



Evaluation of renal traumas according to forensic radiology

 Huseyin Kafadar¹,  Safiye Kafadar²

¹Adiyaman University, Faculty of Medicine, Department of Forensic Medicine, Adiyaman, Turkey

²Adiyaman University, Faculty of Medicine, Department of Radiology, Adiyaman, Turkey

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Abstract

Aim: The goal of the study is to retrospectively assess cases of renal injuries.

Material and Methods: The cases of renal injury presenting at Adiyaman Training and Research Hospital between January 1st, 2013, and December 31st, 2017 were investigated in terms of age, gender, radiologic findings, grade of renal injury, and cause of injury. The degree of kidney injury determined by imaging methods was evaluated in terms of the American Association for the Surgery of Trauma (AAST).

Results: Of the 123 patients with renal injury, 27 were female (21.95%) and 96 were male (78.05%), with an average age of 32.6 ± 16.7 years. In total, 59 cases (47.96%) were younger than 35 years. When the cases were examined according to age groups, 11 (8.94%) cases were under the age of 14 years, 23 (18.70%) cases were aged 15–24 years, and 25 (20.32%) cases were aged 25–34 years. The older age groups included 23 (18.70%) cases aged 35–44 years, 19 (15.46%) aged 45–54 years, 9 (7.31%) aged 55–64 years, and 13 (10.57%) older than 65 years. Overall, 59 (47.96%) injuries were from traffic accidents ($p < 0.005$), 36 (28.96%) from falls, 12 (9.74%) from sharp and penetrating object injuries, seven (5.69%) from gunshot wounds, five (4.07%) from assaults, and four (3.25%) from work accidents.

Conclusion: Renal traumas are life-threatening injuries. We have evaluated renal injuries in terms of radiological and forensic medicine, and we believe the findings contribute to the existing literature on this subject.

Keywords: Forensic medicine; kidney; radiodiagnostic; renal injury; trauma

INTRODUCTION

Traumas are the main causes of morbidity and mortality worldwide. Abdominal traumas are categorized as penetrating and/or blunt according to the injury mechanism (1-6). However, intra-abdominal organ injuries often occur due to blunt trauma rather than from penetrating injuries. Liver and spleen injuries are the most commonly injured intra-abdominal organs, whereas the rate of genitourinary injuries varies from 3 to 10% (1-3,7).

The most commonly injured organ in the genitourinary system is the kidney, and kidney injuries often accompany other organ injuries. The kidneys are well-preserved organs anatomically, as they are protected in the retroperitoneum by the musculoskeletal structures of the posterior and anterior abdominal wall and by the peritoneal and abdominal viscera. Kidney injuries account for approximately 1–10% of all abdominal traumas (2,7-10).

Abdominal traumas are typically evaluated using radiological imaging methods. Ultrasound (US) is a non-

invasive method that offers several advantages, such as low cost, wide availability, minimum preparation, and portability (2, 8-10). The use of US allows easy identification of free intra-abdominal fluids, such as hemoperitoneum. However, obtaining a reliable differentiation of free blood in the abdomen from the urine or other body fluids can be difficult (1,2,11). By contrast, computed tomography (CT) provides basic anatomical and physiological information that can distinguish light injuries from cases requiring intervention in patients with acute trauma (2-4,11). For this reason, US has a limited capacity when compared to CT and has a sensitivity less than 22% for the evaluation of renal parenchymal damage. Currently, since vascular injuries can easily diagnose by CT, angiography is rarely used in renal injuries (2-4,11).

Renal injuries are life-threatening injuries according to forensic medicine. However, the effective use of radiological imaging methods and a correct diagnosis can increase the chances of effective treatment. In the present study, we have evaluated renal injuries in terms

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Corresponding Author: Huseyin Kafadar, Adiyaman University, Faculty of Medicine, Department of Forensic Medicine, Adiyaman, Turkey **E-mail:** dr.hkafadar@gmail.com

of radiological and forensic medicine, and we believe the findings contribute to the existing literature on this subject. We aimed to evaluate renal injuries retrospectively according to the forensic medicine and radiology.

MATERIAL and METHODS

The university ethics committee approved this study. The patients who applied to the Radiology Clinic, Adiyaman Training and Research Hospital between 01.01.2013 and 31.01.2017 were evaluated. The abdominal US, magnetic resonance imaging (MRI), and computed tomography data were examined from the Picture Archiving and Communications System (PACS), and patients with renal injury were enrolled in the study. Patients with isolated ureter injuries, and bladder injuries were not included in this study.

Cases were examined in terms of age, sex, and causes of injury, which included blunt traumas (e.g., traffic accidents, falls, work accidents, and home and school accidents) and penetrating injuries (e.g., gunshot wounds and sharp and penetrating object injuries). The evaluated injuries included perirenal hematomas, renal lacerations, and injuries to the renal arteries and veins. The degree of kidney injury determined by imaging methods was evaluated in terms of the American Association for the Surgery of Trauma (AAST) (1,2,11). The injuries were also evaluated in terms of forensic medicine applications.

The data were examined utilizing a suitable computer-aided package program and the SPSS 19.0 program was used for statistical analyses. Descriptive statistics and continuous variables were presented as mean \pm standard deviation and categorical variables were calculated as frequency and percentage. The Pearson chi-square or Fisher's exact test was utilized, according to suitability, to

compare frequencies after percentages were computed. The differences or relationships between groups were statistically analyzed. P value less than 0.05 was accepted as statistically significant.

RESULTS

In total, 123 patients with renal injury were investigated in the present study. Of these, 27 (21.95%) were female and 96 (78.05%) were male. The average age of the cases was 32.6 ± 16.7 years (Figure 1).

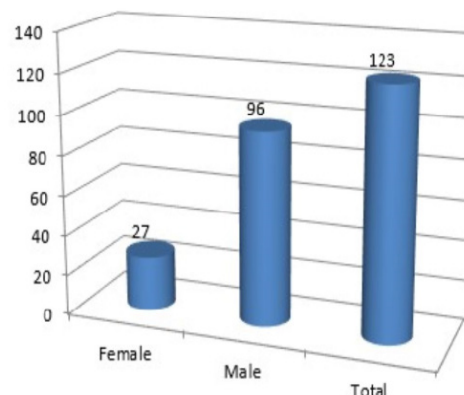


Figure 1. Shows distribution of gender

Most cases (47.96%, $n = 59$) were younger than 35 years. When the cases were examined according to age groups, 11 (8.94%) cases were under the age of 14 years, 23 (18.70%) cases were aged 15–24 years, and 25 (20.32%) cases were aged 25–34 years. The older age groups included 23 (18.70%) cases aged 35–44 years, 19 (15.46%) aged 45–54 years, 9 (7.31%) aged 55–64 years, and 13 (10.57%) older than 65 years (Table 1).

Table 1. Shows reason of injuries according to the age groups

	Under 14 years		15-24 years		25-34 years		35-44 years		45-54 years		55-64 years		Above 65 years	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Gunshot	0	0	1	0.82	1	0.82	2	1.62	2	1.62	1	0.82	0	0
Fall	4	3.25	6	4.87	6	4.87	6	4.87	5	4.07	4	3.25	5	4.07
TA	7	5.69	11	8.94	11	8.94	10	8.94	9	7.31	4	3.25	7	5.69
Stabbing	0	0	4	3.25	4	3.25	3	2.43	1	0.82	0	0	0	0
Fight	0	0	1	0.82	2	1.62	1	0.82	1	0.82	0	0	0	0
WA	0	0	0	0	1	0.82	1	0.82	1	0.82	0	0	1	0.82
Total	11	8.94	23	18.70	25	20.32	23	18.70	19	15.46	9	7.31	13	10.57

TA: Traffic Accident, WA: Work Accident, χ^2 Square, $P > 0.005$

While 19 (15.44%) cases were penetrating injuries, 104 (84.56%) cases were blunt injuries. Examination of the cases according to the cause of injury revealed that 59 cases (47.96%) were traffic accidents ($p < 0.005$), 36 (28.96%) were falls, 12 (9.74%) were sharp and penetrating

object injuries, seven (5.69%) were gunshot wounds, five (4.07%) were assaults, and four (3.25%) were work accidents (Table 2).

Kidney injuries were graded according to the AAST criteria (1,2,11).

Table 2. Shows reason of injuries according to gender

Origin	Gunshot		Fall		TA		Stabbing		Fight		WA		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Female	1	0.82	9	7.31	13	10.57	3	2.43	1	0.82	0	0	27	21.91
Male	6	4.87	27	21.65	46	37.39	9	7.31	4	3.25	4	3.25	96	78.09
Total	7	5.69	36	28.96	59*	47.96	12	9.74	5	4.07	4	3.25	123	100.0

TA: Traffic Accident, WA: Work Accident, χ^2 Square, $P > 0.005$

Grade 1: Injury in the form of subcapsular hematomas without parenchymal laceration and expanding in the kidney (Figure 2).

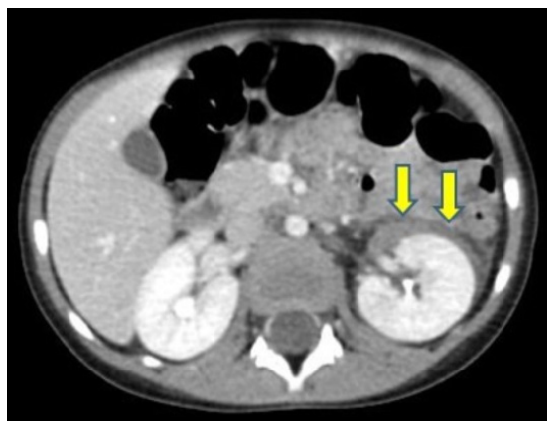


Figure 2. Shows grade 1 renal injury (Yellow arrow shows hematoma)

Grade 2: Superficial, with less than 1 cm lacerations, without affecting collector system; limited non-expanding perinephric/perirenal hematomas associated with retroperitoneum, accompanied by cortical lacerations (Figure 3).



Figure 3. Shows grade 2 renal injuries (Yellow arrow shows hematoma and blue arrow shows laceration)

Grade 3: Lacerations larger than 1 cm in the kidneys without a collecting system injury (Figure 4).

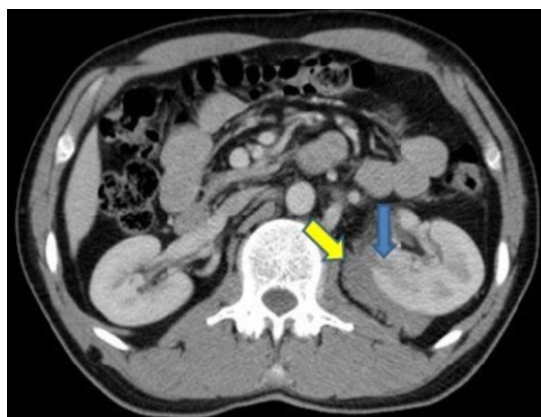


Figure 4. Shows grade 3 renal injuries (Yellow arrow shows hematoma and blue arrow shows laceration)

Grade 4: Deep renal parenchymal lacerations, including the main renal artery and vein, extending from the cortex and medulla to the collecting system (Figure 5A, 5B).



Figure 5. Shows grade 4 renal injuries (Yellow arrow shows hematoma and blue arrow shows laceration)

Grade 5: Laceration that completely shatters the kidney, with vascular avulsion of the kidney hilum (Figure 6A, 6B).

Examination of the cases according to the AAST criteria revealed 52 cases (42.27%) with grade 1 injuries, 31 (25.20%) with grade 2 injuries, 26 (21.13%) with grade 3 injuries, 9 (7.31%) with grade 4 injuries, and 5 (4.06%) with grade 5 injuries. Most cases were grades 1 and 2 and therefore represented minor traumas ($p < 0.05$) (Figure 7).

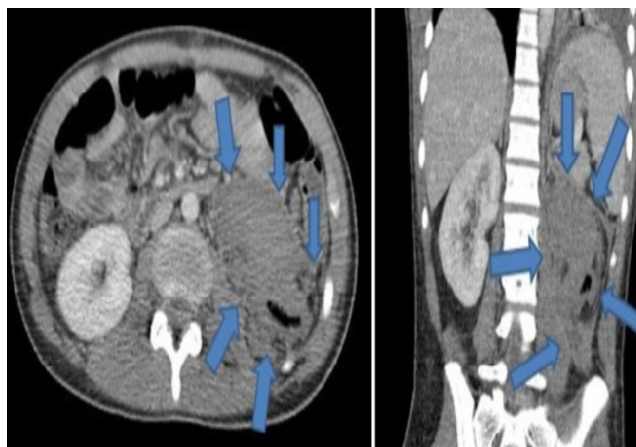


Figure 6. Shows grade 5 renal injuries by gunshot. (Yellow arrow shows hematoma and blue arrow shows laceration)

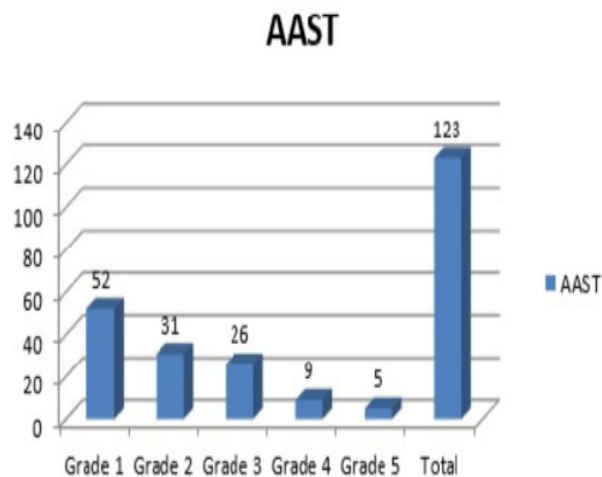


Figure 7. Shows grades of renal injuries

Gender	Cause of injury	Age	Injured organs	Result	Total
Female	Traffic Accident	45	Perirenal hematoma, brain edema, subarachnoid hemorrhage	Exitus	N:2 %1.63
	Fall	29	Perirenal hematoma, brain edema, subarachnoid hemorrhage, pelvis fractures	Exitus	
Male	Traffic Accident	48	Renal injury, brain contusion, subarachnoid hemorrhage, liver laceration	Exitus	N:4 %3.25
	Work Accident	29	Perirenal hematoma, cerebral hematoma, lung contusion	Exitus	
	Traffic Accident	37	Renal injury, cerebral contusion, subarachnoid hemorrhage, lung laceration	Exitus	
	Fall	42	Perirenal hematoma, cerebral contusion, subarachnoid hemorrhage, femur fractures	Exitus	

In total, 102 (82.92%) cases were managed with conservative therapy, whereas 21 (17.08%) patients required surgical operation. In addition, 8 (6.50%) cases underwent nephrectomy.

One or more organ injuries accompanied the renal injuries in 112 (91.05%) cases, and isolated renal injury was found in 11 (8.95%) cases. No deaths occurred due to isolated renal injury, but six patients (1.63%; two females and four males) died due to multiorgan injuries (Table 3).

DISCUSSION

Renal injuries are a life threatening condition and are frequently encountered in forensic medicine practices. Renal injuries account for roughly 1–5% of all traumas (1,10-13). The kidneys are the third most frequently injured solid organ, after the liver and spleen, due to blunt abdominal trauma (1,3).

Renal traumas are mostly seen in the younger age groups. Large retrospective studies have reported a mean age of 20–30 years, and cases with renal injury are mostly under 45 years of age (1-6,14-16). Different studies have

reported that renal trauma is mostly seen in men, as this type of injury is encountered three times more frequently in males than in females (1-5,16,17). In the present study, we determined that of the 123 patients with renal injury, 21.95% were female (n=27) and 78.05% were male (n=96). The average age of our cases was 32.6 ± 16.7 years, and 66.66% of our cases (n=82) were younger than 45 years. These data were consistent with the literature.

Renal injuries can occur due to either penetrating or blunt traumas. Frequently reported causes are high-energy blunt traumas, such as traffic accidents, falls from a height, and contact sports (1,2,10-14). In recent years, the number of cases of blunt renal trauma has increased due to the increased use of motor vehicles in transportation. Therefore, renal injuries due to blunt trauma are becoming more common; however, this ratio varies from country to country, depending on social and economic factors (1,2). Most previous studies have reported an occurrence of renal injuries due to blunt trauma as high as 90–95% in rural areas, whereas the occurrence of penetrating injury was around 20% in urban areas (1,2,14-16). Kawashima

et al. reported that 80–90% of renal injuries occurred because of blunt trauma, (17) and the most common causes of blunt renal injuries were traffic accidents (11, 18). Most of the renal traumas are grade 1, 2, and 3 injuries. The incidence of grade 4 and 5 renal injuries is lower because the kidney is in an anatomically well-protected area, which means that grade 4 and 5 renal injuries only occur following high-energy traumas. In addition to the radiological classification, hematuria can be considered as a finding in renal injuries, and the severity of hematuria may increase following high-energy traumas due to the degree of kidney injury (17).

In our study, we determined that blunt trauma accounted for 84.55% (n = 104) of the cases and penetrating injuries accounted for 15.45% (n = 19). The most common causes of renal trauma were traffic accidents (59 cases; 47.96%) (p<0.005), falls (36 cases; 28.96%), stabbing injuries (12 cases; 9.74%), gunshot wounds (seven cases; 5.69%), assaults (five cases; 4.07%), and work accidents (four cases; 3.25%). These data were consistent with the literature.

Mingoli et al. conducted a meta-analysis of 13,824 cases, including 10,826 cases of penetrating injury and 2,998 cases of blunt renal injury (3). Similarly, Sahin et al. reported that the most common cause of renal injuries was penetrating injuries in 99 patients; gunshots injuries accounted for 81.60% and stab injuries for 18.40% (11). However, our data were not consistent with these studies.

The AAST renal injury scale, established in 1989, was grounded principally on findings from surgical explorations (1,19-21). This grading system, which categorizes renal injuries into five degrees, is frequently utilized in clinical and CT evaluations (1,2,20-22). Contrast enhanced CT is the first imaging modality used to evaluate renal trauma (1,3,11,20-22), diagnosis of trauma and trauma staging of the kidney is the gold standard. CT is a non-invasive method for the detection of renal injuries, it has a high sensitivity and specificity for the detection of parenchymal lacerations in the kidney, and it provides a sensitive detection of urinary extravasation and associated injuries in other organs. Contrast enhanced CT is also useful in detecting vascular injuries of the kidney (1-3, 11, 20-22). In present study, most cases were grade 1 and 2 and arose from minor traumas (p< 0.05). Grade 1 injury was determined in 42.27% (n = 52) of our cases, grade 2 injury in 25.20% (n = 31), grade 3 injury in 21.13% (n = 26), grade 4 injury in 7.31% (n = 9), and grade 5 injury in 4.06% (n = 5). These values were consistent with the literature.

Conservative treatment is more successful in cases of low-grade renal injury caused by blunt trauma, and the complication rate is also low. (1-3,20-22). In this study, 102 (82.92%) cases were managed with conservative therapy, whereas 21 (17.08%) patients required surgical operations. In addition, eight (6.50%) cases underwent nephrectomy.

High-grade renal injuries often have a higher mortality rate than is observed with low grade injuries. The mortality rate in renal injuries ranges from 7–10% of cases (1,2,11,20-22). In our patients, the mortality rate was 4.88% (n = 6) and was due to multiple traumas. This finding was not consistent with the literature.

CONCLUSION

In recent years, the development of radiological diagnostic methods (e.g., US, CT, and MRI) has made possible the rapid treatment of renal trauma cases. Conservative treatment is preferred in patients with hemodynamically stable renal function, and we believe that this has been effective in decreasing nephrectomy rates. In addition, the ability to obtain a rapid diagnosis nowadays allows immediate intervention in cases requiring emergency surgery.

Competing interests: The authors declare that they have no competing interest.

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Ethical approval: The study was approved by Adiyaman University ethical committee (Approval number: 2017/8-19).

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