



Pattern and Severity of Traumatic Renal Injury: A Three-Year Study at Single Level One Trauma Center in Southern Iran

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Abstract

Background: Renal trauma is among the most important trauma challenges. Better management of traumatic renal patients is necessary to improve the patients' clinical outcome.

Objectives: This study aimed to analyze the pattern, severity, mechanism of injury, and outcome in renal trauma.

Methods: This cross-sectional study was conducted in the largest trauma center in southern Iran from March 2018 to June 2022. Adult patients with diagnosed renal trauma based on abbreviated injury scale guideline were included. Variables of age, gender, anatomy of injury, mechanism of injury, length of hospitalization, level of blood pressure, severity of injury, and the outcome of patients have been collected.

Results: In total, 4,416 traumatic patients were admitted to the Emergency Department of the Hospital during the study time, of which 46 cases had traumatic renal injury. The rate of renal injury in the level one trauma center in southern Iran was 0.96%, and the death rate in renal injury victims was 12(26.1%). Most of the injured with renal injury were men 39(84.8%). Blunt trauma was the dominant type of trauma in most victims with renal injury 34(73.9%). Thirty-seven percent (n=17) of traumatic renal injury victim was in mild level (grade 1 and 2), and 16(34.8%) in severe level (grade 4 and 5). Renal injury was mostly associated with thorax injury (n=46) as extra-abdominal organ injury, and liver injury (n=16) and spleen (n=15) as intra-abdominal organ injury.

Conclusion: The results of the present study showed that the severity of injury in patients with renal injury is high, and it is usually associated by injury to other body organs. It is suggested that the traumatic patients should be immediately examined for renal injury in the resuscitation department due to the high mortality rate and severity of these patients.

Keywords: Renal, Renal injury, Trauma

1. Background

Trauma is a leading cause of death and disability worldwide among those under 45-year-old population (1, 2). The rate of renal trauma is 1.4 to 3.2 (3, 4). Although the rate of renal trauma is low, the mortality rate in patients with renal trauma is high (5). Most patients with renal trauma are young men (5). After the spleen and liver, it is the third vulnerable abdominal organ (6-10). Blunt trauma is the most common mechanism of injury in patients with renal trauma (5). A motorcycle accident (68%) followed by a fall from a height of 23% are the most common causes of renal trauma (11).

Trauma due to falling from a height or severe physical injury (blunt/non-penetrating trauma) has been reported as the cause of 80-95% of renal injury, which often occurs due to road accidents (12-14). The average severity of injury in patients with renal injury was significantly higher in comparison to people with injury to other organs (4).

Most renal trauma patients were men with level 1 renal injury classification. In patients with renal trauma, severe or microscopic hematuria with hypotension has also been observed (15). The average injury severity score in patients with renal trauma was 22.5 (11).

Associated injury and degree of renal injury is defined as renal trauma pattern, and there is a significant relationship between the pattern of renal trauma and age, sex, and type of accident (16). Due to the fact that renal trauma has different patterns, the therapeutic and diagnostic evaluation of renal trauma is complex (5, 15). And so far, no study has been performed on the injury pattern of renal trauma patients referred to the trauma level one center in southern Iran.

2. Objectives

Therefore, this study aimed to analyze pattern, severity, mechanism of injury, and outcome in renal trauma.

3. Methods

The study design was cross-sectional, and the study population included all the traumatic renal injured who were referred to the level one trauma center due to trauma in southern Iran between March 2018 and June 2022. Patients with traumatic renal injury aged > 15 years admitted to Emtiaz Hospital and Shahid Rajaei Emergency Center over the study period were included. The injured patients aged < 15

Table 1. Renal injury scale according to American Association for the Surgery of Trauma-Organ Injury Scale

AAST Grade	AIS Severity	Imaging Criteria (CT Findings)
I	2	- Subcapsular hematoma and/or parenchymal contusion without laceration
II	2	- Perirenal hematoma confined to Gerota fascia
III	3	- Renal parenchymal laceration ≤1 cm depth without urinary extravasation - Any injury in the presence of a renal vascular injury or active bleeding contained within Gerota fascia
IV	4	- Parenchymal laceration extending into urinary collecting system with urinary extravasation - Renal pelvis laceration and/or complete ureteropelvic disruption - Segmental renal vein or artery injury - Active bleeding beyond Gerota fascia into the retroperitoneum or peritoneum
V	5	- Segmental or complete renal infarction(s) due to vessel thrombosis without active bleeding - Main renal artery or vein laceration or avulsion of hilum - Devascularized renal with active bleeding - Shattered renal with loss of identifiable parenchymal renal anatomy

AAST: American Association for the Surgery of Trauma; AIS: Abbreviated Injury Scale; CT: Computed Tomography

years, admitted to the Hospital for follow-ups, and the dead on arrival were excluded from the study.

Information was extracted from patients' files using a case report form (CRF). The collection form included: age, sex, anatomy of injury, mechanism of injury (traffic accidents, pedestrian accident, car accident, motorcycle accident, car passenger accident and motorcycle accident, fall, shooting, and stabbing) injuries, duration of hospitalization, blood pressure level, and injured areas according to abbreviated injury scale (AIS) and injury severity score (ISS) were renal injury, patient outcome, and injury severity. Vital signs were measured at the time of arrival at the Emergency Department of the Hospital.

The abbreviated injury scale was determined according to our previous study (17, 18). To calculate an ISS, we squared each AIS code in each of the three most severely affected ISS body regions and added them together ($ISS=A^2 + B^2 + C^2$ where A, B, C are the AIS scores of the three most injured ISS body regions). It is a descriptive scale for estimating injuries caused by trauma to each of the organs (renal and urinary tracts) and introduces the level of threat to the survival of the person according to the individual injury of each organ. This scale has 5 levels. Level 1 of the renal includes mild contusion and subcapsular hematoma without parenchymal rupture. Level 2 includes hematoma, limited around the renal and behind the peritoneum, as well as a tear with a depth of less than 1 centimeter in the parenchyma of the renal cortex. Level 3 includes a tear with a depth which is more than 1 centimeter in the parenchyma of the renal cortex without injury to the urine collection and drainage system. Level 4 includes an extended tear through the renal cortex, medulla, and urinary collecting system, as well as injury to the main renal artery or vascular injury with bleeding, and level 5 is the complete destruction of the organ and its vascular system. Injury severity score is a scale to assess severity of traumatic patients for the whole body, and it numerically expresses the level of threat to survival according to

the injuries of the whole body. In this study, American Association for the Surgery of Trauma-Organ Injury Scale (AAST-OIS) scale was used to determine the grade of traumatic renal injury patients (Table 1). More than one grade of renal injury may be present and should be classified by the higher grade of injury. Advance one grade for bilateral injuries up to Grade III (19). renal trauma diagnosis is defined based on AIS guideline. Rate of traumatic renal injury was measured based on hospital admission during study time (Emtiaz Hospital and Shahid Rajaei Emergency Center).

Categorical variables are presented as frequency with percentage; continuous variables as Mean with Standard Deviation (SD) or Median with interquartile range (IQR). The collected data were analyzed using SPSS software (version 24).

4. Results

In total, 4,416 traumatic patients admitted to the Emergency Department of the Hospital during the study time, of which 46 case had traumatic renal injuries. Therefore, the rate of renal injury in patients referred to the largest trauma center in southern Iran was 0.96%. Most injured with renal injury were men 39(84.8%), and the mean age of patients with renal injury was 30.3 ± 14.8 years. In addition, the most common mechanism of injury were pedestrians 8(17.4%) and then motorcycle drivers 7(15.2%) in traumatic renal injury. Most of the injured with renal injury had blunt trauma 34(73.9%). Moreover, the death rate of renal injury victims was 12(26.1%) (Table 2). Ten nephrectomies were carried out in the study population (21.70%). Furthermore, four nephrorrhaphies were performed in this center during this study (8.70%).

In this study, most injured patients with renal injury 17(37%) were in the mild level of injury based on the AAST injury pattern, followed by the severe level of injury with 16(34.8%) of the patients (Figure 1).

Related and associated injuries were investigated

Table 2. Baseline characteristics, biochemical parameters, and clinical outcomes of traumatic renal injury cases

Characteristics	Traumatic renal injury cases (N=46)
Gender	
Male, n (%)	39 (84.8)
Female, n (%)	7 (15.2)
Age, years (Mean (SD ^a))	30.3 (14.8)
Mechanism of injury	
Car driver, n (%)	2 (4.4)
Car occupant, n (%)	5 (10.9)
Motorcycle Rider, n (%)	7 (15.2)
Motorcycle pillar, n (%)	6 (13)
Pedestrian, n (%)	8 (17.4)
Stab, n (%)	6 (13)
Falls, n (%)	6 (13)
Assaults, n (%)	4 (8.7)
Gunshot, n (%)	2 (4.4)
Trauma type	
Blunt, n (%)	34 (73.9)
Penetrating, n (%)	12 (26.1)
ISS ^b , Mean (SD ^a)	27.2 (16)
Physiology	
On Arrival SBP ^c , Mean (SD ^a)	118.4 (18.8)
On Arrival DBP ^d , Mean (SD ^a)	76.7 (15.8)
On Arrival PR ^e , Mean (SD ^a)	106.1 (18.7)
On Arrival RR ^f , Mean (SD ^a)	18.5 (4.2)
On Arrival GCS^g, n (%)	
3-8	13 (28.3)
9-12	2 (4.3)
13-15	31 (67.4)
Length of stay in hospital, Median (IQR ^h)	12.1 (9.8)
Outcome	
Survival, n (%)	34 (73.9)
Dead, n (%)	12 (26.1)

^aSD: standard deviation; ^bISS: Injury Severity Score; ^cSBP: Systolic Blood Pressure; ^dDBP: Diastolic Blood Pressure; ^ePR: Pulse Rate; ^fRR: Respiratory Rate; ^gGCS: Glasgow Coma Scale; ^hIQR: Interquartile Range

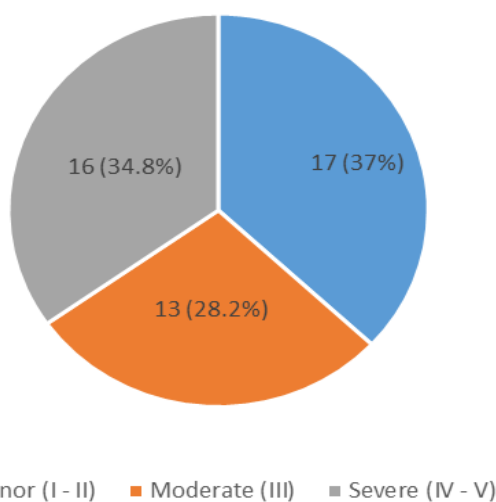


Figure 1. Grading of traumatic renal injury cases according to American Association for the Surgery of Trauma-Organ Injury Scale

in renal injury victims. The results showed that in the case of intra-abdominal injuries, renal injury was more associated with liver injury (n=16) and spleen

injury (n=15). Regarding extra-abdominal injuries, renal injury was more associated with thorax injury [n=46, Figure 2].

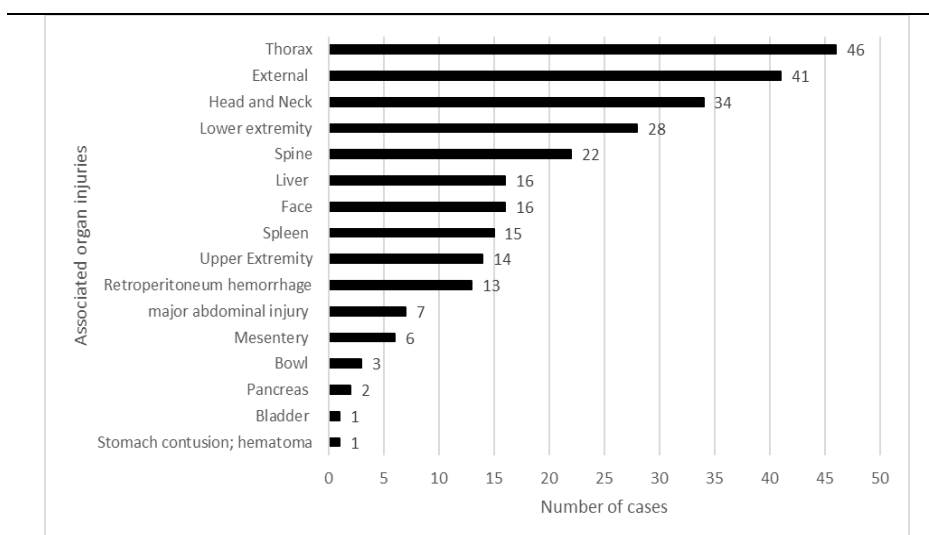


Figure 2. Associated organ injuries among traumatic renal injury cases over three years' study in level one trauma center

5. Discussion

This main finding showed that the rate of renal injury in the largest trauma center in southern Iran was similar to other parts of the country and the death rate in renal injury victims was high. The rate of renal trauma in this study was broadly consistent with other international studies. For instance, the rate of renal injury in the study by McPhee et al. (2015) in London was 1.9% (12), in the study by Khoschnau et al. (2020) in Qatar, 2.4% (4), and in the study by Guareschi et al. (2015) in Brazil, it was 4.15% (20).

We observed a significantly higher number of renal injuries in men. Other studies also reached similar results (6, 9, 10, 12, 20). The higher rate of renal injury in men can be related to their habitual patterns and role as the backbone of families and higher activity levels than women. Most men who use motor vehicles, have hobbies in physical sports and do more outdoor activities are at higher risk (9).

In the present study, the average age of renal injury victims was about 30 years. The mean age of renal injury victims varied between 26 and 34 years in different studies (4, 6, 20-22). In studies that examined children and adults without age restrictions in the inclusion criteria, the average age of the patients was lower and between 22.76 and 24 years old (9, 23). The results of a systematic review study in 2014 also revealed that renal trauma mainly affects young men (24). This is probably because patients in this age group lead more active lives and do more outdoor activities. Moreover, this group of people has a greater tendency to show emotions and often do not pay attention to safety factors (9).

In addition, in this study, most victims with renal injury were pedestrians (17.4%) and then motorcycle drivers (15.2%). This result was consistent with many studies performed in Qatar, Indonesia,

Pakistan, Saudi Arabia, and India that showed road accidents or motor vehicle accidents are the common mechanism of renal injury (4, 6, 9, 21, 23). It seems that due to the fact that in these studies the injury mechanisms are not separated in detail, they are not comparable with our research. Only in the study of Shoobridge et al. (25) in Australia the mechanisms of injury were more detailed; and the common mechanism of renal injury was motor vehicle accidents followed by pedestrians, and motorcycle accidents. What is certain is that high-speed motor vehicle collisions can cause severe renal injury; therefore, in addition to parenchymal rupture, it can also cause vascular injury. Injuries to the flank should be considered renal injury until proven otherwise. Consequently, the direct transfer of kinetic energy and rapid deceleration puts the renal at high risk for injury (9).

Blunt trauma accounts for 70-80% of renal trauma (23). In our study, blunt trauma was the common type of trauma in most patients injured with renal injury; therefore, 78.3% of renal injuries were caused by blunt trauma. Blunt injuries are more common than penetrating injuries in renal trauma. Blunt injury accounts for 80-95% of renal injuries in the United States (13). This is consistent with several studies conducted in different countries showing similar results (6, 9, 12, 25). However, in a study by Guareschi et al. (20) in Brazil, penetrating trauma was responsible for 84.8% of renal injury cases.

The AAST-OIS classification scale is used worldwide to grade renal injury. In this classification, the severity is evaluated based on the depth of renal parenchyma injury and the involvement of the urine collection system and renal vessels (19). On the other hand, computed tomography (CT) has become the standard in diagnosing organ injury after trauma, because it provides detailed images of abdominal and

retroperitoneal structures. This method has 100% sensitivity/specificity for solid organ injury and is more sensitive and specific than intravenous pyelogram, ultrasound, or angiography (26). In this study, CT imaging was used for the initial evaluation of patients. And renal injury patients were graded based on AAST-OIS. Around 37% of injured renal injury was in mild level (grade 1 and 2), and 34.8% in severe level (grade 4 and 5). In the study conducted by Lloyd et al. (15), Guareschi et al. (20), and McPhee et al. (12), most patients with traumatic renal injury were 65%, 51.4%, and 44%, respectively, in grade 1 and 2. Additionally, in a study carried out by Khan et al., the victims of renal injury were grade 1 and 2 (50%) and grade 4 and 5 (26%) (6). Moreover, in a study performed by Shoobridge et al., 46% of renal injuries were grade 1 and 2, and 29.3% were grade 4 and 5 (25). The results of these studies were completely consistent with the current research. Identification of patients with high-grade renal injury provides an opportunity for appropriate counseling regarding the risks and indications of secondary bleeding, hypertension, and long-term renal dysfunction (27).

In the present study, the renal injury was more often associated with thorax injury (n=46) as injury to extra-abdominal organs. This result was consistent with the results of other studies. In various studies, most of the non-abdominal related injuries were thorax injuries (4, 22, 23). In addition, in this study, liver injury (n=16) and spleen injury (n=15) were the most common injuries of intra-abdominal organs. Similar results have been obtained in other studies. For instance, in a study by Khoschnau et al., the most common abdominal injuries were liver (35%) and spleen (25%) (4). In the study by Guareschi et al. (20), the liver injury occurred in 25.13% and spleen in 18.45% of the associated injuries. In another study conducted by Patel et al., the spleen (48%) and liver (20%) were the most affected intra-abdominal organs (23). In addition to their anatomical locations, which are directly adjacent to the renal, these two organs are relatively fixed in the abdominal cavity; therefore, they are prone to injury if exposed to trauma. In addition, the presence of injury in other important intra- and extra-abdominal organs aggravates the patient's condition and affects the prognosis (9).

The death rate in renal injury victims was 26.1%. Although the mortality rate of traumatic renal injury patients varied between 2.9% and 11.2% in different studies (6, 7, 14, 26), in the present study the mortality rate was relatively high. It can be said that the cause of the difference in the mortality rate of these patients in different studies is related to the difference in the clinical characteristics of the patients, mechanism of injury, type of trauma, degree of renal injury, and injury of related organs (5).

The current study was the first study that

analyzed the pattern of renal injury in the level one trauma center in the southern Iran for the first time. Furthermore, identification of renal injury in trauma patients referred to this center based on CT findings was one of the key strengths of this study.

There were several limitations to our study. This research was a retrospective analysis, and many clinical factors were not available. In addition, renal injuries accounted for a small percentage of trauma injuries in this study; therefore, we were unable to describe more variables in different subgroups, such as patients with various degrees of injuries. It is suggested to use data mining and modeling methods to predict the outcome of renal trauma patients (17, 28).

6. Conclusion

The results of the study showed that the mortality rate among traumatic renal injury patients was high. The severity of the injury of these patients is high, and it is usually associated by the injury of other body organs. Injured people with non-penetrating trauma, pedestrians, and motorcyclist victims are more susceptible to renal injuries. Due to the high mortality rate of these patients, it is suggested that the injured should be immediately examined for renal injury in the resuscitation department.

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Footnotes

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Author's Contribution :MY: conceptual and design study, data acquisition, data analysis, drafted and revision paper. MK: contributed to conceiving and design of the study, interpretation of data, commented on drafts, and made significant revisions to the paper. NB: contributed to the design of the study, interpretation of data, commented on the draft, and made significant revisions to the paper. ZGH: contributed to the design of the study, statistical analysis, commented on drafts, and made significant revisions to the paper.

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