Original Article

The Accuracy of Various Types of Urinalysis in Terms of Predicting Intra-Abdominal Injury in Emergency Trauma Patients: A Diagnostic Accuracy Study

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Abstract

Background and Objectives: Given the importance and prevalence of trauma patients in the emergency department and the questioning of urinalysis value in predicting intra-abdominal injury, this study was conducted to examine the accuracy of various types of this test. **Methods:** This diagnostic accuracy study was conducted on adult patients with abdominal trauma. Data gathering were performed retrospectively until sample size completion using a preprepared checklist. Required data, including demographic characteristics, diseases confounding urinalysis, trauma mechanism, important associated injuries, vital signs, etc., were recorded. Accuracy of urinalysis (including macroscopic, microscopic and dipstick) results was compared with findings of patients' enhanced computed tomography (CT) scan findings that was considered as the gold standard, reported by a radiologist. **Results:** Totally, 152 multiple trauma patients with the mean age of 37.9 ± 17.7 years were enrolled (90.8% males), of whom 66 (43.42%) patients had hematuria and the CT scan was abnormal in 30 (19.73%) cases. There was a significant correlation between gross hematuria and abnormal CT scan ($P < 0.01$) as opposed to microscopic or dipstick hematuria ($P > 0.05$). Based on the findings, the highest sensitivity was for dipstick and microscopic equally and highest specificity, positive predictive value, negative predictive value, positive and negative likelihood ratios, NLR and accuracy were for the gross test. **Conclusions:** Microscopic hematuria and dipstick had no significant correlation with abnormal CT scan findings and cannot predict the intra-abdominal injuries in multiple trauma patients. But, macroscopic hematuria could be valuable in this regard.

Keywords: Abdominal injuries, accuracy, emergency service, hematuria, hospital, urinalysis

Introduction

Considering trauma as the most leading cause of death under 45 years old and one of the most frequent hospital admission reasons worldwide, the significance of its management is obvious.[1-4] Diagnostic approach and efficient evaluations were always controversial as soon as the patient admission in the emergency department (ED) and majority of studies are still insisting in doing computed tomography (CT) scan in different ways.[5-7] Despite high sensitivity (94%–100%) and specificity (96%–100%), routine use of CT scans for evaluation of intra-abdominal injury is not possible.[8,9] Although there is no plausible study of high-energy trauma

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to obtain a clinical tool for the selective use of CT scan, they are some clinical prediction rules to aid the decision making of CT scan indication with sensitivity up to 86%–100% that each is applicable for the same study.[5,8] Many paraclinical examinations like focused assessment with sonography in trauma (FAST), diagnostic peritoneal lavage, biochemical tests and urinalysis (U/A) alongside reliable physical examination, are the most common diagnostic measures in this regard; some findings may help improving decision making during this process such as hematuria, abdominal tenderness, positive FAST, which are all impressive in this regard.[8,10-12] Assertion in urinalysis separately as a prediction variable of genitourinary and intra-abdominal injury in blunt traumas is noticeable recently.[13-15] Although some recommend considering urinalysis as an adjutant for diagnosis, it is routine in crowded trauma centers and sometimes, positive result leads to further time and money consuming tests. On the other hand, some believe that unlike gross hematuria which is an important sign of injury, microscopic hematuria is not, so routine U/A could be omitted as a part of the assessment of all trauma patients.[16] In general, the value of complete urine test in the management of abdominal trauma and its accuracy for predicting intra-abdominal injury is controversial; however, in some hospitals, this test is done routinely for all patients and in some only in special cases.[16,17] Therefore, this study was conducted to examine the accuracy of various types of urinalysis, including macroscopic gross and microscopic and dipstick tests, in predicting intra-abdominal injury in trauma patients, of course, compared with one of the most widely used modalities, CT scan.

Methods

Study design and setting

This diagnostic accuracy study was conducted during 2019–2010 over the annual records of ED of the main trauma center (Sina Hospital) in Tehran, Iran. Given the retrospective nature of this study, no change was made in the diagnostic and therapeutic process of the patients, so it did not impose an additional cost to the patient or health-care system. All information was confidential, and no information was reported individually. The study complied with the Ministry of Health's ethical guidelines and performed after obtaining the required approval from the ethics committee of Tehran University of Medical Sciences (IR.TUMS.IKHC.REC.1397.170).

Among over 10,000 records, trauma patients older than 15 years old, who underwent both any type of urinalysis and abdominopelvic CT scan with intravenous contrast, were eligible. Those with diseases or urinalysis confounding factors such as coagulopathy, menstrual period, polycystic kidney disease and urinary tract infection (UTI) were excluded. In addition, we have ignored incomplete records like those who had left the hospital with personal consent before completing the diagnostic process.

Study patients

Considering $\alpha = 1\%$ and $\beta = 10\%$, the least sample size for 95% confidence calculated as 120 patients. Due to the retrospective nature of the study and the possibility of data defects in the files, 25% was added to this amount.[14,18] In this study, enrolled patients were divided into 3 groups, including those with gross hematuria, positive dipstick test and microscopic hematuria. According to the American Urological Association guideline, microscopic hematuria has been defined as the presence of >3 red blood cells (RBCs)/high power field or one cross on dipstick.[19] Apparently, those with gross hematuria were not included in the microscopic hematuria group.

In the present study, CT scan was considered as the gold standard for diagnosis of intra-abdominal injuries. The CT scans were performed by a Siemens 16-slice machine from the diaphragm to the pelvic outlet. The distance between each cut of CT images was 1 cm. Obtained images were interpreted by an expert radiologist.

Data gathering

Data were all gathered from patients' records in a preprepared checklist including demographics, trauma mechanism (car crash, motorcycle accident, motor-vehicle-pedestrian accident or falling), past medical histories (coagulopathy, menstruation, polycystic kidney disease or UTI), physical examination (vital signs, abdominal tenderness, the existence of rib or pelvic fracture), urinalysis (gross hematuria, dipstick, and microscopic hematuria), organ damage based on enhanced abdominopelvic CT scan reports (including liver, spleen, kidney, pancreas, ureter, bladder, hollow viscus, extra-peritoneal hemorrhage and free fluid with grading based on American association of trauma surgery,[20] FAST exam and also outcomes included observation in ED or ward, discharged without surgical intervention, died or underwent surgery.

Statistical analysis

Data were analyzed using IBM SPSS software package, version 20.0, (SPSS Inc., Chicago, IL, USA), using Chi-square test for complete urinalysis test compared with enhanced abdominopelvic CT scan findings to predict intra-abdominal injury to calculate sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (LR+), and negative likelihood ratio (LR−), $P < 0.05$ was considered statistically significant.

Results

In this study, 152 patients with the mean age of 37.9 ± 17.7 years were evaluated; of whom 138 (90.8%) cases were male. Based on the findings, the most common trauma mechanism was motor vehicle collision. Totally, 66 (43.42%) patients had some kind of hematuria. There were totally 30 (19.7%) abnormal scan among 152 evaluated cases, in which there were 46 abnormal findings. In fact, some patients had more than one abnormal finding in their CT scan. There was no case of pancreatic or ureter injury; however, the most frequent finding was free fluid ($n = 16$, 10.5%). Eight patients (5.3%) were died in hospital [Table 1]. Figure 1 shows the flowchart depicting all included patients regarding their urine test and clinical consequences.

Regarding urinalysis as our main variable, while there was a correlation between gross hematuria ($P < 0.001$) and abnormal CT scan findings, there was no correlation between microscopic hematuria ($P = 0.882$) and dipstick test ($P = 0.703$) with it [Table 2]. The results showed that the highest sensitivity was for dipstick and microscopic equally and the highest specificity, PPV, NPV, LR+, LR − and accuracy were for the gross test [Table 3].

We recognized that gross hematuria had 100% sensitivity for diagnosing bladder injury, but the sensitivity had fallen to lower than 16% while evaluating other abnormalities. However, gross hematuria specificity was more than 94% for all injuries. Looking for microscopic hematuria, we observed that its specificity was about 60% (lower than the gross test) while regarding the sensitivity, except bladder, this test showed higher performance [Table 4].

Discussion

The findings of this study reveal that unlike gross hematuria, there was no significant relationship between microscopic hematuria itself and abnormal CT scans; hence, it does not supply sufficient accuracy to predict intra-abdominal damage. We found that the sensitivity of microscopic hematuria was superior to that of the gross test (33.33% vs. 18.18%), while their specificity calculated 60.5% and 98.32%, respectively. About NLR, PLR, NPV, PPV, and accuracy, we found gross hematuria had better function than microscopic as we see microscopic NLR = 1.1 that means no change in our likelihood. Regarding the comparison of dipstick and microscopic hematuria, all statics showed better performance as opposed to comparison with the gross test, which except sensitivity, dipstick function was inferior. It is also obvious that both gross and microscopic tests were not positive in patients with hollow viscus injury and also the tests were not positive in one case with splenic injury and in two cases with the adrenal injury.

Due to urinalysis as a subject of contention, numerous studies investigated the role of complete urine test parallel with CT scan in predicting intra-abdominal injury and on the other hand there is no consensus regarding definite indications of using CT scan in management of trauma patients and utilization of this kind of imaging largely depends on the opinion of the in-charge physician.[21] There are inconsistent results; some conclude that gross hematuria but not the microscopic has correlation with intra-abdominal injury and requires further examinations and rely on the mechanism of trauma and recommend doing U/A in cases with falling and direct flank traumas.[18] In contrast, we can see studies that insist on routine complete urinalysis with a mean of 90% sensitivity and specificity.[16] Regarding dipstick urinalysis in abdominal trauma patients, previous retrospective studies find it low prognostic beneficial procedure to become as a predictor.[22] Despite all this and the time-consuming process, urinalysis is almost routine in many trauma centers in Tehran.

In this study, we can see a significant relationship between gross hematuria and abnormal CT scans, whereas this association with microscopic hematuria is not significant ($P < 0.05$). Regarding the microscopic hematuria for prediction of intra-abdominal damage, we can only see that NPV was over 95% and even 100% for splenic damage. On the other hand, PPV was about 3%, which bolds the probable importance of this test in the negative case.

Given dipstick performance approximating the microscopic test and even a little better in all parameters and its lower

Table 1: Frequency of demographic and baseline characteristics of study patients (*n*=152)

Variable	*n* (%)
Sex	
Male	138 (90.8)
Female	14 (9.2)
Physical exam findings	
Abdominal tenderness	22 (14.5)
Rebound tenderness	1 (0.7)
Abdominal wall ecchymosis	7 (4.6)
Associated injuries	
Pelvic fracture	21 (13.8)
Lower rib fracture	12 (7.9)
Traumatic brain injury	36 (23.7)
Spinal injury	18 (11.8)
Abnormal CT scan	
Liver	6 (3.9)
Spleen	1 (0.7)
Kidney	5 (3.3)
Adrenal gland	2 (1.3)
Bladder	2 (1.3)
Hollow viscus	2 (1.3)
Free fluid	16 (10.5)
Extra-peritoneal hemorrhage	12 (7.9)
Urinalysis	
Gross	8 (5.3)
Dipstick	55 (36.2)
Microscopic	58 (38.2)
Intervention	
Surgery	5 (3.3)
Observation	22 (14.5)
Outcome	
Discharged	144 (94.7)
Death	8 (5.3)

Table 2: Frequency of urinalysis types and abnormal computed tomography scans

Urine tests	Result	Abdominal CT scan		Total (*n*)
		Positive (*n*)	Negative (*n*)	
Gross (*n*=8)	Positive	6	2	8
	Negative	27	117	144
Dipstick (*n*=55)	Positive	6	49	55
	Negative	2	87	89
Microscopic (*n*=58)	Positive	11	47	58
	Negative	16	70	86

CT: Computed tomography

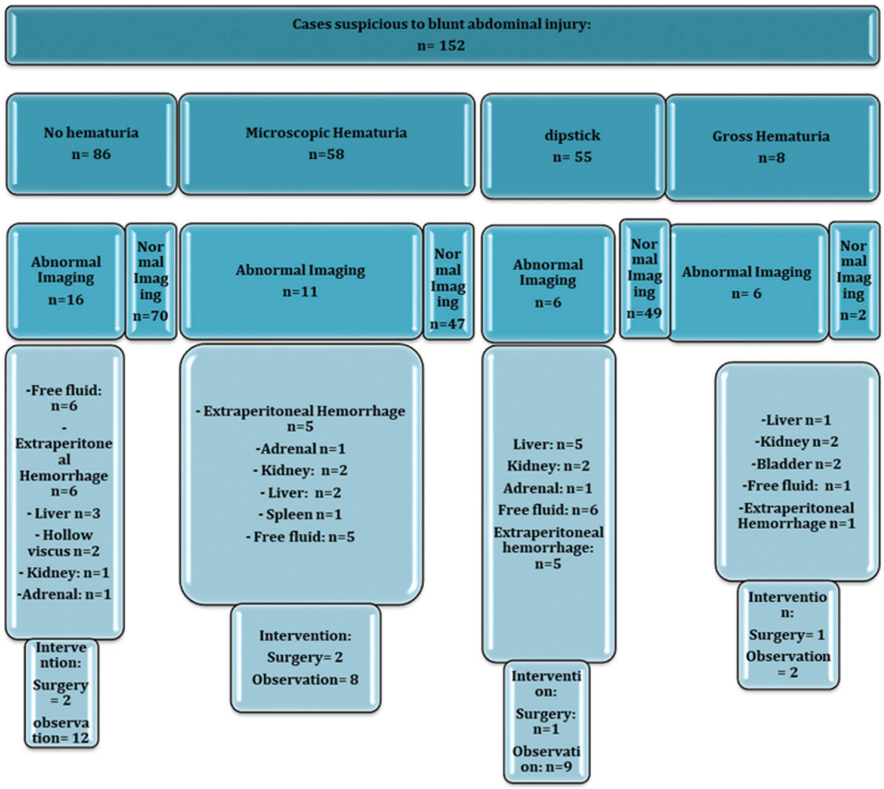

Figure 1: Flowchart depicting all included patients regarding their urine test and clinical consequences

Table 3: Efficacy of different methods of urinalysis compared with enhanced abdominopelvic computed tomography

Value	Gross (%)	Dipstick (%)	Only microscopy (%)
Sensitivity	18.18	33.33	33.33
Specificity	98.32	63.03	60.5
PPV	75	20	18.97
NPV	81.25	77.32	76.6
LR+	10.82	0.9	0.84
LR−	0.83	1.06	1.1
Accuracy	80.92	56.58	54.61

PPV: Positive predictive value, NPV: Negative predictive value, LR+: Positive likelihood ratio, LR−: Negative likelihood ratio

cost with the faster result, it may be reasonable to perform dipstick instead of the latter; however, both of them had no significant correlation with our gold standard and also there is contradictory evidence which necessitates using these tests cautiously.[22] According to recent studies, FAST has lower sensitivity but more specificity when the emergency resident trying to do that, (93.1% and 93.4%, respectively) in comparison with the trial of radiology residents (96.5% and 92.3%, respectively).[23]

Fifty-six percent of patients had no hematuria (meaning lower than three RBC) which underwent enhanced abdominopelvic CT based on clinical findings, and this is the group with the most requiring intervention, noticing the importance of clinical clues which also evaluating this issue in several studies. As Cotton *et al*.[24] in their important study pointed out that absence of abdominal tenderness, abrasion, ecchymosis, and normal liver enzymes in children can rule out an intra-abdominal injury with a sensitivity of 100%; and some other found that if abdominal physical exam, ultrasound, chest X-ray and laboratory findings (hematocrit, white blood cell, and serum glutamic oxaloacetic transaminase or aspartate transaminase) are normal, intra-abdominal injury can be ruled out and interestingly, the clinician's overall subjective impression with regard to the presence of an abdominal injury was very similar to that of ISS and not better than that of a single item like liver enzyme,[25,26] However, due to careless clinical exams and low accurate ultrasounds in diagnosing nonbleeding parenchymal damage and hollow viscus injuries, clinical exams or ultrasound alone is not a reasonable approach to delineate the patient outcome, but combination of clinical presentation and FAST results, as shown in Shojaee *et al*. study, has sensitivity and specificity similar to CT scan in diagnosis of intra-abdominal injury.[26]

In the current study, 10 out of 58 patients with positive U/A required intervention for intra-abdominal injury and it means that 6.94% of suspected blunt abdominal trauma patients without gross hematuria; who had important injuries may be missed without U/A. Furthermore, the majority of cases without hematuria required intervention. In other words, the sensitivity and NPV of this test for intra-abdominal injury among patients with clear urine appearance required intervention were 46% and 83%, respectively. Hence, to prevent undiagnosed

Table 4: The three urine test parameters with organ specific enhanced abdominopelvic computed tomography abnormal findings

Injured organ	Test	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Liver (*n*=6)	Gross	16.67	96.5	12.5	97.47	94.17
	Microscopic	33.33	61.64	3.45	95.74	60.53
	Dipstick	83.33	65.75	9.09	98.97	66.45
Kidney (*n*=5)	Gross	40	95.27	22.22	97.92	93.46
	Microscopic	40	61.9	3.45	96.81	61.18
	Dipstick	40	63.95	3.64	96.91	63.16
Bladder (*n*=2)	Gross	100	96	25	100	96.05
	Microscopic	0	61.33	0	97.87	60.53
	Dipstick	0	63.33	0	97.94	62.5
Spleen (*n*=1)	Gross	0	94.7	0	99.3	94.08
	Microscopic	100	62.25	1.72	100	62.5
	Dipstick	0	63.58	0	98.79	63.16
Hollow viscus (*n*=2)	Gross	0	94.97	0	98.61	93.42
	Microscopic	0	61.33	0	97.87	60.53
	Dipstick	0	63.33	0	97.94	62.5
Adrenal (*n*=2)	Gross	0	94.97	0	98.61	93.42
	Microscopic	50	62	1.72	98.94	61.84
	Dipstick	50	64	1.82	98.97	63.82
Free fluid (*n*=16)	Gross	6.25	94.85	12.5	89.58	85.53
	Microscopic	43.75	62.5	12.07	90.43	60.53
	Dipstick	37.5	63.97	10.91	89.69	61.18
Extraperitoneal hemorrhage (*n*=12)	Gross	8.33	95	12.5	92.36	88.16
	Microscopic	41.67	62.14	8.62	92.55	60.53
	Dipstick	41.67	64.29	9.09	92.78	62.5

PPV: Positive predictive value, NPV: Negative predictive value

intra-abdominal, it may be still recommended to perform this test routinely.

Limitations

Retrospective nature of the study precludes understanding of the timing of requesting CT scan before U/A result or after that. We have not been able to predict priority and delay of urinalysis compared to urinary catheters implement, and the most important limitation is the low number of samples and retrospectivity, which probably confront with recall bias. Despite the lack of significant correlation between microscopic hematuria and abnormal CT, further studies (e.g., multi-center studies) on the use of this test for clinical decision-making are necessary, and this test still has a place next to clinical findings.

Conclusions

According to the findings of the present study, despite lack of significant correlation between microscopic hematuria and abnormal CT, further studies are necessary to finalize the approach, until then other evaluations like laboratory and image findings should be considered.

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Conflicts of interest

There are no conflicts of interest.

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