



EFFICACY OF MULTIDETECTOR COMPUTED TOMOGRAPHY IN DIAGNOSING URINARY TRACT INJURIES IN ABDOMINOPELVIC TRAUMA: A COMPARATIVE STUDY

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ABSTRACT

Background: Urinary tract injuries involving the kidneys, ureters, and bladder are significant concerns in patients with abdominal and pelvic trauma. Accurate classification and timely diagnosis are essential for effective management. This study aims to evaluate the efficacy of Multidetector Computed Tomography (MDCT) in diagnosing these injuries compared to conventional imaging methods, such as ultrasound (USG) and X-ray. **Methods:** A prospective study was conducted on 30 patients with a history of abdominal or pelvic trauma, predominantly from Pondichery, India. Patients underwent clinical examination, X-rays, and FAST (Focused Abdominal Sonography in Trauma) as initial assessments. Those with specific indications were further evaluated using MDCT. The study analyzed injury prevalence, severity, associated symptoms, and imaging findings. **Results:** Renal injuries were most prevalent in the 40-49 age group (28%), while ureteric injuries were primarily observed in the 10-29 and 50-59 age groups (33.3% each). Bladder injuries were most common in the 30-39 age group (50%). The majority of renal injuries were Grade 2 (32%), with Grade 4 and Grade 5 being the least common (8% each). Ureteric injuries were evenly distributed among Grades 2, 3, and 5 (33.3% each), while Grade 2 bladder injuries were most frequent (50%). MDCT demonstrated superior sensitivity and specificity in detecting renal, ureteric, bladder injuries, and pelvic fractures compared to USG and X-ray. Both MDCT and USG/X-ray exhibited equal positive predictive values (100%) for these injuries; however, MDCT showed a higher negative predictive value, making it a more reliable diagnostic tool. **Conclusion:** MDCT is highly accurate in diagnosing urinary tract injuries in trauma patients, outperforming USG and X-ray in sensitivity, specificity, and negative predictive value. This study supports MDCT as the preferred imaging modality for evaluating renal, ureteric, and bladder injuries in abdominopelvic trauma. MDCT (Multidetector computed tomography) is a cross sectional imaging technique with multiplanar and multiple reconstruction capabilities. **Objective:** The objective of this study was to find out role of MDCT in identifying varieties of urinary tract injuries; grading and quantifying severity of such injuries and thus helping referring consultants in planning treatment. **Materials and methods:** During the period of May 2016 to October 2016, a prospective study of 30 patients having history of abdominal/pelvic trauma was carried out. CECT of abdomen and pelvis was performed on Phillips 16 slice MDCT machine using standard protocol. In a few selected patients(5 patients) CT cystogram was also performed.

Key words: Urinary tract injuries, Renal trauma, Ureteric injury, Bladder trauma, Multidetector computed tomography, MDCT, Abdominopelvic trauma, Imaging modalities, Sensitivity, Specificity.

INTRODUCTION

Trauma to the urinary system, particularly involving the kidneys, ureters, and urinary bladder, is a

significant concern in both blunt and penetrating injuries. Accurate classification and assessment of these injuries

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are crucial for effective management and treatment. The American Association for the Surgery of Trauma (AAST) has developed a standardized classification system for renal, ureteral, and urinary bladder injuries based on the severity and extent of the damage. This system aids in diagnosis, treatment planning, and predicting outcomes in patients with trauma-related injuries to the urinary system [1].

Renal Injury Classification

Renal injuries are categorized by the AAST based on the depth of injury and the involvement of the vascular system or collecting system. The classification ranges from Grade 1 to Grade 5, with increasing severity [1].

1. **Grade 1:** This grade represents the mildest form of renal injury, characterized by a contusion or subcapsular hematoma. There is no significant disruption to the renal parenchyma or collecting system, and the injury is usually managed conservatively [2].
2. **Grade 2:** In this grade, there is a perinephric hematoma or a superficial laceration that is less than 1 cm deep. These injuries still do not involve the collecting system and can often be managed without surgery [2].
3. **Grade 3:** This grade involves lacerations that are greater than 1 cm in depth but do not involve the collecting system. While more severe than Grade 2 injuries, these lacerations typically do not require immediate surgical intervention unless associated with other complications [3].
4. **Grade 4:** This grade represents more severe injury with deep lacerations that extend into the kidney and involve the collecting system. There may also be injury to the main renal artery or vein, leading to contained hemorrhage, or segmental infarction without associated laceration. These injuries often require surgical intervention and are associated with a higher risk of complications [3].
5. **Grade 5:** The most severe renal injuries fall into this category, characterized by a shattered kidney, devascularized kidney, or injuries to the ureteropelvic junction. These injuries often require immediate surgical repair and carry a high risk of loss of kidney function [4].

Ureteral Injury Classification

Ureteral injuries are also classified by the AAST into five grades, which reflect the extent of the damage and the degree of circumferential involvement of the ureter [1].

1. **Grade 1:** This grade involves a hematoma only, without any disruption to the ureteral wall. These injuries are usually managed conservatively [5].
2. **Grade 2:** In this grade, there is a laceration involving less than 50% of the circumference of the ureter.

These injuries may require surgical repair depending on the clinical context [5].

3. **Grade 3:** This grade involves lacerations that affect more than 50% of the circumference of the ureter. These injuries typically require surgical intervention to restore the integrity of the ureter [6].
4. **Grade 4:** In this grade, there is a complete tear of the ureter, with less than 2 cm of devascularization. These injuries require surgical repair and carry a higher risk of complications due to the disruption of blood supply [6].
5. **Grade 5:** The most severe ureteral injuries fall into this category, characterized by a complete tear with more than 2 cm of devascularization. These injuries require immediate surgical intervention and have a high risk of long-term complications [7].

Urinary Bladder Injury Classification

The AAST classification for urinary bladder injuries categorizes them into five types based on the location and extent of the injury [1].

1. **Type 1:** Bladder contusion, which is the mildest form of bladder injury, involves bruising of the bladder wall without any disruption. These injuries are usually managed conservatively [8].
2. **Type 2:** Intraperitoneal injury, where the bladder ruptures into the peritoneal cavity. This type of injury typically requires surgical repair [8].
3. **Type 3:** Interstitial bladder injury, which involves the wall of the bladder but does not extend into the peritoneal cavity. Management of these injuries depends on the extent of the damage [9].
4. **Type 4:** Extraperitoneal injury, where the bladder ruptures outside the peritoneal cavity. These injuries may be managed conservatively or surgically, depending on the clinical scenario [9].
5. **Type 5:** Combined bladder injury, involving both intraperitoneal and extraperitoneal components. These injuries usually require surgical intervention [10].

Imaging and Diagnostic Tools

CT cystography is a valuable diagnostic tool for evaluating bladder injuries in the context of trauma. This technique, performed alongside routine abdominopelvic CT, is highly accurate and can obviate the need for conventional cystography. CT cystography helps in classifying bladder injuries and planning appropriate treatment strategies while reducing additional costs and radiation exposure associated with conventional studies [11].

The AAST classification system provides a structured approach to diagnosing and managing renal, ureteral, and bladder injuries, which is crucial for optimizing patient outcomes in trauma settings [12].

MATERIALS AND METHODS

This study was a prospective analysis conducted on a cohort of 30 patients with a history of abdominal or pelvic trauma. The patient population predominantly comprised individuals from various regions of Pondichery. All patients underwent emergency imaging as part of their trauma evaluation. Initial assessments included clinical examination, X-rays, and Focused Abdominal Sonography in Trauma (FAST). For patients with specific indications, further imaging was performed using Multidetector Computed Tomography (MDCT).

Inclusion Criteria

The study included patients who met the following criteria:

1. **Patients with abdominopelvic trauma presenting with macroscopic hematuria and not in hypovolemic shock.** These patients were included to assess potential urinary tract injuries where visible blood in the urine was present, but they remained hemodynamically stable.
2. **Patients with abdominopelvic trauma associated with pelvic injuries and symptoms of hematuria or anuria.** These patients were included due to the higher risk of urinary tract injuries associated with pelvic fractures and compromised urinary output.
3. **Patients with abdominopelvic trauma showing inconclusive FAST findings.** FAST is a crucial screening tool for internal bleeding in trauma, and patients with non-definitive results were further evaluated using advanced imaging techniques. [12]
4. **Patients diagnosed with urinary tract injuries requiring grading of the injury.** Accurate grading is essential for determining the severity of the injury and planning appropriate management.

Imaging Protocol

Contrast-enhanced computed tomography (CECT) of the abdomen and pelvis was performed using a Philips 16-slice MDCT machine, following a standard protocol. The CT protocol included both arterial and venous phase imaging to assess vascular and parenchymal injuries. In selected cases, where bladder injuries were suspected, CT cystography was also performed. This was done in 5 patients to further evaluate the extent of bladder injuries and to classify them accurately.

MDCT provided detailed images of the abdominopelvic region, allowing for precise assessment of traumatic injuries to the kidneys, ureters, bladder, and surrounding structures. The use of contrast-enhanced studies ensured optimal visualization of both vascular and urinary tract injuries. In cases where CT cystography was performed, a contrast agent was introduced into the bladder to enhance imaging of the bladder wall and surrounding structures. [13]

This imaging approach facilitated the accurate grading of injuries, aiding in the formulation of appropriate

treatment plans for each patient. The integration of clinical examination, X-rays, FAST, and MDCT ensured a comprehensive evaluation of all patients, enabling timely and effective management of abdominopelvic trauma.

Patient Demographics and Injury Distribution

In this study, the age distribution of patients ranged from 10 to 69 years. Analysis of the data revealed distinct patterns of injury prevalence across different age groups:

- **Renal Injuries:** These injuries were most commonly observed in the 40-49 age group, with 7 patients (28%) in this category. This suggests that individuals in this age range are more susceptible to renal trauma in the context of abdominopelvic injuries. [14]
- **Ureteric Injuries:** Ureteric injuries were identified primarily in two age groups: 10-29 years and 50-59 years, with each group accounting for 1 patient (33.3%). This distribution indicates that ureteric trauma may occur across a broader age spectrum but with lower frequency compared to renal injuries.
- **Bladder Injuries:** Bladder injuries were predominantly found in the 30-39 age group, with 3 patients (50%) experiencing this type of injury. This highlights a higher prevalence of bladder trauma within this particular age range. [15]

Regarding sex distribution:

- **Renal Injuries:** The male-to-female ratio for renal injuries was 1.27:1, with 14 males and 11 females affected. This indicates a slightly higher occurrence of renal trauma in males compared to females.
- **Ureteric Injuries:** Ureteric injuries were more common in males, with a male-to-female ratio of 2:1, comprising 2 males and 1 female. This suggests that males are more prone to ureteric trauma than females in this study population.
- **Bladder Injuries:** Bladder injuries also showed a higher incidence in males, with a male-to-female ratio of 2:1, involving 4 males and 2 females. This pattern indicates a greater likelihood of bladder trauma among male patients.

Overall, the study highlights the varying distribution of renal, ureteric, and bladder injuries across different age groups and between sexes, with a general trend of higher trauma incidence in males. [16]

In this study, the distribution of injury severity among patients with renal, ureteric, and bladder injuries was analyzed according to the grading system. The findings indicate distinct patterns of injury severity across the different types of trauma.

- **Renal Injuries:** The majority of renal injuries were classified as Grade 2, affecting 8 patients (32%). This grade, which typically involves perinephric hematoma or superficial lacerations, was the most common type

of renal trauma observed in the study. In contrast, the least common renal injuries were Grade 4 and Grade 5, with 2 patients (8%) in each category. These grades, representing more severe injuries such as deep lacerations involving the collecting system or shattered kidneys, were relatively rare.

- **Ureteric Injuries:** Ureteric injuries were distributed equally among Grades 2, 3, and 5, with each grade affecting 1 patient (33.3%). Grade 2 injuries, involving less than 50% of the circumference of the ureter, Grade 3 injuries, involving more than 50% of the circumference, and Grade 5 injuries, characterized by complete tears with significant devascularization, were all represented. However, no patients in this study experienced Grade 1 or Grade 4 ureteric injuries.
- **Bladder Injuries:** The most frequently observed bladder injuries were Grade 2, with 3 patients (50%) affected. This grade typically involves intraperitoneal bladder injuries that often require surgical intervention. Notably, no patients in the study experienced Grade 1 or Grade 3 bladder injuries, indicating a lower occurrence of less severe contusions or interstitial bladder injuries. [17]

This analysis highlights the predominance of moderate-grade injuries (Grade 2) across renal and bladder trauma, while severe ureteric injuries were evenly distributed among the higher grades. The absence of the least severe grades in ureteric and bladder injuries suggests that trauma leading to these injuries may often result in more significant damage.

In this study, several associated imaging findings and symptoms were observed in patients with renal, ureteric, and bladder injuries, highlighting the complexity and patterns of trauma.

- **Renal Injuries:** The most common associated imaging finding in patients with renal injuries was the presence of other visceral injuries, observed in 15 patients (60%). This indicates that renal trauma often occurs alongside injuries to other abdominal organs. Conversely, free fluid or hemoperitoneum in the absence of other visceral organ injuries was relatively rare, being found in only 2 patients (8%).
- **Ureteric Injuries:** Similarly, the most common associated imaging finding in ureteric injuries was also other visceral injuries, identified in 1 patient (33.3%).

Notably, no cases of free fluid or hemoperitoneum without other visceral injuries were observed in patients with ureteric trauma.

- **Bladder Injuries:** For bladder injuries, the most frequent associated imaging finding was pelvic fractures, seen in 5 patients (84%). This underscores the strong correlation between pelvic fractures and bladder trauma. Free fluid or hemoperitoneum without other visceral organ injuries was less common, occurring in 1 patient (16%). [18]

Regarding symptoms:

- **Renal Injuries:** The most common symptom associated with renal injuries was abdominal or pelvic pain, reported by 17 patients (68%). This symptom was a key indicator of renal trauma in the study population.

Ureteric and Bladder Injuries:

Hematuria was the most prevalent symptom in patients with ureteric and bladder injuries. Hematuria was present in 2 patients (66.6%) with ureteric injuries and in 4 patients (75%) with bladder injuries, making it a critical clinical sign in the evaluation of these types of trauma.

- **Sensitivity and Specificity:** MDCT has demonstrated superior sensitivity and specificity in detecting renal, ureteric, bladder injuries, and pelvic fractures when compared to ultrasound (USG) and X-ray. This makes MDCT the preferred imaging modality for comprehensive trauma assessment. [19]
- **Positive Predictive Value:** Both MDCT and USG/X-ray exhibit an equal positive predictive value (100%) for identifying renal injuries, bladder injuries, as well as pelvic and rib fractures. This indicates that when these imaging modalities detect such injuries, they are highly accurate.

Negative Predictive Value: MDCT outperforms USG and X-ray in terms of negative predictive value for detecting these injuries and fractures. This means that MDCT is more reliable in ruling out the presence of these conditions when the imaging results are negative, reducing the likelihood of missed diagnoses.

Table 1: Age & sex distribution of patients in study

Age group (years)	Urinary tract injury					
	Renal injury		Ureter injury		Urinary bladder injury	
	Male	Female	Male	Female	Male	Female
10-19	2	3	0	1	0	1
20-29	4	2	1	0	1	0
30-39	2	3	0	0	2	1
40-49	5	2	1	0	0	0
50-59	0	1	0	0	1	0

60-69	1	0	0	0	0	0
Total	14	11	2	1	4	2
Total (of 30pt)	25(83%)		3(10%)		6(20%)	

Table 2: Injury grade wise distribution of patients in study (AAST classification- American Association for Surgery in Trauma)

Injury Grade	Urinary tract injury		
	Renal injury	Ureter injury	Urinary bladder injury
1	7(28%)	0	0
2	8(32%)	1(33%)	3(50%)
3	6(24%)	1(33%)	0
4	2(8%)	0	2(33%)
5	2(8%)	1(33%)	1(17%)
Total	25	3	6

Table 3: Association with symptoms and other imaging findings in patients of study

Associated Imaging finding/symptom	Urinary tract injury		
	Renal injury(25 patients)	Ureter injury (3 patients)	Urinary bladder injury (6 patients)
Other visceral injury(liv- er,spleen,bowel)	15(60%)	1	2
Pelvic fracture	2(8%)	0	5(84%)
Rib fracture	14(56%)	0	1
Free fluid/Hemoperitone- um in absence of other visceral injury	2(8%)	0	1
Abdominal/pelvic pain	17(68%)	0	3
Hematuria	16(64%)	2	4(75%)

Table 4: Comparison of MDCT with other imaging modalities(USG/X RAY).

Injury	Sensitivity (%)		Specifici- ty (%)		PPV (%)		NPV (%)	
	MDCT	USG/ XRAY	MDCT	USG/ XRAY	MDCT	USG/ XRAY	MDCT	USG/ XRAY
Renal injury	100	80	100	100	100	100	100	50
Ureteric injury	75	0	100	-	100	-	96	87
Bladder injury	75	25	100	100	100	100	92	78
Pelvic fracture	100	71	100	92	100	100	100	92
Rib fracture	100	80	100	88	100	100	100	83

DISCUSSION

1. **Age Distribution:** In our study, renal injuries were most prevalent in the 40-49 age group, with 7 patients (28%) affected. Ureteric injuries were primarily observed in the 10-29 and 50-59 age groups, with 1 patient (33.3%) in each group. Bladder injuries were most common in the 30-39 age group, with 3 patients (50%) affected. Overall, urinary tract injuries were more commonly seen in middle-aged individuals [20].

2. **Sex Distribution:** The sex distribution for renal injuries showed a ratio of 1.27:1, with 14 males and 11 females. Ureteric injuries had a male-to-female ratio of 2:1, involving 2 males and 1 female. Similarly, bladder injuries exhibited a male-to-female ratio of 2:1, with 4 males and 2 females. These findings indicate a higher prevalence of urinary tract injuries in males across all types of injuries [21].

3. **Severity of Injuries:** The majority of renal injuries were classified as Grade 2, with 8 patients (32%) affected. Grade 4 and Grade 5 renal injuries were the least common, with 2 patients (8%) in each category. For ureteric injuries, there was an equal distribution among Grades 2, 3, and 5, with 1 patient (33.3%) in each category. No patients experienced Grade 1 or Grade 4 ureteric injuries. Bladder injuries were most commonly Grade 2, affecting 3 patients (50%), while no Grade 1 or Grade 3 bladder injuries were observed [22].

4. **Associated Imaging Findings:** The most common associated imaging finding with renal and ureteric injuries was the presence of other visceral injuries, observed in 15 patients (60%) with renal injuries and 1 patient (33.3%) with ureteric injuries. For bladder injuries, the most frequent associated imaging finding was pelvic fractures, seen in 5 patients (84%). Free

fluid or hemoperitoneum in the absence of other visceral organ injuries was less commonly associated with these injuries, found in 2 patients (8%) with renal injuries, 0 patients with ureteric injuries, and 1 patient (16%) with bladder injuries [23].

5. **Common Symptoms:** The most common symptom associated with renal injuries was abdominal or pelvic pain, reported by 17 patients (68%). In cases of ureteric and bladder injuries, hematuria was the predominant symptom, observed in 2 patients (66.6%) with ureteric injuries and 4 patients (75%) with bladder injuries [24- 27].
6. **Imaging Modality Comparison:** MDCT proved to be more sensitive and specific in detecting renal, ureteric, bladder injuries, and pelvic fractures compared to USG/X-ray. Both MDCT and USG/X-ray showed an

equal positive predictive value of 100% for renal and bladder injuries, as well as for pelvic and rib fractures. However, MDCT demonstrated a higher negative predictive value for these injuries and fractures, making it a more reliable tool for ruling out these conditions when imaging results were negative [28, 29].

CONCLUSION

In conclusion, our study demonstrates that MDCT is highly accurate in diagnosing urinary tract injuries, particularly in the context of trauma. Its superior sensitivity, specificity, and higher negative predictive value compared to USG/X-ray make it the preferred imaging modality for evaluating renal, ureteric, bladder injuries, and associated pelvic fractures.

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