CT findings of KUB Injury in Hemodynamically Stable Blunt Abdominal Injury Patients with Microscopic Hematuria

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Background: *According to controversial guideline for management in case of hemodynamically stable blunt abdominal injury with microscopic hematuria. Most of the patients could be omitted for abdominal computed tomography (CT). Despite high sensitivity and specificity of abdominal CT, in addition to high medical cost, there are risks from radiation exposure and adverse reaction from use of contrast media.*
Objective: *To evaluate the prevalence of KUB injury on abdominal CT in case of hemodynamically stable blunt abdominal injury with microscopic hematuria.*
Material and Method: *Forty-one studies of abdominal CT performed during 1 January 2010 and 30 June 2012 were retrospectively reviewed for KUB injury (categorized by AAST organ injury scale) by consensus of two experienced radiologists.*
Results: *KUB injury was found in 36.6% from all selected CT studies. Almost all cases could be managed conservatively. The cutoff point of microscopic hematuria at 20 cells/hpf has sensitivity 80% and specificity 46.15%.*
Conclusion: *One-third of the patients have KUB injury but almost all of them could be conservatively managed. We proposed that the cutoff point of hematuria be equivalent to or greater than 20 cells/hpf to be one of the indicators for predicting KUB injury that needs radiological evaluation; but it should be carefully considered along with clinical information.*

Keywords: *Abdominal computed tomography, KUB injury, Blunt abdominal injury, Microscopic hematuria*

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According to European Association of Urology (EAU) guidelines on urological trauma[1], there is equivocal management in adult patients who have evidence of microscopic hematuria and hemodynamic stable. If the mechanism is a rapid deceleration injury or suspected major associated injury, imaging is recommended. However, in some circumstances, the mechanism is unclarified.

Most of the patients who were sent for abdominal computed tomography (CT) had negative results or non-operative management. Despite high sensitivity and specificity of abdominal CT, in addition to high medical cost, there are risks from radiation exposure and adverse reaction from the use of contrast media.

Furthermore, there is no cutoff point for the amount of microscopic hematuria that indicates the KUB injury in adult patients. Unlike pediatric patient, microscopic hematuria of more than 50 cells/hpf indicates further investigation[2].

The authors studied the patients with hemodynamic stable blunt abdominal injury and microscopic hematuria, who were sent for total abdominal CT at Thammasat University Hospital, to describe the prevalence of KUB injury on CT images.

Primary objective

To describe the prevalence of KUB injury on CT images in patients with hemodynamically stable blunt abdominal injury and microscopic hematuria and were sent for total abdominal CT at Thammasat University Hospital, then categorized by site of injury and grading by AAST organ injury scale.

Secondary objective

To determine the cutoff point for microscopic hematuria that may indicate the KUB injury in patients with hemodynamically stable blunt abdominal injury.

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Material and Method

Data collection

Sixty-seven abdominal CT studies of patients who have blunt abdominal trauma with microscopic hematuria at Thammasat University Hospital during 1 Jan 2010 to 30 June 2012 were collected. Twenty-six studies were excluded owing to incomplete medical record (7 patients), pediatric patients (6 patients), gross hematuria (11 patients) and evidence of KUB stone (2 patients). Forty-one studies were enrolled in this study. All images were reviewed by consensus of 2 experienced radiologists (NV, a 9-years experienced body imaging radiologist and KT, a 5-years experienced genitourinary imaging radiologist) for the site of KUB injury, number of injury sites, grading according to AAST organ injury scaling and other organ injuries.

In all cases, age, gender, mechanism of injury, amount of microscopic hematuria, type of operation and intra-operative findings were reviewed from the medical records and laboratory information system.

CT protocol

All cases underwent multiphasic contrast enhanced CT of the whole abdomen with 64-slice MDCT scanner (Brilliance CT 64-channel scanner, Philips). Pre-contrast scan was performed. Bolus of intravenous contrast material, typically 100-150 mL (300-320 mg of iodine per ml, total iodine load of 30-48 g) injected at a rate of 3-5 mL/sec through an 18- or 20-gauge cannula located in a large peripheral vein. A bolus of saline solution (about 20-50 mL) was injected immediately following the contrast material by using a dual-syringe power injector at a rate of 3-5 mL/sec. Arterial, portovenous and delayed contrast enhanced scan after 10 or 12 minutes (for KUB system) were performed in all cases. CT cystogram was done in case with suspected urinary bladder injury. Reformatted axial images at 5-mm intervals were obtained for all phases. Reformatted coronal images at 3-mm intervals were reconstructed only for portovenous phase. Additional reconstruction was done in selected cases.

Ethics consideration

The study received prior approval from the Research Ethics Board of our institution (Faculty of Medicine, Thammasat University). Informed consent was waived.

Statistical analysis

Prevalence of KUB injury was described in percentage, sub-grouped by injury site and grading according to AAST organ injury scale. Logistic regression was used to evaluate the amount of hematuria for predicting KUB injury, by considering sensitivity and specificity.

Results

Forty-one patients were enrolled in this study.Majority of the patients is male, 28 in 41 cases (68.3%) (Table 1). Ages range from 15 years to 60 years. Mean age is 33 years. Mechanisms of injury are motor vehicle accident, fall from height, crush injury and body assault (Table 1). Amount of hematuria ranges were from 3-5 cells/hpf to >100 cells/hpf (Table 2).

Prevalence of the KUB injury is about 36.6% (15 in 41 cases) (Table 3). The highest prevalence is renal injury: 34.2% (14 in 41 cases) (Table 3) (Fig. 1-4). Five of these fifteen cases (33.3%) underwent surgical management. Only one case had the indication from KUB injury that was a urinary bladder injury. The remaining cases were sent for surgery because of suspicion of bowel injury (3 cases) and peritonitis (1 case). All other renal and ureteric injuries were managed conservatively.

Grade 3 renal injury (Fig. 3) shows the highest prevalence, 6 in 14 cases (42.9%) (Table 4). Two cases of ureteric injury were graded 1 (Fig. 5). Only one case of urinary bladder injury was graded 5 (Fig. 6).

Most of renal injury cases (12 in 14 cases, 85.7%) showed microscopic hematuria greater than or equal to 20-30 cells/hpf (Table 5).

By using logistic regression analysis, sensitivity and specificity at various levels of hematuria are demonstrated in Table 6.

Discussion

Blunt trauma accounts for 80% of all renal injuries. Hematuria after blunt abdominal injury is also common[3]. In the present study, prevalence of renal injury on CT imaging is about 34.2%, higher than that in the study by Porter JM et al. Their study reported prevalence of renal injury at 10% in case of hemodynamically stable blunt abdominal trauma[4].

Only one case showed indication for surgery from KUB injury, which is grade 5 bladder injury. Most of KUB injury cases can be managed by non-operative management. This result is similar to the present study by Qin R et al which revealed that 64.8% of all renal trauma cases can be treated with conservative and supportive therapy[5]. A grade 3 renal injury can also be managed conservatively with renal sparing procedures such as endourologic techniques,

nephroraphy or partial nephrectomy. From the study by El Khader K et al only patients with pedicle injury (grade 4) required total nephrectomy[6]. In our study, all cases of renal injury (100%) can be managed conservatively. However, our data do not have grade 5 renal injury.

Miller KS et al studied 1,588 patients who had history of blunt trauma and presented with microscopic hematuria and no shock. They found that 584 patients were sent for imaging and the imaging showed 581 renal contusions (grade 1), 1 minor laceration (grade 2) and 2 major laceration (grade 3)[7]. In the present study, the largest number of renal injury is grade 3 (6/14 cases, about 42.9%).

Campbell EW et al reported that only 3 in 15 patients of ureteric injury have prior blunt abdominal injury. Intravenous pyelography and abdominal computerized tomography scanning were diagnostic in only 33% of cases. Hematuria was present in only 63% of these patients, emphasizing the lack of reliability of this sign in ureteral trauma[8]. The present study also shows only two cases of ureteric injury that shows periureteric hematoma. However, a case of microscopic ureteric injury that causes hematuria may not be demonstrated by CT.

Table 1. Demographic data

Demographic data	Number of case, n = 41 (%)
Gender	
Male	28 (68.3)
Female	13 (31.7)
Mechanism of injury	
Motor vehicle accident	26 (63.5)
Pedestrian injury	6 (14.6)
Crush injury	3 (7.3)
Body assault	3 (7.3)
Fall from height	3 (7.3)

Fig. 1 Grade 1 renal injury. A 15-year-old male presented with motor vehicle accident. CT shows subtle low attenuation lesion at the upper pole of right kidney (arrow), representing renal contusion. No subcapsular hematoma or perinephric hematoma is detected

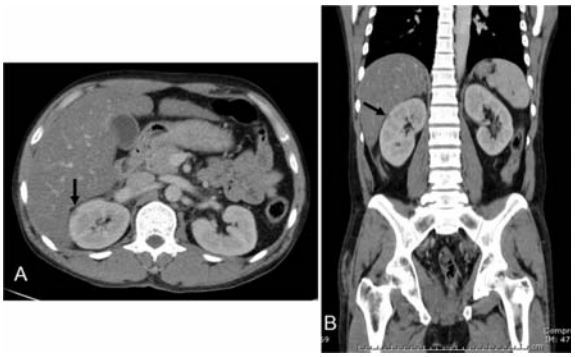

Fig. 2 Grade 2 renal injury. A 40-year-old male presented with pedestrian injury. CT shows small renal laceration (arrow) at the interpolar region of right kidney, measuring about 0.7 cm in depth.

Table 2. Number of case, categorized by amount of hematuria

Amount of hematuria (cells/hpf)	Number of CT-positive case, n = 15 (%)	Number of CT-negative case, n = 26 (%)
3-5 cells/hpf	1 (6.7)	1 (3.9)
5-10 cells/hpf	1 (6.7)	3 (11.5)
10-20 cells/hpf	1 (6.7)	5 (19.2)
20-30 cells/hpf	0	3 (11.5)
30-50 cells/hpf	1 (6.7)	2 (7.7)
50-100 cells/hpf	4 (26.6)	5 (19.2)
>100 cells/hpf	7 (46.6)	7 (26.9)

Table 3. Prevalence of injury, categorized by organ

Injured organ	Number of case, n = 41 (%)
KUB system	15 (36.6)
Kidney	14 (34.2)
Ureter	2 (4.8)
Bladder	1 (2.4)
Other abdominal organ	25 (61.0)

Remarks All of ureteric injury cases are coincided with renal injury. Some cases of other abdominal organ are also reported with KUB injury.

Table 4. Grading of renal injury

Grade of renal injury	Number of case, n = 14 (%)
Grade 1	4 (28.6)
Grade 2	1 (7.1)
Grade 3	6 (42.9)
Grade 4	3 (21.4)
Grade 5	0

Table 5. Numbers of positive renal injury cases on CT study, categorized by grade of renal injury and amount of hematuria

Hematuria (cells/hpf)	Grade of renal injury				
	1	2	3	4	5
3-5			1		
5-10			1		
10-20	1				
20-30					
30-50				1	
50-100	2	1			
>100	1		4	2	

In the present study by Brewer ME et al, 214 patients underwent cystography for microscopic hematuria. No bladder injuries were identified. Positive predictive value of microscopic hematuria in case of suspected bladder injury is 0%[9]. Surprisingly, the present study showed one case of urinary bladder injury that has microscopic hematuria (50-100 cells/hpf).

In the present study by Hossein T et al no normotensive child with fewer than 50 RBCs per high-power field had a significant renal injury; and

Fig. 3 Grade 3 renal injury. A 42-year-old male presented with motor vehicle accident. CT shows renal laceration (black arrow) at the lower pole of right kidney with perinephric hematoma, measuring about 2.6 cm in depth. No involvement of the collecting system is evident. There are also liver laceration at hepatic segment V/VI (white arrow) and hemoperitoneum. This case also has splenic laceration (not shown).

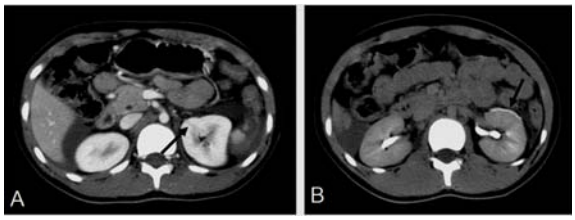

Fig. 4 Grade IV renal injury. A 30-year-old female presented with motor vehicle accident. A) CT scan on portovenous phase shows a 1.5-cm renal laceration (solid arrow) at the upper pole of left kidney. Shattered spleen is also detected on this. B) CT scan on delayed phase shows urine extravasation into the perinephric space (solid arrow).

conversely, all children with significant renal injuries had neither large amounts of hematuria or shock[10]. From statistical analysis, hematuria equivalent to or greater than 20 cells/hpf has most desirable sensitivity and specificity (sensitivity 80.00% and specificity 46.15%). By using this cutoff point, 12 in 14 cases (85.7%) of renal injury had hematuria equivalent to or greater than 20 cells/hpf. These cases include all of grade 4 and most of grade 3 (4 in 6 cases) renal injury. The only one case of urinary bladder injury also showed hematuria greater than 20 cells/hpf. Two false-negative cases are grade 3 renal injury, which underwent conservative management. On the other hand, this cutoff point had quite high false-positive rate (17 in 26 cases) owing to its fair specificity.

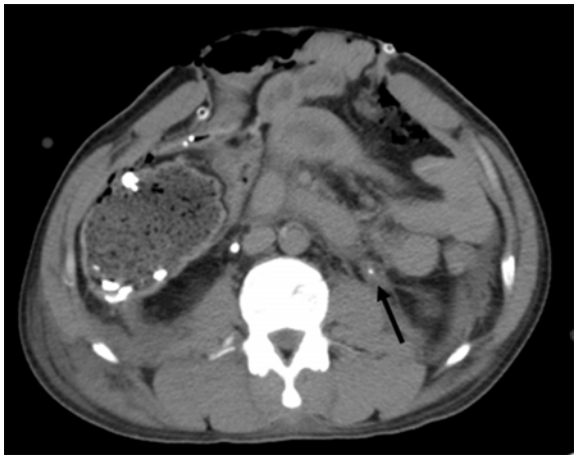

Fig. 5 Grade 1 ureteric injury. A 46-year-old male presented with fall from height. Axial CT scan on delayed phase shows left ureteric wall thickening and periureteric hematoma (arrow) without gross contrast extravasation.

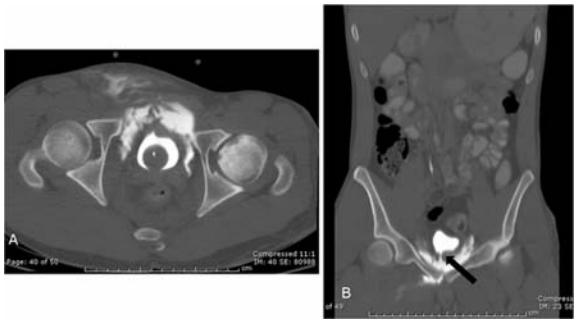

Fig. 6 Grade 5 urinary bladder injury. A 20-year-old male presented with motor vehicle accident. A: Axial CT scan on delayed phase (bone window) shows contrast extravasation into prevesical space and anterior lower abdominal wall, representing extraperitoneal bladder rupture. B: Coronal reconstruction shows the ruptured site at bladder base (arrow).

Table 6. Sensitivity and specificity of each cutoff point of hematuria

Hematuria (cells/hpf)	Sensitivity (%)	Specificity (%)
<3	100.00	0.00
≥3	93.33	3.85
≥5	86.67	15.38
≥10	80.00	34.62
≥20	80.00	46.15
≥30	73.33	53.85
≥50	46.67	73.08
≥100	0.00	100.00

Limitation of the study

The present study is retrospective; hence, there are limited number of cases, incomplete medical record and selection bias. Some cases were directly managed without imaging study. Not all of KUB injury grades were included in this study. Lastly, some grades of KUB injury (such as ureteric contusion, bladder contusion) may not be demonstrated by CT images.

According to the above limitations, accuracy of the cutoff point of hematuria may not represent a real target population. Further investigation with a higher number of cases is needed for accurate determination of the cutoff point of hematuria.

Conclusion

Only one-third of the cases with blunt abdominal injury, with hemodynamic stable and microscopic hematuria, have radiological evidence of KUB injury. Almost all of them can be managed conservatively. The authors propose the cutoff point of microscopic hematuria equivalent to or greater than 20 cells/hpf to be one of the indicators for predicting KUB injury that needs radiological evaluation; but it should be carefully considered along with clinical information.

Potential conflicts of interest

WP Financial activities related to the present article: author employed as resident at Thammasat University Hospital; Faculty of Medicine, Thammasat University paid for supporting the author to perform and present data in this article. Financial activities not related to the present article: none to disclose. Other relationships: none to disclose. NV no potential conflicts of interest to disclose. KT no potential conflicts of interest to disclose.

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สิ่งตรวจพบของการบาดเจ็บของไต ท่อไต และกระเพาะปัสสาวะจากเอกซเรย์คอมพิวเตอร์ช่องท้องในผู้ป่วยได้รับบาดเจ็บจากของไม่มีคมที่ท้องและตรวจพบเม็ดเลือดแดงในปัสสาวะที่ไม่สามารถเห็นได้ด้วยตาเปล่า

วริฏฐา เภตราสุวรรณ, กานต์ แตงเที่ยง, นพดล วิฑิตสุวรรณกุล

ภูมิหลัง: *เนื่องด้วยแนวทางเวชปฏิบัติในผู้ป่วยที่ได้รับบาดเจ็บจากของไม่มีคมที่ท้องและตรวจพบเม็ดเลือดแดงในปัสสาวะที่ไม่สามารถมองเห็นได้ด้วยตาเปล่านั้นยังเป็นที่ถกเถียงกันในปัจจุบัน ผู้ป่วยส่วนใหญ่ที่ถูกส่งมาตรวจเอกซเรย์คอมพิวเตอร์ช่องท้องมักไม่พบความผิดปกติ หรือถูกรักษาต่อโดยวิธีที่ไม่ต้องผ่าตัด เพราะเหตุนี้แม้ว่าเอกซเรย์คอมพิวเตอร์ช่องท้องจะเป็นวิธีตรวจที่มีความไวและความจำเพาะสูง แต่อาจทำให้ผู้ป่วยได้รับสารทึบรังสีและรังสีโดยไม่จำเป็น รวมทั้งค่าใช้จ่ายที่เพิ่มขึ้นด้วย*

วัตถุประสงค์: *เพื่อประเมินความชุกของการบาดเจ็บของไต ท่อไต และกระเพาะปัสสาวะที่พบโดยการตรวจเอกซเรย์คอมพิวเตอร์ช่องท้องในผู้ป่วยที่ได้รับบาดเจ็บจากของไม่มีคมที่ท้องและตรวจพบเม็ดเลือดแดงในปัสสาวะที่ไม่สามารถมองเห็นได้ด้วยตาเปล่า*

วัสดุและวิธีการ: *เก็บรวบรวมข้อมูลการทำเอกซเรย์คอมพิวเตอร์ช่องท้องในผู้ป่วยที่ได้รับบาดเจ็บจากของไม่มีคมที่ท้องและตรวจพบเม็ดเลือดแดงในปัสสาวะที่ไม่สามารถมองเห็นได้ด้วยตาเปล่า ระหว่างวันที่ 1 มกราคม พ.ศ. 2553 ถึงวันที่ 30 มิถุนายน พ.ศ. 2555 ได้ทั้งสิ้น 41 ราย ภาพเอกซเรย์คอมพิวเตอร์ช่องท้องทั้งหมดถูกนำมารายงานผลซ้ำ โดยรังสีแพทย์ผู้เชี่ยวชาญ 2 คน เพื่อรายงานผลการบาดเจ็บของไต ท่อไต และกระเพาะปัสสาวะตามเกณฑ์สากล (AAST organ injury scale)*

ผลการศึกษา: *พบการบาดเจ็บของไต ท่อไต และกระเพาะปัสสาวะรวมคิดเป็นร้อยละ 36.6 ของจำนวนผู้ป่วยที่ศึกษา เกือบทั้งสิ้นของผู้ป่วยที่มีการบาดเจ็บของไต ท่อไต และกระเพาะปัสสาวะ ได้รับการรักษาด้วยวิธีไม่ผ่าตัด นอกจากนี้แล้วการศึกษายังพบว่าปริมาณเม็ดเลือดแดงในปัสสาวะที่มากกว่าหรือเท่ากับ 20 เซลล์ต่อหัวตรวจกำลังขยายสูง อาจใช้เป็นหนึ่งในตัวบ่งชี้ทำนายการบาดเจ็บของระบบทางเดินปัสสาวะ โดยมีความไวร้อยละ 80 และความจำเพาะร้อยละ 46.15*

สรุป: *หนึ่งในสามของผู้ป่วยที่ได้รับการบาดเจ็บโดยของไม่มีคมที่ท้องตรวจพบการบาดเจ็บของไต ท่อไต และกระเพาะปัสสาวะ แต่เกือบทั้งหมดของผู้ป่วยกลุ่มนี้ได้รับการรักษาโดยไม่ผ่าตัด ทางกลุ่มผู้วิจัยขอเสนอปริมาณเม็ดเลือดแดงในปัสสาวะที่มากกว่าหรือเท่ากับ 20 เซลล์ต่อหัวตรวจกำลังขยายสูงเพื่อเป็นหนึ่งในตัวบ่งชี้ที่ทำนายการบาดเจ็บของไต ท่อไต และกระเพาะปัสสาวะ นำมาใช้คัดเลือกผู้ป่วยเพื่อรับการตรวจเพิ่มเติมด้วยเอกซเรย์คอมพิวเตอร์ช่องท้อง และควรใช้ค่าปริมาณเม็ดเลือดแดงนี้ด้วยความระมัดระวังโดยพิจารณาประกอบกับอาการผู้ป่วยเป็นสำคัญ*