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ARTICLE

Renal trauma: a 6-year retrospective review from a level 1 trauma center in Denmark

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ABSTRACT

Background: Management of renal trauma injuries is shifting towards more conservative approaches in hemodynamically stable adult patients, even for high grade and/or penetrating trauma. The objective of this study was to analyze the patterns of injury, management and complications in renal trauma patients at a Danish university hospital with a level 1 trauma center.

Method: Patients diagnosed with renal trauma at Rigshospitalet, Copenhagen, Denmark, between January 2010 and December 2015 were identified retrospectively by the ICD-10 code. Data were collected from electronic patient records. Imaging was classified by radiologists.

Results: Out of 107 patients identified, blunt injuries comprised 93%. Median age was 28. The distribution of injury grade according to AAST was 20% grade I, 4% grade II, 33% grade III, 33% grade IV and 10% grade V. All patients with grade I–III were managed conservatively. Two patients were treated with angioembolization (1 with grade IV and 1 with grade V). Five patients with grade IV were treated with an internal ureteral stent and one patient with grade IV blunt trauma had an emergency nephrectomy performed. Overall complication rate was 7%. No patient died due to their renal injury. Renal function was normal in all patients at discharge, assessed by eGFR measurement. Of the 50% of patients who were followed up with a renography, none developed obstruction due to the renal trauma.

Conclusion: The vast majority of renal injuries were due to blunt trauma. Hemodynamically stable patients, even with penetrating and/or high-grade blunt trauma, were managed non-operatively and there was a low rate of complications.

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Renal trauma; kidney injuries; AAST classification; emergencies; trauma

Introduction

Renal injuries occur in ~1–5% of all trauma cases [1]. Blunt trauma occurs more frequently than penetrating injury [2], although the distribution varies greatly between populations. Diagnosis is usually made by a computed tomography (CT) scan but can also be done during emergency laparotomy. Renal injury is classified into grade I–V with increasing severity according to the AAST (American Association for the Surgery of Trauma), as shown in Table 1. This classification corresponds to the risk of complications and need for intervention and is a predictor of reduced kidney function and death [3]. The treatment for renal injury due to trauma consists of one or a combination of the following: conservative management, minimally invasive intervention (e.g. angioembolization), placement of stent or drain, or open surgical intervention. Over the last decades, the paradigm for treatment has shifted away from surgical intervention towards more conservative approaches, due to the staging system and the development of interventional radiological procedures. Emergency surgical intervention remains necessary in the case of persistent hemodynamic instability, regardless of type of trauma, but it is well documented that hemodynamically stable patients with grade I–III can be managed conservatively with good results [3]. Controversy has previously existed regarding the management of hemodynamically stable patients with blunt grade IV–V injuries and penetrating injuries, but contemporary knowledge now supports conservative treatment [4]. This is to our knowledge the first study in a Scandinavian setting, where penetrating traumas are rare.

The objective of this study was to analyze our 6-year experience of renal trauma at a level 1 trauma center and report on patterns of injury, management as well as early and late complications.

Methods

A retrospective study on renal injury due to trauma in the period from 1 January 2010 to 31 December 2015 was conducted at Rigshospitalet, which has both a urological department and a level 1 trauma center in Copenhagen, Denmark, serving as a secondary hospital to approximately 750,000 people. Using the WHO International Classification of Disease, Tenth Revision (ICD-10), we identified patients with renal injury (DS37.0). Patients below 18 years of age were excluded, as were patients with suspected renal trauma (e.g. microscopic hematuria) who did not have a CT verified renal

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Table 1. American Association for the Surgery of Trauma Kidney Injury Scale.

Grade	Description
I	Contusion (hematuria with normal imaging) or subcapsular hematoma without parenchymal laceration
II	Non-expanding perirenal hematoma confined to Gerota's fascia or laceration of the parenchyma <1 cm without urinary extravasation
III	Laceration of the parenchyma >1 cm without collecting system rupture or urinary extravasation
IV	Parenchymal: laceration extending through the renal cortex, medulla and collecting system Vascular: Main artery or vein injury with contained hemorrhage
V	Parenchymal: Completely shattered kidney. Vascular: Avulsion of renal hilum which devascularizes the kidney

injury and patients without trauma (e.g. iatrogenic renal injuries). We reviewed electronic patient records for data on patient characteristics including age and gender, type and mechanism of injury, associated injuries, initial management, need of blood transfusions, days of admission, complications, follow-up renal scintigraphy and post-trauma kidney function (eGFR). Lastly, we reviewed the Shared Medication Record (FMK) which provided access to current medication and prescriptions to obtain information on prescribed antihypertensive medicine on all patients at follow-up which ended at 1st of October 2017.

Conservative treatment at Rigshospitalet typically implies: bed rest until stable, analgesics, prophylactic antibiotics and close monitoring of blood pressure, pulse and blood levels of hemoglobin and creatinine. The patients are recommended a follow-up renal scintigraphy 3 months after trauma and follow-up of blood pressure with their general practitioner (GP).

The initial radiology reports contained a description of the trauma but did not systematically grade the kidney injury. For this study, two radiologists independently re-assessed and classified all cases according to the AAST organ injury severity scale (Table 1). Any discrepancies were discussed and consensus was achieved in all cases.

Statistics: Descriptive statistics were analyzed for the population characteristics and outcomes using SPSS (software version 25; IBM).

Results

Admissions

A total of 107 patients were admitted to Rigshospitalet with renal injury over a 6-year period from January 2010 until December 2015. Of these, 63% ($n = 68$) were admitted to the urological ward either directly or via the trauma center, while the rest were admitted to other wards (primarily the department of abdominal surgery and the neurosurgical department). On average 18 patients (range 13–23) were admitted per year.

Of the patients received at Rigshospitalet, 50% ($n = 53$) were primarily received at other hospitals and transferred to our facility due to either the degree or type of injury.

Demographics

Males comprised 81% ($n = 87$) of all patients with renal injury. The median age at admission was 28 years (range = 18–92) for the total cohort. The median age was similar between males and females; females 33 years (range = 18–83) and males 32 years (range = 18–92). However, there was a difference in pattern of age distribution (Figure 1). When grouping patients in 5-year intervals from the age of 18, males had the highest incidence from age 18–33 years, after which the incidence generally decreased with age. For females the incidence was more consistent across ages.

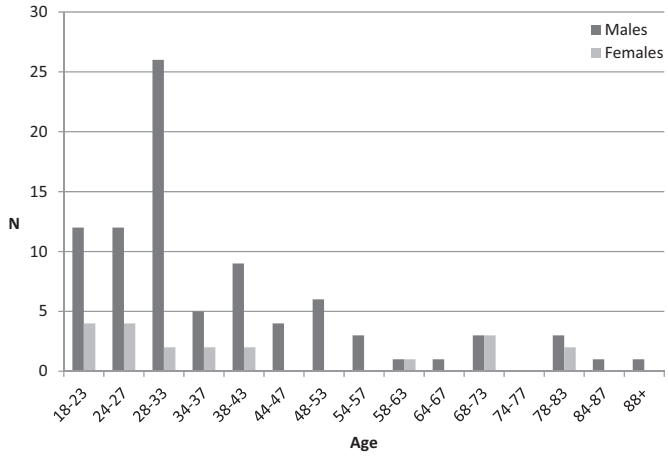

Figure 1. Age distribution for males and females.

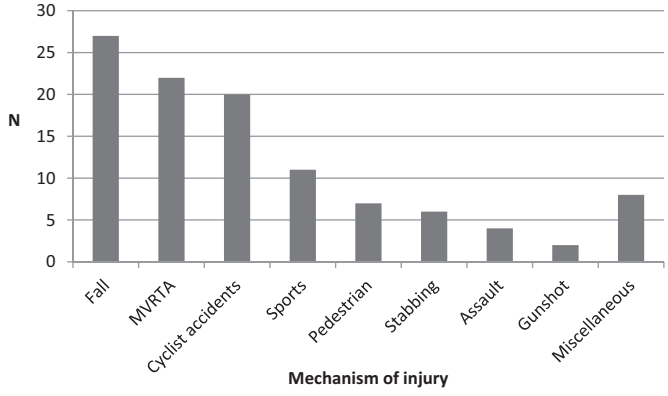

Figure 2. The distribution of number of patients on mechanism of injury (MVRTA, motor vehicle road traffic accidents).

Mechanisms of injury

The mechanisms of injuries of all traumas admitted to the hospital are shown in Figure 2. Blunt injuries comprised 93% ($n = 99$). Of the blunt injuries the predominant mechanism of injury was falls, comprising 27% ($n = 27$), while other causes included motor vehicle road traffic accidents (22%), cyclist accidents (20%), sports injuries (11%), accidents involving pedestrians (7%), blunt assaults (4%) and miscellaneous (8%).

There were eight penetrating injuries (7%), all in male patients, comprising six stabbings and two gunshots.

Imaging and grade of injury

The injury was for all patients diagnosed from a contrast enhanced CT, of which 37% ($n = 40$) did not include an excretory phase. The reasons for omitting an excretory phase were not documented. Of these 40 patients, 18 were graded as grade III despite a lack of delayed phase imaging.

The distribution of grade of renal injury was 20% grade 1 ($n = 22$), 4% grade 2 ($n = 4$), 33% grade 3 ($n = 35$), 33% grade 4 ($n = 35$) and 10% grade 5 ($n = 11$). The distribution was the same for patients admitted directly to the urological ward and patients admitted to other wards.

Of the eight penetrating injuries, five were grade III, two were grade IV and one was grade V.

Of the 107 patients with renal trauma, 58% ($n = 62$) had concomitant injury of other organs.

Associated organ injury was present in 23% ($n = 5$) of grade 1 injury, 25% ($n = 1$) of grade 2, 57% ($n = 20$) of grade 3, 54% ($n = 19$) of grade 4 and 63% ($n = 7$) of grade 5, not including minor injuries where observation or treatment in hospital was not necessary.

Treatment and complications

In 92% ($n = 96$) of the cases patients were treated conservatively with regards to their renal injury, 5% ($n = 5$) were treated with an internal JJ ureteral stent due to extravasation of urine, 2% ($n = 2$) were treated with embolization and 1% ($n = 1$) had an emergency nephrectomy performed. This patient had a blunt grade IV injury and was initially planned for embolization but due to hemodynamic instability a nephrectomy was performed. All other patients requiring intervention sustained their injury as a result of blunt trauma and were all grade IV–V as well as shown in Table 2. All cases of blunt trauma with grade I–III were managed conservatively. All patients with penetrating trauma were conservatively managed with regards to their renal injury, but seven out of the eight patients required a laparotomy for concomitant abdominal injury.

Out of all 107 patients with renal injury, four patients with blunt renal injury died; three died almost immediately in the trauma center due to polytrauma with significant head and/or intrathoracic injury and one patient died during admission in the Intensive Care Unit (ICU). None of the cases had renal injury as the presumed cause of death.

Of the 68 patients admitted to our urological ward, 13% ($n = 9$) were treated with one or more blood transfusions. From the other patients we could not obtain valid data on blood transfusions. Seven percent ($n = 5$) of the patients originally admitted to the urological ward were readmitted within 30 days, all because of infections. One patient had a grade III injury and four patients grade IV. Three patients were treated for urosepsis. One patient had re-bleeding and infection and was treated conservatively. The last patient (grade IV) was treated with antibiotics for infection and a follow-up CT revealed a pseudoaneurism and massive urinary extravasation; this patient was treated with an internal stent and the pseudo aneurism was embolized successfully. Only patients with symptoms of complications had repeat CT imaging performed in accordance with EAU guidelines [4] and patients with signs of infection who responded clinically to antibiotics did not have repeat CT imaging performed.

Follow-up

Out of the 103 patients who survived their injury, two patients had a solitary kidney at follow-up (one had a nephrectomy due to renal trauma and the other due to previous renal cell carcinoma). Of the remaining 101 patients suitable for a split function renal scintigraphy, 56% ($n = 57$) had this performed after 2–3 months. The percentage distributed on trauma grade was 59% ($n = 13$) of grade I patients, 33% ($n = 1$) of patients with grade II, 43% ($n = 32$) of patients with grade III, 68% ($n = 23$) of patients with grade IV and 60% ($n = 6$) of patients with grade V. Of the 44 patients who did not have a split function renal scintigraphy performed, two were not Danish citizens, five did not show up for the planed examination and the remaining 37 patients were never referred to the examination. Of the 37 patients who were never referred, 21 were discharged from the urological ward and 16 were discharged from another ward. The results of follow-up renal scintigraphy regarding distribution of function according to grade of injury are outlined in Figure 3. Reduced function is set to <43%. None of the patients with grade I–II had reduced function except one patient where a stricture of the ureteropelvine junction was diagnosed on contrast enhanced CT and this patient was the only one who had delayed excretion.

Kidney function was also monitored by using estimated glomerular filtration rate (eGFR) and was within the normal range (>60 mL/min) for all 104 patients at the time of discharge from hospital.

Out of 103 patients, four patients were not Danish citizens and, therefore, we do not have information on their blood pressure or medication. Of the remaining patients, 10 had started on antihypertensive medicine after their trauma at the end of follow-up. The distribution of trauma grade for

Table 2. Management of renal trauma.

	Conservative, *n* (%)	Embolization, *n* (%)	Internal stent, *n* (%)	Nephrectomy, *n* (%)	Deceased <24 h, *n* (%)	Total, *n* (%)
Grade I	22 (21)					22 (21)
Grade II	4 (4)					4 (4)
Grade III	33 (31)				2 (2)	35 (33)
Grade IV	28 (26)	1 (1)	5 (5)	1 (1)		35 (33)
Grade V	9 (8)	1 (1)			1 (1)	11 (10)
Total	96 (90)	2 (2)	5 (5)	1 (1)	3 (3)	107 (100)

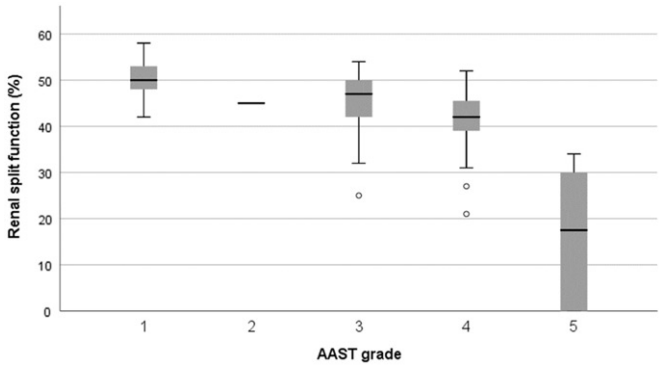

Figure 3. Results of follow-up renal scintigraphy displaying the renal split function in percentage for the affected kidney with regards to trauma grade.

these patients were: four with grade I, two with grade II, two with grade III, one with grade IV and one with grade V. Of these only one was under 50 years of age and this patient was diagnosed with polycystic kidney disease.

Discussion

Consistent with previous studies on renal trauma we found that the majority of patients were younger males with blunt trauma [1,5–7]. Falls, motor vehicle RTA and cycling accidents accounted for most cases in the present study, which was expected in a country with restrictive weapons regulations and where bicycling is a common means of transportation. We found a high proportion of major renal trauma (>grade III) compared to previous studies [1,5,8], which most likely reflects the study setting including patients admitted directly to a level 1 trauma center, where 50% of the patients transferred from other hospitals because of either type or severity of the injury. As this study is retrospective and relies on diagnosis codes, it is possible that some patients admitted with renal injuries in addition to other major problems may have been missed. Also, we excluded patients with microscopic hematuria who did not have a CT scan. This could potentially alter both the distribution of grade of injury as well as the complications rate. However, we hypothesize that these most likely represent low-grade renal injuries where complications are not common and thus possibly an overestimation of the total complication rate. In this retrospective study of renal trauma in 107 patients admitted to a university hospital with a urology department and a level 1 trauma center, no patient died due to renal trauma and only one patient had emergency open surgical intervention due to the renal injury itself and underwent nephrectomy after grade IV blunt renal trauma. Our nephrectomy rate of 1% is significantly lower than previous studies [1,5,7–9], some of which were conducted outside of centers with urological specialization, consistent with previous evidence that the nephrectomy rate for renal trauma is higher in more rural places without urological expertise [5].

All grade I–III injuries were managed conservatively. Most patients with grade IV–V injury were also managed conservatively, in consensus with previous reports [6,10,11]. Five percent of the patients (all grade IV) were successfully treated with an internal stent due to massive urinary extravasation and 2% with angioembolization due to ongoing bleeding. No patient in our population needed re-embolization or delayed nephrectomy, which makes for a higher primary success rate than reported in previous studies [12,13]. Whether intervention in relation to extravasation of urine in renal trauma is beneficial remains uncertain [14].

For those patients with renal injury due to trauma as their main problem we had a complication rate of 7% which is similar to previous studies, although there was a large proportion of high-grade renal trauma in our study. All patients had normal kidney function assessed by eGFR at discharge from hospital.

At our institution, a renal scintigraphy is recommended 2–3 months after renal injury in accordance with EAU guidelines and, as expected, the risk of reduced kidney function is higher with increased injury grade [4,15]. None of the patients with grade I–II had reduced kidney function on their renal scintigraphy except one where a stricture of the ureteropelvine junction was diagnosed that was unrelated to the renal trauma; after later surgical repair, a postoperative renal scintigraphy showed normal split function. This was also the only case where renal scintigraphy identified excretion problems, which would generally be the only identifiable treatable abnormality on the nuclear follow-up scan. We suggest that renal scintigraphy has no clinical consequence for most patients with renal injury without ureteral involvement.

We recommend that patients have follow-up measurements of blood pressure after renal trauma, but as this occurs out of the hospital setting we could only obtain data on their prescribed medicine and not on the measured blood pressure. Nine out of ten patients who were started on antihypertensive medicine after their renal injury were >50 years. As the general risk of developing essential hypertension increases with age, we cannot conclude whether the development of hypertension is a consequence of their renal trauma. One patient was only 39 but diagnosed with polycystic kidney disease, offering another likely explanation for the development of hypertension. Patients developing hypertension were distributed on all grades of renal injury. We do not know if all patients had the recommended follow-up visit with their GP, or if some patients who had hypertension were treated with lifestyle modifications and not medication. Lastly, we do not know if our follow-up time was appropriate for detection of hypertension in all patients. We therefore cannot conclude whether there is an increased risk of hypertension after renal trauma, nor whether follow-up for this indication is rational. Some radiological difficulties regarding the grading deserve mentioning. First, the AAST does not specifically include assessment of active bleeding in the grading system. In this study all cases of active bleeding are interpreted as grade IV as a minimum since bleeding is a sign of damage to the vessels. Second, 37% of all cases had a contrast enhanced CT performed with no excretory phase. This leads to a possible down-grading of the trauma, especially grade IV to grade III injuries if extravasation of urine is not sufficiently demonstrated. Finally, the parenchymal grade V (shattered kidney) is rarely used since it is difficult to

define. These limitations, however, do not change our conclusions regarding treatment or follow-up.

Conclusions

This study shows that penetrating trauma is rare at our hospital and that the majority of blunt traumas are due to falls, motor vehicle RTA and cycling accidents. Our findings support, that even high-grade blunt injuries and stable penetrating injuries do well with non-operative management. No patients died due to their renal injury and no patients had delayed nephrectomy performed at our hospital. Furthermore, our results show that renal scintigraphy has no clinical consequence in this patient population. Lastly, we found that 10% of this population were prescribed antihypertensive medication during follow-up, but blood pressure measurements were not done systematically and we cannot conclude whether there is an increased risk of hypertension after renal trauma nor whether follow-up for this indication is rational.

Disclosure statement

No potential conflict of interest was reported by the authors.

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