

## THE ASSOCIATION BETWEEN PELVIC FRACTURES (RING AND ACETABULUM FRACTURES) AND OTHER ORGAN SYSTEM INJURIES

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Pelvic fractures are often associated with injuries of intra-abdominal organs and intrathoracic injuries. Between January 1, 2004 and June 31, 2009, at the Clinic for Orthopaedic Surgery and Traumatology, Clinical Center Niš, 216 patients with pelvic disruption were treated. All patients were evaluated according to sex, age, mechanism of injury, anatomical injury scale (AIS), injury severity scale (IIS), type of fracture, method of treatment, associated injuries of visceral organs, duration of hospitalization and monitoring of the patient check-ups. The aim of this work was to determine the frequency of occurrence of intra-abdominal and intrathoracic injuries in patients with pelvic fractures and to study the relationship between different types of fractures. In the analyzed group there were 116 (53.7%) male patients and 100 (46.3%) female patients. The average age of patients was 45.3 years. In total, there were 139 isolated fractures of the pelvis. In relation to the mechanism of injury, 153 patients had sustained low energy trauma, while 63 patients had sustained high energy trauma. In the group of patients with the fracture of the pelvis sustained under the force of low intensity, 17 patients had fallen from the ladder, whereas 136 patients had fallen at home. In patients with the injury that occurred under the force of high intensity, 49 patients were injured in car accidents, and 14 had fallen from a great height. Combined injuries of intra-abdominal and intrathoracic organs with pelvic fracture were observed in 28 (12.9 %) patients. *Acta Medica Medianae 2015;54(3):27-33.*

**Key words:** fractures of the pelvis, abdominal injuries, intrathoracic injury, associated injuries

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### Introduction

Fractures of the pelvis account for 3% of all fractures of the skeleton (1, 2). Discontinuity in the pelvic ring injury is devastating, often associated with neurovascular, and intra-abdominal complications, and injuries of the genitourinary system (3). Although in the last few years a great progress in the treatment of these complex fractures has been made, there is still a high rate of morbidity and mortality associated with fractures of the pelvic ring (4-6). The most common cause of pelvic ring disruptions is sustained by high energy trauma, such as falling from a height or a motorcycle accident.

Low energy trauma can also be the cause of pelvic ring injuries, especially in the elderly population. Usually low energy trauma causes stable fractures that are successfully treated with conservative measures of treatment, while pelvic injuries provoked by high energy trauma require surgical intervention. For successful treatment of severe pelvic injuries, an experienced team of trauma surgeons, orthopedic surgeons, urologists and radiologists is required (7). The aim of this study was to determine the risk of IAIT (intra-abdominal and intrathoracic) injury in patients with fractures of the pelvis and to study the relationship between the different types of fractures.

### Materials and Methods

In this study, we examined a group of 216 patients with pelvic disruption who were transported by the emergency services to Surgical Clinic, Clinical Center Niš, in the period from January 1, 2004 to June 31, 2009, who were further treated at the Clinic for Orthopaedic Surgery and Traumatology, Clinical Center Niš. All patients were evaluated according to sex, age, mechanism of injury, anatomical injury scale (AIS), scale of injury severity

(ISS), and type of fracture. We also compared the use of conservative in relation to operational measures of treatment, then the amount of applied blood transfusion, the existence of associated injuries of visceral organs, the duration of hospitalization and condition of the patient after surgical or conservative treatment.

Motorcycle accidents and falls from a height are the most common causes of trauma provoked by the force of a high level intensity (high energy trauma), while falls sustained at home, including falls from ladders or falls in the bathroom, are the causes of pelvic ring fractures provoked by the force of a low level intensity (low energy trauma).

The first step in treating these patients was taken in keeping with the ABC protocol (airway, breathing, circulation), according to the instructions of the Advanced Trauma Life Support-a (ATLS) published by the American Association of Surgeons for the initial management of the traumatized patient.

To assess the hemodynamic stability of the patient, we used the following parameters: blood pressure (the patient whose systolic blood pressure was below 90 mmHg was considered hemodynamically unstable), heart rate (hemodynamically unstable patient had more than 110 heart beats per minute), presence of clinical symptoms of insufficiency of blood circulation in visceral organs (oliguria, vasoconstriction of peripheral vascular disease or mental confusion due to intoxication or brain trauma), even after resuscitation measures taken according to the instructions of ATLS and after compensation of lost blood and fluids by using infusions (8, 9).

The assessment of all patients on admission was performed on the basis of AIS and ISS scales and it was recorded in the medical documentation (10). To all patients admitted to the emergency surgical room, routine radiographs were made, especially radiograph of the pelvis with hips, whereas in cases where it was necessary to do detailed preoperative planning with the aim of surgical treatment of fractures, CT scan was done. In some cases, a target inlet and outlet X-ray view of the pelvis were done, or Judet's oblique obturator and iliac acetabular view, and abdominal ultrasonography in cases of suspected trauma of the abdomen.

Interpretation of radiographic examinations was performed by radiologists and orthopedic surgeons; pelvic ring fractures were classified according to the Young-Burgess classification system, which is based on the mechanism of injury. According to this classification, pelvic ring fractures are distinguished by the direction of the force injuries caused by lateral compression forces or lateral compression fractures (LC), anteroposterior compression fractures of the pelvis (APC), vertical shear fractures of the pelvis (VS), and combined fractures (CM) (5). Fractures of the acetabulum were monitored based on the Letournel-Judet's classification. This classification system comprises ten types of fractures which were divided into two subgroups: the first consists of five elementary (primary) acetabular fractures such as fractures of the posterior

wall of the acetabulum, posterior column, anterior wall, anterior column and the transverse acetabular

**Table 1.** Young-Burgess classification

Type of fracture	Number of patients	%
APC	97	44.9
LC	44	20.3
VS	25	11.5
CM	4	1.8
Total	170	78.5

**Table 2.** Letournel-Judet classification of acetabular fractures

Type of fracture	Number of patients	%
posterior wall	21	9
posterior column	20	9
anterior wall	14	6
anterior column	11	5
transverse fractures	11	5
Total	77	34

lar fractures, while the other subgroup included five types of complex fractures (Table 1 and 2) (11).

A set made of radiographic images was examined twice, with the classification of injuries done on the day of the injury and by the collegium the day after the analysis of the entire medical records. Patients were immobilized after admission, and a detailed assessment of the condition of the patient after trauma was made. All vital signs were registered, followed by the rectal and perineal examination and a detailed neurological and vascular examination of the patient. Values of AIS and ISS scales were calculated and registered by the trauma team (anesthesiologist, general surgeon, orthopedist) within the first 24 hours. The leader of the trauma team at the hospital was an orthopedic surgeon. As a first step, planned radiographic images were made and then, in selected cases, CT scan was done. Ultrasound examination of the abdomen was performed in cases of clinical signs of acute abdomen. Additional iliac and obturator oblique radiographs of the pelvis were done in patients with fractures of the acetabulum. For statistic evaluation, we used a t-test for independent and dependent samples.

## Results

Of the total number of patients treated in this study, 116 (53.7%) patients were male and 100 (46.3%) were female, so that the ratio was 1.16:1 in favor of male patients. The average age of patients was  $45.3 \pm 2$  years, while the average age of male patients was  $45.6 \pm 2$  years and average age of female patients was  $45.5 \pm 2$  years. According to the type of injury, there were 139 isolated fractures of the pelvis in 170 patients, 77 acetabular fractures, and 31 combined fractures of the pelvis. In relation to the mechanism of injury, 153 patients

**Table 3.** Data collected on IAIT injuries associated with pelvic fractures

Trauma	High energy	Low energy	Type of fracture	AIS	ISS	Age	Intervention
Two ruptures of the diaphragm	1	1	2AAC	9/5	35/11	19/70	primary suture of the diaphragm, blood transfusion.
Two ruptures of the liver	2		2YAPC	6/8	26/34	34/52	surgical reparation
One rupture of the spleen	1		1YCM	7	27	40	splenectomy
Six retro-peritoneal hemorrhages	6		4YLC-1YAPC-1YVS	8/6/4/7/5/3	34/26/16/27/25/9	73/43/37/65/2/46	conservative treatment, blood transfusion
Three pleural effusions	3		2YLC-1AAC	8/7/4	28/27/16	62/39	conservative treatment, blood transfusion
One tension pneumothorax	1		1YLC	6	26	49	thoracic suction
Six cases of free fluid in abdomen	5	1	2YLC-1YAPC-2APC1ATC	4/4/3/4/6/7	16/16/9/16/26/27	64/39/76/58/32/56	conservative treatment, blood transfusion.
Seven cases of acute abdomen	5	2	2YLC-1YAP-3ATC- 1AAC	7/8/5/7/7/4/5	26/16/18/28/22/18/12	73/74/34/32/35/22/36	peritoneal lavage, blood transfusion.

had low energy trauma (mean age 57 years), of which 17 patients had experienced a fall from the ladder, 14 had fallen in the bathroom, and 122 had fallen at home, whereas 63 patients had high energy trauma (mean age 40 years), of which 40 patients were injured in motorcycle traffic accidents, nine as pedestrians in traffic accidents, while 14 were injured when falling from a height.

Patients had different types of associated injuries: 28 (12.9%) had IAIT injury. In seven patients who had clinical signs of acute abdomen, abdominal lavage through supraumbilical approach was performed. Abdominal lavage was negative. The total of 82 (37.9%) patients with hemodynamic instability were given emergency blood transfusion, including those patients who underwent emergency surgical treatment. Of these patients, 21 had a combined pelvic ring fracture, 20 had pelvic fractures with the vertical shearing of the ring, 11 had anterior compression fractures and seven patients had lateral compression fracture of the pelvis (Table 3). Nineteen patients with acetabular fractures received blood transfusion. Urogenital complications occurred in 24 (11%) patients, while cystostomy suprapubica was performed in two patients. Intracranial injuries were verified in seven patients (3.2%).

In total, 11 (5%) patients with lateral compression fractures of the pelvis had IAIT complications, 5 (2%) patients had anterior compression fractures, 1 (0.4%) patient had a fracture of the pelvis with vertical shear and 1 (0.4%) patient had a complex pelvic ring fractures. In patients with acetabular fractures, 4 (1.8%) had anterior column acetabular fracture, 3 (1.3%) patients had fractures of the posterior column, 4 (1.8%) had transverse acetabular fracture and no fracture of the posterior and anterior wall of the acetabulum.

Patients with IAIT injuries had a mean AIS score of 6, which is significantly higher than in other patients - 1.9 ( $P=0.001$ ), and mean ISS score of  $23\pm 8$ , which is also significantly higher than in other patients -  $4.6\pm 4$  ( $P=0.001$ ). The mean age of patients with IAIT injuries was  $45\pm 1$  years, as there was no statistically significant difference compared to other patients with fractures of the pelvis, who had a mean age of  $39\pm 1$  years ( $P=0.230$ ). Patients with IAIT injury have suffered significantly greater percentage of high energy trauma (92%) than those without IAIT injuries (19%).

Thirteen patients with unstable fractures were subjected to an orthopedic surgical procedure (three patients in the first 24 hours; eight patients underwent external fixation, and five patients underwent the method of internal fixation). Surgical intervention performed in three patients in the first 24 hours after admission referred to the surgical treatment of haemodynamic instability due to bleeding in the pelvis. Later surgical interventions were related to patients who were haemodynamically stable, but in whom the open surgical repositioning was necessary. The method of pelvic external fixation was used in three laterocompression injuries, three anteroposterior injuries, complex pelvic injuries and a pelvic injuries with vertical movement, while the method of internal fixation was applied in one case of laterocompression injury, in two cases of posterior column acetabular fractures, in two cases of anterior column acetabular fractures and in one patient with transverse acetabular fractures. External fixation was used for hemodynamically unstable patients as an emergency procedure, but as a definitive treatment of secondarily performed open reduction and internal fixation of fractures in the event of significant dislocation of fracture (diastasis of the pubic symphysis greater than 25 mm

and sacral fracture with dislocation of more than 10 mm). Seventy-seven (35.65%) patients had a fracture of the acetabulum (three of them were subjected to internal fixation). The average time elapsed from admission of a patient in the hospital to the surgical intervention, except for those patients who were not operated as emergency cases in the first 24 hours, was 13 days, and the average duration of hospitalization was 27 days. Within the first 24 hours of admission, any lethal outcome was not noticed. During the study period four patients died, but only one death related to the violation of the pelvis (one patient who was treated with external fixation of pelvic died because of systemic organ failure and organ systems). The most common type of pelvic ring injuries was anteroposterior compression injury of the pelvis (open book injury) (44%). The mean follow-up of patients was 45.5 months. Regarding the association between fractures of the pelvis and fractures of other parts of the skeletal system, 150 (69.44%) patients had other fractures of the pelvic ring alone, whereas 66 (30.56%) had associated fractures (17 patients with fractures of the upper extremity and spine, and 49 with fractures of the lower extremities).

### Discussion

Fractures of the pelvis are very complex fractures that can cause a lethal outcome of patients because of uncontrolled bleeding, prolonged systemic shock and organ failure and organ systems due to the exhaustion of compensatory mechanisms. Major pelvic fractures result from very high-energy trauma such as those generated in road traffic accidents, crush injuries or falls from height. They require urgent hospital treatment. Less severe, stable fractures which do not damage the structural integrity of the pelvic ring can result from lower-energy impact. They typically involve fractures of only one of the pelvic bones. Fractures of pubic rami with insignificant or minimal trauma can be a presentation of osteoporosis. Age of the patient is an important factor because of changes in the composition of bone mass and quality of the skeleton. After the age of 40, the majority of people experience the loss of cancellous bone mass, and the pelvic ring has a reduced resistance to the

direct effect of force, so that older patients can obtain very complex fractures of the pelvic ring even during low energy trauma. Data from the literature suggest that pelvic fractures are more common in patients aged between 20 and 40 years of age, with a higher incidence in men than women (12-16). In our study, the mean age of patients was 45.3 years, and was higher in the group with low energy trauma (57) than in the group of patients with high energy injuries of the pelvis (40), with the male to female ratio 1, 1:1. A very important step in the initial evaluation of the traumatized patient is an anteroposterior pelvic x-ray of both hips. Even X-ray images of only one half of the pelvis (hemipelvis) can be useful in 90% of cases in assessing the degree of instability of the pelvic ring fractures (17). Visuitipol et al. showed that the reliability of the determination of the type of fracture based on X-ray or 3D CT images is almost the same (11). We evaluate all of our patients on the basis of the plain radiographs of the pelvis with both hips in the anteroposterior projection and CT images. Very often signs of intraabdominal injury/intrathoracic organs may be masked by the very painful sensation at the site of disruption of the pelvis. In our study, we examined the correlation between these injuries and fractures of the pelvis, and we found that the degree of IAIT injury was 12.9%. Murr et al. have examined 70 patients with pelvic injuries to determine in which patients there is an increased risk of intraabdominal injuries and found that 11 (16%) patients had severe disruption of the pelvic associated with visceral organs injuries (18).

The most common type of pelvic fractures associated with IAIT injuries in our study was the lateral-compression injuries (5%). In their study, the analysis of 100 patients with lateral compression fractures of the pelvis, type I, Lefavre et al. Found that the highest AIS scores were found for fractures of the extremities (2.4), followed by chest (1.28) and abdominal (1.03) injuries, where the trend of increasing average values of IIS score ( $P=0.0014$ ) was observed in patients with the fracture of the sacrum. Lunsj et al. published that ISS is the most important factor in predicting mortality rate in patients with fractures of the pelvis, not the type of fracture (19), while Tashibana et al. observed that mortality is significantly higher in pa-



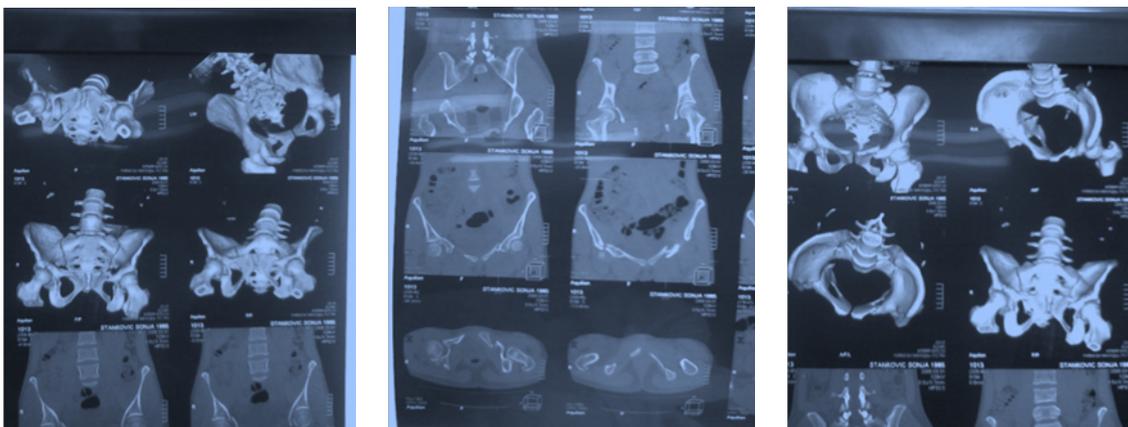
**Figure 1.** Radiographic presentation of a patient with complex fractures of the pelvic ring (a), after urgent stabilization of pelvic ring with external fixator (b) and plain abdominal radiography of the abdomen during the follow-up of patients with signs of paralytic ileus with the presence of gas shadows in the abdomen.

tients with unstable pelvic fractures (20). In examining the fracture of the pelvis on the basis of AO classification, in their study. Siegmenh et al. reported 16 patients (41%) with pelvic fractures type B, and 23 (59%) patients with type C fractures of the pelvis. In their analysis of the association between the type of fracture of the pelvis with the injuries of other organs and organ systems the most commonly observed were injuries of the spleen, liver and kidneys (58.9%), followed by injuries of the genitourinary tract (46.6%), nerve lesions (25.6%) and vascular lesions (15.3%). Outside the pelvic most frequently injured organ the system were chest injuries (56.4%). In our study, the percentage was 1.8% (21) (Figure 1).

For development of pelvic fractures high energy force is required, and therefore associated injuries of the abdomen, chest and head injuries are very common. In our study, we observed 3.2% of head injuries. Pelvis fractures are, also, closely associated with urological complications (22, 23). Percentage, frequency of urogenital injuries range from 15-20%, and in most cases it is the rupture of the bladder and/or urethra. In our study, the range is 10.6%, while Pavelka et al. reported 13.5% (24,25). Combined injuries of other organs and organ systems are encountered frequently in acetabular fractures, which are an integral part of the pelvic ring and are often provoked by the force of high level intensity (motor vehicle accidents). Porte et al. examined in their study the association between acetabular fractures with injuries of other organs, and they divided acetabular fractures on the basis of the direction of injury force to the acetabular fractures caused by the effect of axial load (posterior wall fractures, fractures of the posterior column and posterior wall/column acetabulum) and the acetabular fractures caused by the effect of lateral forces on the trochanter region. Recorded data and the results are published to determine the association between acetabular fractures, caused by the activity of different force vectors, and violations of other parts of the locomotor system (skeleton) and visceral organs injuries. Thus, it was observed that the acetabular fractures caused by the influence of lateral impact

forces had significantly greater association with the appearance of retroperitoneal hematoma, rupture of the spleen, liver and kidney lesions, vascular injury and rupture of the bladder than acetabular fractures caused by the force on the back side (axial load) (26). In our series, 35.6% of patients with fractures of the acetabulum were verified, whereby in relation to IAIT, the fracture of anterior column was present in 4 patients (1.8%, the effect of lateral forces), as well as the transverse acetabular fractures (4 patients, 1.8%, lateral impact force), whereas there were 3 (1.3%) patients with fractures of the posterior column (axial force impact) (Figure 2).

Hemodynamic status of the patient with a fracture of the pelvis can be significantly compromised due to bleeding in the chest, abdominal or retroperitoneal bleeding in case of high energy trauma. Therefore, it is the leading cause of death among patients with acetabular fractures due to hemorrhagic shock. The best way to reduce the diameter of the pelvic ring and stop the bleeding is the method of external fixation of the pelvis. Application of external fixator reduces significantly the diameter of the pelvis and achieves the effect of tamponade, which significantly facilitates the easy transport of the patient and continuation of monitoring of the vital signs of the patient's condition (27,28). This technique was applied in 152 patients (70.37%). The absence of hemodynamic stability in patients who underwent external fixation is an important indicator of the existence of arterial bleeding. In such cases, angiography is indicated in order to detect the bleeding site (12). If hemodynamic stability is achieved in a patient who had suffered blunt trauma of the abdomen, it is necessary to perform abdominal lavage through supraumbilical approach, as diagnostically effective procedure in the evaluation of the state of intra-abdominal injuries. In our hospital, abdominal ultrasound was carried out before the appearance of the signs of acute abdomen in patients with blunt trauma of the abdomen; if necessary, the patients then underwent abdominal lavage. In this way we interviewed in 13 (28.08%) patients in our series. Data from the



**Figure 2.** CT scan of a patient with IAIT injury and fractures of the acetabulum caused by lateral effect of high energy force

world's literature varies when it comes to laparotomy in polytraumatised patients with fractures of the pelvis and range from 15-35%.

A total of 37.9% of patients in our department received blood transfusion. Compared with data from the literature, Demetrides et al. reported 38.4% of transfused patients, while in Gurevitz et al. study this percentage was 33.3%. In our study, the need for transfusion depended on the severity of trauma. According to Jeroukhimov et al. for patients with high pelvic AIS score, the amount of transfused blood should be considered as an indication for early angiography (16, 29,30).

### Conclusion

Fractures of the pelvis represent a very severe injury of the locomotor system and are often associated with intra-abdominal injuries and intrathoracic organ injuries. Pelvic trauma can lead to

severe, uncontrollable hemorrhage and death related to prolonged shock and multiple organ failure. Besides clinical examination of a patient's injury, X-ray of the pelvis, CT and MSCT remain the important tool in the diagnosis of these severe injuries. To determine the diagnosis of associated injuries of the abdomen and thorax, in addition to non-invasive method of treatment, invasive methods of treatment can be applied. Very often, the signs of intra-abdominal injuries and intrathoracic organs may be overlooked because of the dominant findings at the site of pelvis disruption. In the care of patients with pelvic fractures associated with intra-abdominal and intrathoracic injuries, the participation of team is very important, in which besides orthopedic surgeons, urologists, abdominal and thoracic surgeon, anesthesiologist has an important place.

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## PRELOMI KARLICE UDRUŽENI SA POVREDOM INTRAABDOMINALNIH I INTRATORAKALNIH ORGANA

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Prelomi karlice su često udruženi sa povredama intraabdominalnih i intratorakalnih organa. U periodu od 01. januara 2004. godine do 31. juna 2009. godine na Klinici za ortopediju i traumatologiju Kliničkog centra u Nišu lečeno je 216 pacijenata sa disrupcijom karlice. Svi pacijenti su bili evaluirani prema polu, starosti, mehanizmu povređivanja, anatomskoj skali (AIS), skali težine povreda (IIS), tipu preloma, načinu lečenja, udruženim povredama visceralnih organa, dužini trajanja hospitalizacije i praćenjem stanja pacijenata na kontrolnim pregledima. Cilj rada bio je da se utvrdi učestalost nastanka intraabdominalnih i intratorakalnih povreda kod pacijenata sa prelomom karlice i da se ispita povezanost sa različitim tipovima preloma. U analiziranoj grupi bilo je 116 (53,7%) pacijenata muškog pola i 100 (46,3%) ženskog. Prosečna starost pacijenata bila je 45,3 godine. Ukupno je bilo 139 izolovanih preloma karlice. U odnosu na mehanizam povređivanja, 153 pacijenta je imalo povredu izazvanu silom slabog intenziteta, dok je 63 pacijenta imalo povredu izazvanu silom jakog intenziteta. Kod pacijenata kod kojih je do preloma karlice došlo pod dejstvom sile niskog intenziteta, 17 pacijenata je imalo pad sa merdevina, a 136 pad kod kuće. Kod pacijenata kod kojih je do povrede došlo pod dejstvom sile visokog intenziteta, 49 pacijenata je povređeno u saobraćajnoj nesreći, a 14 prilikom pada sa velike visine. Udružene povrede intraabdominalnih i intratorakalnih organa sa prelomom karlice registrovano je kod 28 (12,9%) pacijenata. *Acta Medica Medianae* 2015; 54(3):27-33.

**Ključne reči:** prelomi karlice, intraabdominalne povrede, intratorakalne povrede, udružene povrede.