war zone to health centers more rapidly. Rapid transfer gives the opportunity of surgical intervention before complete impairment of hemodynamic status and development of widespread peritoneal contamination. This may be one of the reasons why primary repair and anastomosis techniques have become widespread<sup>8,9</sup>. However, this is directly proportional to the economic and technological powers of the warring sides and can be a decisive factor in wars between regular armies. In recent years, civil wars have occurred in various countries and some of them are still continuing. In such wars, transportation of the victims to safe areas and to medical facilities is delayed due to various factors such as underdeveloped technological and economic conditions, ruined roads, and collapsed health system<sup>10</sup>. In our study, time from injury to hospital admission was determined as an important factor both in determining the method of treatment and in mortality. In addition, a close relationship was found between prolonged time from injury to hospital admission and hemodynamic instability. It was also revealed that as the time from injury to hospital admission increased, the rates of mortality and stoma requirement also increased. Depending on these findings, we postulate that prolonged time from injury to hospital admission causes hemodynamic instability, thus affecting the type of treatment and mortality.

The biggest problem in the early stages of injuries caused by high-velocity firearms is continuous bleeding. If the bleeding cannot be stopped immediately and the proper resuscitation is not initiated, lethal triad consisting of acidosis, hypothermia and coagulopathy is inevitable<sup>11</sup>. Patients that retain a blood pressure of less than 90 mmHg despite adequate fluid resuscitation can be

considered hemodynamically instable. The administration of fluid and transfusion of blood and blood products in hemodynamically instable patients before the bleeding is stopped can accelerate the development of the lethal triad. Attempting to perform the final operation in these patients leads to time loss in the operation. This in turn contributes to the development of lethal triad and increases the rates of mortality and missed injuries<sup>12-14</sup>.

In our study, hemodynamic instability was considered to be the most important risk factor for mortality and also for the treatment method. Hemodynamic instability was more common in patients with high ISS scores. Furthermore, a close relation was observed between prolonged time from injury to hospital admission and hemodynamic instability. Hemodynamically unstable patients received significantly more erythrocyte suspension preoperatively and underwent damage control surgery. In the initial surgery, after controlling the bleeding, all the bowel injuries were closed with single-layer primary sutures to prevent contamination. In patients with colorectal injury, stoma was created during the second surgery and they were included into the group of patients with stoma. This application was considered to be the reason for the higher mortality rates found in the patients that underwent stoma creation.

Literature shows that there is a relation between the localization of injury in the colorectal area and stoma creation. It has been shown that the closer the localization of the injury is to the distal colorectal area, the higher stoma requirement is. It has also been determined that although the incidence of the stoma creation is the least in the right colon, it is the highest in rectal traumas. The main features of rectal traumas include uncontrolled pelvic hemorrhage, coexistence of anal sphincter injuries, and the relation of the trauma with the urinary tract. Previous studies indicated that in rectal injuries, ISS scores were higher, hemodynamic instability was more common, and the need for damage control surgeries was higher. Furthermore, anastomotic leakage, abscess, wound dehiscence, and missed injuries have been shown to be more common in patients with rectal injuries, particularly in hemodynamically instable patients<sup>8,15,16</sup>. In line with the literature, we also found a significant difference between the type of treatment and the localization of the injury. We also observed that the closer the localization of the injury is to the distal colorectal area, the higher stoma requirement is. Nevertheless, the rate of stoma requirement was higher in the patients with rectal traumas. This finding can be attributed to the preferences of the surgeon and the high ISS scores and higher hemodynamic instability in rectal traumas. The complications seen in our patients were also associated with hemodynamic instability. However, no relation was found between the mechanism of injury shrapnel or firearm and wound localization, mortality rate, and type of treatment.

## Conclusion

In this study, hemodynamic instability was found to be the main factor affecting mortality, stoma requirement, and postoperative complications in colorectal injuries caused by high-velocity firearms. The factors associated with hemodynamic instability included high ISS score, prolonged time from injury to hospital admission, and transfusion of multiple blood products. Additionally, the localization of the injury was another factor in determining the type of treatment. We believe that treating the patients with colorectal trauma at the closest location to the war zone by controlling the bleeding before the development of hemodynamic instability or immediately transferring the patients to an appropriate health center can reduce both the mortality rate and stoma requirement.

## Riassunto

Le lesioni traumatiche del colon-retto rappresentano una delle più comuni cause di mortalità in guerra e l'elemento fondamentale del trattamento consiste nella riparazione immediata della lesione o la confezione di un ano artificiale.

Lo studio consiste nella revisione retrospettiva dei dati clinici di pazienti di questo genere. Sono stati valutati l'intervallo tra l'evento traumatico e il ricovero in ospedale, il tipo di trattamento adottato, la sede anatomica della lesione coloretale, la gravità dell'ISS Injury Severity Score, l'instabilità emodinamica, e l'incidenza della mortalità.

La casistica consta di 61 pazienti, con intervallo medio dal trauma al ricovero di 160±19 minuti. In 24 pazienti 39,3% si trattava di lesione del colon destro, in 18 pazienti 29,5% del colon sinistro, ed il 19 31,2% di lesioni del retto. Il valore medio dell'ISS nei 61 pazienti era 16 IQR 5.

La mortalità e l'incidenza di complicazioni sono risultate più elevate nei pazienti con instabilità emodinamica, e nello stesso gruppo  $p < 0,05$  la necessità di esecuzione di una stomia.

La mortalità totale ha riguardato 15 pazienti 24,5% sul totale, e 10 di essi 66,6% presentavano instabilità emodinamica.

Dall'analisi risulta che l'instabilità emodinamica è il fattore più importante connesso con la mortalità, insieme con il tipo di trattamento da adottare nelle lesioni coloretali da causa bellica.

Riteniamo dunque che nelle vittime di guerra per lesioni coloretali l'intervento chirurgico eseguito prima dell'insorgenza dell'instabilità emodinamica può ridurre sia l'incidenza della mortalità che la necessità della stomia.

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