Role of multidetector computed tomography findings in grading renal injuries at Assiut University Hospital: a clinical audit study

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Aim

To assess the performance of our Radiological Department and value of multidetector computed tomography (MDCT) in renal injured patients at Assiut University Hospital during 1 year.

Patients and methods

This prospective study was done in the period from April 2017 to March 2018 in Assiut University Hospital on all patients with renal trauma who presented to the trauma unit diagnosed as having renal trauma by CT with contrast and to correlate the findings seen in the MDCT with clinical and operative data of patients with renal injuries.

Results

Of the 61 traumatized patients who came to the trauma unit of Assiut University Hospitals with different forms of renal injuries, 48 (78.7%) were males and 13 (21.3%) were females. The range of age of those patients was between 1 and 70 years, with a mean age of 23.18 years. The cause of injury in 55 (90.2%) patients was blunt trauma, whereas penetrating trauma (firearm and stab wound) was present in six (9.8%) patients. Of the enrolled patients, 13 (21.3%) patients were hemodynamically unstable. Hematuria was present in 37 (60.7%) patients and 24 (39.3%) patients had clear urine. Conservative management was the main line for renal injuries in the current study, where 44 (72.1%) patients were followed conservatively. Nephrectomy was done in 12 (19.7%) patients, whereas renal repair was done in three (4.9), and angioembolization and double J stent were required in one patient each. Of the enrolled patients, 56 (91.8%) patients improved and survived.

Conclusion

Contrast-enhanced MDCT may be the best imaging modality for the assessment of renal trauma and other involved organs, as it provides significant anatomic and functional details essential to establish the type and extent of vascular, collecting system, or parenchymal injuries. Developments in CT techniques are useful for the patient choice for the best treatment and to prevent failure of conservative treatment.

Keywords:
focused assessment of multidetector computed tomography, grades of renal injury, renal trauma

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Introduction

Trauma is interpreted as a physical damage or injury to living tissue caused by an external force. Trauma is the sixth main cause of death globally, accounting for 10% of all mortalities. It accounts for nearly five million deaths each year around the world and produces incapacity to millions more [1,2]. Genitourinary trauma involves both sexes and in all age groups but is more common in males. The most frequently injured organ in the genitourinary system is the kidney, and renal trauma can be seen in up to 5% of all injured cases [3,4].

Renal trauma has been categorized by the American Association for the Surgery of Trauma (AAST) into five classes according to the degree of tissue damage; it occurs in 10% of all abdominal injury cases [5].

Contrast-enhanced multidetector computed tomography (MDCT) may be the best imaging modality for the assessment of renal trauma and other involved organs, providing significant anatomic and functional details essential to establish the type and extent of vascular, collecting system, or parenchymal injuries. Developments in computed tomography (CT) techniques are useful for the patient choice for the best treatment and to prevent failure of conservative treatment.

Advantages of multidetector row computed tomography

The main benefits of MDCT are faster scanning time, increased volume coverage, and developed spatial

and temporal resolution [6]. These values result in an increased number of slices obtained within a certain amount of time, which depends on the number of rows or channels.

Grading of renal trauma

The common approved grading system for renal injuries was established by the AAST (Table 1) [7].

This verified system has clinical and prognostic relevance and helps to estimate the demand for intervention [8].

It also estimates disability after penetrating or blunt trauma and mortality after blunt injury [9].

Scheme for changes include classification of the intermediate grade injury into grade 4a (low-risk cases likely to treat conservatively) and grade 4b (high-risk cases likely to benefit from intervention and operative management), established on the presence of major radiographic risk factors, including laceration, intravascular contrast extravasation, and perirenal hematoma entanglement [10].

In addition, there is a proposition that grade 4 injuries involve all collecting system injuries, comprising ureteropelvic junction injury of any extremity and venous and segmental arterial injuries, whereas grade 5 injuries should comprise only hilar injuries, involving thrombotic events [11].

This study aimed to assess the performance of our radiology department and the value of multislice computed tomography (MSCT) in renal injured patients at Assiut University Hospital during 1 year and to correlate the findings seen in the MSCT with clinical or operative data of patients with renal injuries.

Table 1 Kidney injury scale of the American Association for the Surgery of Trauma[7]

Grade	Interpretation of injury
1	No laceration
	Nonexpanding subcapsular hematoma
	Contusion
2	Cortical laceration <1 cm deep without extravasation or nonexpanding perirenal hematoma
3	Cortical laceration >1 cm without collecting system injury
4	Laceration extending to cortico-medullary junction into the collecting system
	Vascular injury involving segmental renal artery or vein injury with contained hematoma or vessel thrombosis or partial vessel laceration
5	Vascular injury involving the renal pedicle, or avulsion or shattered kidney

[a]Advance one grade for bilateral injuries up to grade 3.

Patients and methods

A prospective, clinical, audit study was performed in the Diagnostic Radiology Department in Assiut University Hospital. The patients underwent MSCT scanning for the diagnosis of renal injury grades during the period from April 2017 to March 2018.

Patient selection criteria:

- Inclusion criteria were as follows: patients who are diagnosed to have renal tissue injury by contrast CT and were able and well cooperating with the study requirement
- Exclusion criteria were as follows: patients discharged from the hospital without having MSCT examination.

Equipment and examination protocol

MDCT was done as follows: the scan is carried out using 16-row General Electric (GE, New York, New York, USA) Bright Speed or 64-row Toshiba (Tokyo, Japan) Aquilion MDCT scanners.

THE IV contrast is adjusted accord to weight and 120–150 ml of nonionic iodinated contrast media (270 mg iodine/ml) was injected into the vein by appropriate rate (3.5 ml/s) for fear of rupture vein.

Arterial phase scan begins after the start of injection of contrast media by 20–30 s. This phase is the best for determining arterial vascular lesions (as pseudoaneurysms or renal artery avulsion or arteriovenous fistulae and thrombosis) and for diagnosis of active extravasation of contrast material from arterial system; in addition, it enables accurate delineation of the anatomy of arterial system and subsequent variants.

In the porto-venous phase, the scan should be delayed till 80 s after injection (PI). This phase is mandatory for diagnosis of hematoma, parenchymal lesions (as segmental infarctions or lacerations), and venous vascular lesions (i.e., thrombosis of the renal vein or avulsion) and must be carry out in case of suggestion of renal injury; in addition, it represents a functional aid for assessing the relevance of active extravasation of contrast material from arterial system and enables accurate determination of damage to other abdominal organs and parenchyma.

Delayed excretory scan is accurately controlled by the clinical condition of the patient and the findings in the arterial and portal phases. The timing of the delayed phase depends on kidney function, which in our study take less time which renal function test was not done at any case of our study and may vary from 10 to 20 or more; 15 min may represent a suitable accommodation

in most of our cases. Delayed accession is essential for the detection of the injury of collecting system, by showing urine extravasation (hyperdense urine), and may help in the differentiation between renal infarction and parenchymal contusion.

Statistical analysis

Data were collected and analyzed using Statistical Package for the Social Science (version 20, IBM, Armonk, New York, USA). Continuous data were expressed in the form of mean ± SD or median (range), whereas nominal data were expressed in the form of frequency (percentage).

We compared the nominal data of different groups in the study by χ^2 test. If P value less than 0.05, it is significant.

Results

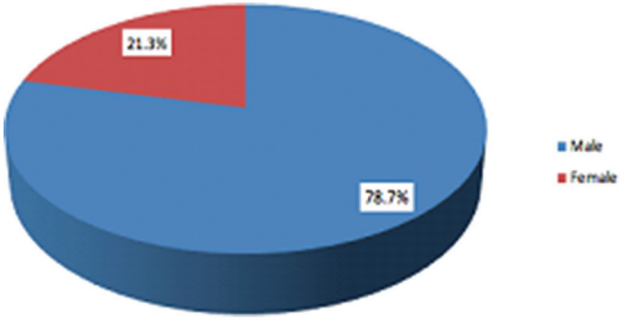
Our study included 61 patients who came to the Trauma Unit of Assiut University Hospitals with different forms of renal injuries. Of those patients, 48 (78.7%) were males and 13 (21.3%) were females. The age range of those patients was between 1 and 70 years, with a mean age of 23.18 years (Fig. 1 and Table 2).

The cause of damage in 55 (90.2%) patient was blunt trauma, whereas penetrating trauma (firearm and stab wound) presented in six (9.8%). Of the enrolled patients, 13 (21.3%) patient were hemodynamically unstable. Hematuria was present in 37 (60.7%) patients and 24 (39.3%) patients had clear urine (Fig. 2).

Type of trauma and grade of renal trauma

Renal injury grades from grade I till grade V occurred in eight (14.5%), two (3.6%), 10 (18.2%), 23 (41.8%), and 12 (21.8%) patients, respectively, secondary to blunt trauma (Table 3).

Figure 1



Sex distribution in the current study.

Six patients in the study had penetrating trauma. Each of grades I and V renal injury presented in one patient, and each of grades III and IV presented in two patients, whereas none of those patients with penetrating trauma had grade II renal injury. There is no obvious difference between types of trauma based on renal injury grades ($P > 0.05$) (Fig. 3).

Renal injury grades and management types in the currents study

The most frequent renal injury grades was grade IV presented in 25 (41%) followed by grade V in 13 (21.3%) patients and grade III presented in 12 (19.7%) patients. Grades I and II injuries presented in nine (14.8%) and two (3.3%) patients, respectively (Table 4).

Conservative management was the main line for renal injuries in the current study, where 44 (72.1%) patients were followed conservatively. Nephrectomy was done in 12 (19.7%) patients whereas renal repair was done in three (4.9), and angioembolization and double J stent were required in one patient each. Of the enrolled patients, 56 (91.8%) patients improved and survived (Table 4).

Multi-organ Injury based on Mode of Trauma and associated Injuries in the Current Study: It was noticed that only 4 patients (6.6%) have no other injuries. The

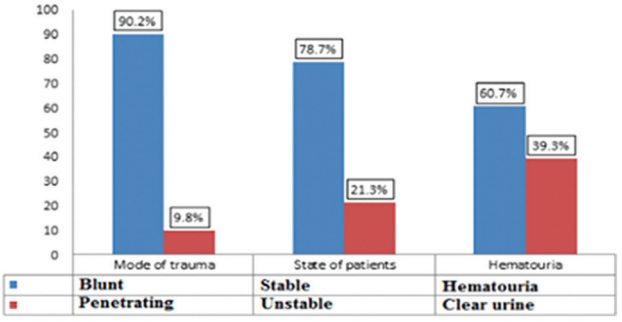
Table 2 Age of enrolled patients based on sex

	Male (*n*=48)	Female (*n*=13)	*P*
Age (range)	23.56 (1-70)	21.85 (3-55)	0.31

Table 3 Type of trauma and grade of renal injury

	Blunt trauma (*n*=55) [*n* (%)]	Penetrating trauma (*n*=6) [*n* (%)]	*P*
Grades			0.11
1	8 (14.5)	1 (16.7)	
2	2 (3.6)	0	
3	10 (18.2)	2 (33.3)	
4	23 (41.8)	2 (33.3)	
5	12 (21.8)	1 (16.7)	

Figure 2



Mode of trauma, state of patients, and hematuria in the studied patients.

most frequent associated finding was intraperitoneal free collection (hemoperitoneum) presented in 48 patients (78.6%) followed by splenic tear in ….. patients (27.8%) and lung injuries in 16 patients (26.2%). Hepatic tear was found in 8 patients (13.3%). Other associated injuries are summarized at (Table 5). It was noticed that 51 patients (92.7%) of those with blunt trauma had multiorgan injury while 5 patients (83.3%) of those with penetrating trauma had only renal injury (P = 0.03) (Table 5). Renal Injury Grades and Management types in the Currents Study: The most frequent renal injury grade was grade IV presented in 25 patients (41%) followed by grade V in 13 patients (21.3%) and grade III presented in 12 patients (19.7%). Grade I and grade II injuries presented in 9 (14.8%) and 2 (3.3%) patient (Table 6 and Fig. 4)

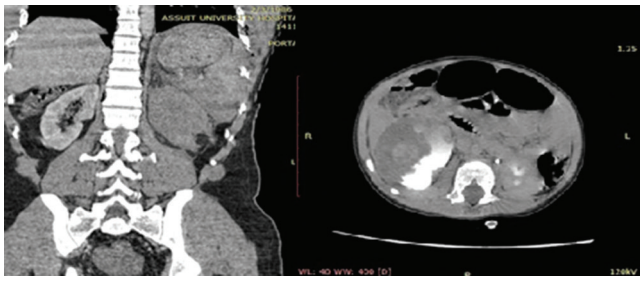
Table 4 Grade of renal injury and hematuria

	Hematuria (n=37) [n (%)]	Clear urine (n=24) [n (%)]	P
Grades			0.01
1	2 (5.4)	7 (29.2)	
2	1 (2.7)	1 (4.2)	
3	6 (16.2)	6 (25)	
4	19 (51.4)	6 (25)	
5	9 (24.3)	4 (16.7)	

Table 5 Multiorgan injury based on mode of trauma and associated injuries in the current study

	Mode of trauma [n (%)]		
Multiorgan injury	Blunt (n=55)	Penetrating (n=6)	P
51 (92.7)	5 (83.3)		0.03
Associated injuries			n=61
Intraperitoneal free collection (hemoperitoneum)	48 (78.6)		
Splenic tear	17 (27.8)		
Lung injuries	16 (26.2)		
Hepatic tears	8 (13.3)		
Retroperitoneal hematoma	5 (8.2)		
Nothing	4 (6.6)		
Fracture spine	4 (6.6)		
Fracture pelvis	3 (4.8)		
Fracture femur	1 (1.6)		
Colonic perforation	1 (1.6)		

Figure 3



Coronal and axial MSCT shows large right perinephric hematoma with laceration more than 1 cm, partially shuttered lower pole, and B shows urinary extravasation. Grade 4 renal trauma. MSCT, multislice computed tomography.

Discussion

Renal injury from different causes of trauma creates difficult task to clinicians in giving definite diagnosis. Most of these patients experience multiple injuries, and the associated clinical signs and symptoms of the intra-abdominal injury may obscured by other multiple injuries. However, MDCT can provide a fast and accurate assessment of the status of the abdominal organs, abdominal wall, and retro peritoneum. The use of MSCT has allowed determination of the current direction in the management of blunt intra-abdominal injuries toward nonoperative management [12].

MDCT is considered the best method for the radiographic evaluation of patients with renal injury and has absolutely substituted intravenous urography [13].

MDCT provides all the main details relating to the grade of parenchymal injury with or without involvement of pelvicalyceal system and renal vascular injuries and also provides details about the functional status of the kidneys with a short examination time.

The renal injury scale categorized by the Organ Injury Committee of the AAST is empirical and easily adjusted to radiologic evaluation of renal injury.

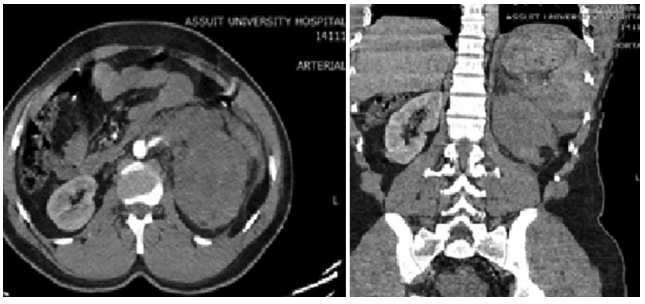
Classification of renal injuries according to severity helps in the selection of accurate treatment and the prognosis of results of management [14].

Renal trauma is common in people with age group 15–45 years, and in this age, renal injury is considered the major cause of death [15].

Males are more affected than females mostly owing to higher exposure to accidents. In a study done by Osman and colleagues, the distribution of age followed the same distribution of age in global studies.

Regarding the mechanism of trauma, most constricted injuries of the genitourinary organs

Figure 4



Axial and coronal MSCT shows medium left perinephric hematoma with laceration more than 1 cm, left renal artery thrombus, and global infarction. Renal injury grade 5. MSCT, multislice computed tomography.

Table 6 Renal injury grades and management types in the current study

	n=61 [*n* (%)]
Grade of renal injuries	
1	9 (14.8)
2	2 (3.3)
3	12 (19.7)
4	25 (41)
5	13 (21.3)
Type of management	
Conservative	44 (72.1)
Nephrectomy	12 (19.7)
Renal repair	3 (4.9)
Angioembolization	1 (1.6)
Double J stent	1 (1.6)
Outcome	
Survive	56 (91.8)
Died	5 (8.2)

were due to blunt abdominal trauma and accounted for up to 80–90% of total cases, of which the main cause of blunt trauma was motor car accidents, whereas penetrating trauma accounted for just about 10% of all renal trauma; however, its prevalence is growing [13].

Osman *et al*. [16] stated 80% of patients had closed blunt trauma and penetrating trauma was seen in 20% of patients, which is similar to our study.

In our study, nine (14.8% of cases) patients had grade 1 injury, two (3.3% of cases) patients had grade 2 injury, 12 (19.7% of cases) patients had grade 3 injury, 25 (40% of cases) patients had grade 4 injury, and 13 (21.3% of cases) patients had grade 5 injury.

In a study by Osman and colleagues, CT with contrast examination was done for all patients, and the MDCT findings were classified according to the AAST grading system. According to the finding in previous classification grade 1 injury was detected in nine (14.8%) patients, having small contusion as a positive finding and no laceration or perinephric hematoma, who refer that the most common type of renal injury are grade 1 injuries (75–85% of cases), which matches with the studies of Alonso and colleagues.

MDCT is now the best method in the management and detection of trauma in a study comprising 24 patients mainly having renal trauma [17].

Conservation now is considered the main approach of treatment even in high grades of renal trauma. In our study, in terms of percentage of conservation and intervention cases, our study included 61 patients, of whom conservative management was done in 44 patients and intervention management in 17 patients. The study by Henderson *et al*. [18] included 65 patients, where 48 patients underwent conservation management and 17 patients had intervention.

In a study by Lanchon *et al*. [19], which included 151 patients with renal trauma, 41 patients had intervention management. The main cause of intervention was persistent hemorrhage in eight patients, which was similar to our study, as the main cause of intervention.

Our limitations of this study is that it was difficulty to perform serial CT follow-up in all cases which helped in determination of the extravasation and the size of hematoma progression owing to economic level of the patients, the lack of uniformity in reporting timing of intervention, and definition of failure of conservative therapy.

Conclusion

MDCT is now one of the most reliable and effective methods in determining grades of renal injury, with the advantage of being extremely fast and minimally invasive. Contrast-enhanced MDCT may be the best imaging modality for the assessment of renal trauma and other involved organs, giving significant anatomic and functional details essential to establish the type and extent of vascular, collecting system, or parenchymal injuries. Developments in CT techniques are useful for the patient choice for the best treatment and prevent failure of conservative treatment.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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