Original Article

A Retrospective Review of Renal Injuries and Clinical Outcomes Correlated to AAST Grading System at Siriraj Hospital

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Objective: To compare the AAST renal injury grading system of 1989 with the revision of 2011, in the aspect of surgeons' decisions and patient management at Siriraj Hospital. This study also aims to create confidence among radiologists to select the most accurate grading system to analyze renal injuries.

Materials and Methods: A retrospective study of 35 renal trauma patients who visited the Division of Trauma Surgery at Siriraj Hospital from January 2011 to December 2016. Contrast-enhanced MDCT of abdomen were performed and were classified according to the American Association for Surgery of Trauma grading system (AAST). The demographic data, clinical data, trauma score and management considerations also collected for each patient.

Results: Twenty-one of 35 patients were managed by non-operative management (NOM). The others were managed by operative procedures including interventional radiology. Grade IV was the most common injury in these two groups. In NOM group, mean Injury Severity Score (ISS), Revised Trauma Score (RTS), survival probability (Ps) by Trauma Injury Severity Score (TRISS) were 18, 7.73 and 97.99%, respectively. In operative and interventional radiology management group, mean ISS, RTS, and Ps of TRISS were 23, 7.64 and 95.03%, respectively. There is no significant statistical difference in hospital stay, number of surgical and interventional radiology management of these two grading systems.

Conclusion: The AAST grading systems of 1989 and 2011 are not statistically different from the perspective of management and clinical outcome. However, radiologists need to inform surgeons of MDCT findings, such as extra-luminal contrast extravasation or vascular lesion, which are not addressed in the 1989 or in the 2011 grading systems, for proper management.

Keywords: Renal injuries grading system, Clinical outcome

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Renal injury occurs in up to 5% of all patients hospitalized for trauma, and responsible for 24% of traumatic abdominal solid organ injuries[1]. The major cause of renal injury is blunt abdominal trauma, which accounts for 80 to 90% of all cases[2].

Contrast-enhanced multi-detector computed tomography (MDCT) of the abdomen has become a routine practice and is considered the gold standard imaging modality at many trauma centers to diagnose renal injury in hemodynamic stable patients[3]. The goals of renal imaging are to detect the location, severity of renal injury and accurately identify the stage of injury. Renal imaging is also to identify pre-existing renal pathology in the injured kidney and detect associated abdominal organ injuries[4]. Radiologists play an important role in identifying renal injuries and describe renal injuries according to the American Association for Surgery of Trauma (AAST) grading system in order to inform, help increase the diagnostic confidence and clinical management decision of surgeons, which also decrease the rate of unnecessary exploratory laparotomy.

The original renal injury grading system created in 1989 by the Organ Injury Scaling (OIS) Committee of the American Association for the Surgery of Trauma, was classified into five grades (I to V) with increasing severity, with poor prognosis in grade V[5] (Table 1). This grading system is adopted as a standard method for radiological reporting and classification system used in renal trauma nowadays. Although the original AAST system of grading renal injuries is primarily based on surgical findings, there is a good correlation with the MDCT findings[3].

In 2011, Buckley JC and McAninch JW published the Revision of current AAST Renal Injury Grading System[6] (Table 2). Although no change made in the definition of renal injuries grade I to III, the study downgraded shattered kidneys to grade IV. The revised renal injury staging classification

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Table 1. The original renal organ injury grading system by the Organ Injury Scaling Committee of the American Association for the Surgery of Trauma[5].

Grade	Injury	Description
I	Contusion	Microscopic or gross hematuria, urological studies normal
	Hematoma	Subcapsular, nonexpanding without parenchymal laceration
II	Hematoma	Nonexpanding perirenal hematoma confined to renal retroperitoneum
	Laceration	<1.0 cm parenchymal depth of renal cortex without urinary extravasation
III	Laceration	>1.0 cm parenchymal depth of renal cortex, without collecting system rupture or urinary extravasation
IV	Laceration	Parenchymal laceration extending through the renal cortex, medulla, and collecting system
	Vascular	Main renal artery or vein injury with contained hemorrhage
V	Laceration	Completely shattered kidney
	Vascular	Avulsion of renal hilum which devascularizes kidney

Table 2. Revision of the American Association for Surgery of Trauma Renal Injury Grading System[6]

Grade	Injury	Description
I	Parenchyma	Subcapsular hematoma and/or contusion
	Collecting system	No Injury
II	Parenchyma	Laceration <1 cm in depth and into cortex, small hematoma contained within Gerota's fascia
	Collecting system	No Injury
III	Parenchyma	Laceration >1 cm in depth and into medulla, hematoma contained within Gerota's fascia
	Collecting system	No Injury
IV	Parenchyma	Laceration through the parenchyma into the urinary collecting system Vascular segmental vein or artery injury
	Collecting system	Laceration, one or more into the collecting system with urinary extravasation Renal pelvis laceration and/or complete ureteral pelvic disruption
V	Vascular	Main renal artery or vein laceration or avulsion main renal artery or vein thrombosis

(RISC) grade V included only main renal artery and/or vein injury. All urinary collecting system and segmental vascular injuries were included in the revised RISC as grade IV. Buckley J and McAninch JW also compared the nephrectomy rate and clinical renal salvage rate between the original renal injury grading system with this revised renal injury classification and found that they were not significantly different[6].

Siriraj Hospital serves as a level 1 trauma center in Bangkok. Although renal trauma is not frequently an observed condition, the decision for management and clinical outcome remain a challenge to surgeons. Management of traumatic renal injuries has changed from operative exploration to non-operative management in the majority of the cases in the past few decades[1]. Most renal injuries can be managed non-operatively, but the indications for surgery include massive renal hemorrhage with associated hemodynamic instability, expanding retroperitoneal hematoma, and ureteropelvic junction avulsion[3]. According to the increasing availability of minimally invasive techniques such as angiographic embolization at Siriraj Hospital, high-grade renal injuries (grade IV to V), can be managed by non-operative technique with low morbidity and mortality.

Although Siriraj Hospital had used the AAST renal injury grading system, no study was performed on correlation of clinical outcomes. The purpose of this study is to evaluate the incidence of renal injuries, associated trauma score, demographic data, mechanism of injury, management, hospital stay, clinical outcomes and early complications associated with the 1989 renal injury grading system and the current revision. This study also examines whether there are any differences in outcome on patient management between these two systems as well as to create confidence among radiologists to select the most accurate and beneficial grading system.

Materials and Methods

This retrospective study approved by Siriraj Institutional Review Board (Si. 092/2017) and undertaken at Siriraj Hospital between January 2011 and December 2016. The renal trauma patients who had abdominal MDCT scan and the images saved to the picture archiving and communication system (PACS) at Siriraj Hospital were included in the study.

The exclusion criteria comprised the patients not diagnosed by MDCT scan at Siriraj Hospital, had previous renal diseases, and had incomplete medical records.

The patients' demographic data collected included age, sex and mechanism of injuries. The grading of renal injury also classified according to revision of current AAST renal injury grading system in 2011 as well as to the original grading

system in 1989 for comparison. Management classified into two groups; non-operative management (NOM) and operative management including interventional radiology management. Clinical outcome, associated organ injury, hospital stay, complication and trauma score in each group were also analyzed.

Imaging technique

MDCT of abdomen performed with non-enhanced images, portovenous or nephrographic, and delayed excretory phases.

Statistical analysis

Descriptive statistics were used to summarize the data. The results presented as mean $\pm$ SD. All available data were entered into a database and were analyzed with standard statistical software (IBM SPSS Statistic version18). Student t-test was used to compare the periods of hospital stay between two grading systems. Fisher's exact test also compared the number of surgical and interventional radiology management between two grading systems.

Ethics consideration

The present study was approved by Siriraj Institutional Review Board (Si. 092/2017) and performed at the Faculty of Medicine Siriraj Hospital, Mahidol University.

Results

Forty-three renal trauma patients had visited the Division of Trauma Surgery. Eight patients were excluded from this study (seven patients had referred from another hospital and had not had abdominal MDCT scan at Siriraj Hospital, one patient had referred back to another hospital and thus did not have a complete medical record). Thirty-five patients were included in the study.

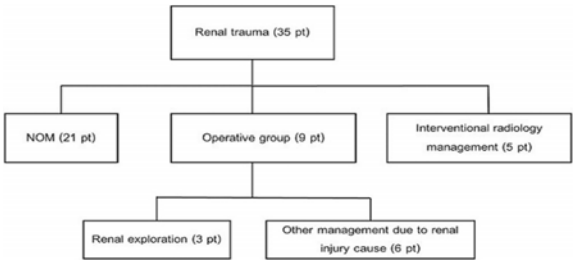

Figure 1. Management strategy.

There were 30 male and 5 female patients with an average age of 27 years old, ranging from 2 to 68 years old. The most common cause was blunt abdominal injuries caused by traffic accidents (24 cases), falling injury (4 cases), body assault (2 cases) and sporting injury (1 case). There were 4 cases of penetrating renal injuries. These results were the same as previously published research[7,8].

The grading results of renal injury classified according to the 1989 grading system were grade I = 1, grade II = 8, grade III = 10, grade IV = 12, and grade V = 4.

The grading results of renal injury classified according to 2011 grading system were grade I = 1, grade II = 8, grade III = 10, grade IV = 15, grade V = 1.

Twenty-one patients managed by non-operative management (NOM), 14 patients managed by operative procedures (3 renal explorations, 6 other intra-abdominal organ explorations, 5 interventional radiology management) (Figure 1). The median of overall hospital stay was 9 days (range 2 to 180 days). In NOM group, mean ISS, RTS, the survival probability (Ps) by using TRISS were 18, 7.73 and 97.99%, respectively. Most common grading of renal injury in this group was grade IV (38.09%). Mean ISS, RTS, the Ps by using TRISS in operative and interventional management group were 23, 7.64 and 95.03%, respectively. Most common renal injury grading in this group was also grade IV (50%).

In the revised renal injury grading system, only grade IV and V were reclassified. In this study, almost all grade V downgraded into grade IV. The total number of patients in grade IV and V were 16 patients (Table 3).

The mean hospital stay of grade IV was 11.75 days in 1989 grading system, whereas in grade IV in the revision system in 2011 was 11.6 days (t-test, $p = 0.9575$). There was no statistically significant difference between hospital stays between two groups.

In management consideration, the number of patients in operative group grade IV in the 1989 grading system was only one patient (overall 12 patients in grade IV), whereas grade IV of the 2011 grading system were 4 patients (overall 15 patients in grade IV) (Fisher's exact test, $p = 0.341$). There was no statistically significant difference of operative management between two groups.

With regard to interventional radiology management, there were 3 patients in grade IV in both systems (Fisher's exact test, $p = 1.00$). There was no statistically

Table 3. Number of renal trauma patients in grade IV and V classification

		Revised Renal Injury Grading System in 2011		
		AAST Grade IV	AAST Grade V	Total
1989 AAST Classification	AAST Grade IV	12	0	12
	AAST Grade V	3	1	4
	Total	15	1	16

significant difference in interventional radiology management between the two groups.

No patient died in the NOM group and 3 patients failed in NOM (two patients developed post-traumatic pseudoaneurysm that needed embolization (Figure 2) and one patient developed infected perinephric urinoma).

No patients died in the operative group. One patient had developed iatrogenic subintimal dissection at segmental branch of renal artery during coil and gelfoam embolization (Figure 3), while another had developed perinephric urinoma. In the operative group, only 3 patients had renal explorations (all were classified in revision renal injury grade IV).

Discussion

In the present study, the most common cause of renal trauma patients was blunt abdominal injury. The majority of renal trauma patients classified in grade IV (15 of 35 patients) whereas most of patients in other institutions classified in lower grade[7,8].

Figure 2. Arterial phase CT kidney (A) and selective left renal angiography (B) showed an intrarenal pseudoaneurysm with arterio-venous fistula at upper pole of left kidney. Post-embolization angiography (C) revealed total occlusion of arterial feeders of left renal pseudoanuerysm.

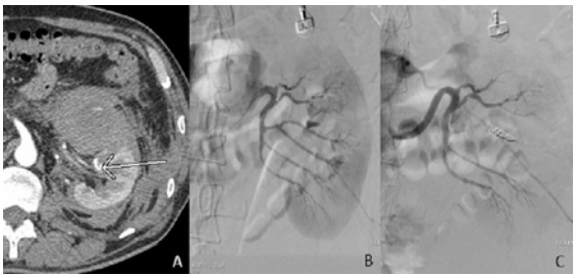

Figure 3. Arterial phase CT kidney (A) and selective left renal angiography (B) showed contrast extravasation from anteroinferior segmental branch of left kidney (arrow). Post-coil and gelfoam embolization (C) revealed total obliteration of anteroinferior segmental branch of left renal artery.

Non-operative management is the treatment of choice even for high-grade renal injuries at Siriraj Hospital, especially in stable patients. Only 3 grade V patients required renal explorations.

Low-grade renal injury can be healed completely without any complications. The early complications which occur within one month include; urinoma, post-traumatic pseudoaneurysm and subintimal dissection of segmental branch of renal artery from iatrogenic cause. All of these patients classified in grade IV to V of current AAST renal injury grading system in 2011. In NOM group, three patients in grade IV failed NOM. Two patients developed post-traumatic pseudoaneusym and another developed infected perinephric urinoma, which required percutaneous drainage. In operative and interventional radiology management group, two patients in grade IV failed the treatment. One had subintimal dissection of segmental branch of renal artery from iatrogenic cause and another had perinephric urinoma. No patient died in the present study.

The original renal injury grading system in 1989 is the standard method for classifying renal injury and has been common consensus between radiologists and surgeons for proper management. However, in 2011 the revision to AAST grading system downgraded the shattered kidney from grade V to grade IV. The present study compared the result in aspect of hospital stay, surgical and interventional radiology management between these two classifications.

The result shows no statistically significant difference among the periods of hospital stay, number of surgical and interventional radiology management between two classifications.

Several CT findings are still not addressed by either the 1989 grading or a revision grading system such as extraluminal contrast extravasation, vascular lesion, pseudoaneurysm or arteriovenous fistula. Based on the data, authors suggest that if patients are classified into grade IV or grade V with extraluminal contrast extravasation or vascular lesion, radiologists should promptly notify surgeons and get into contact with interventional radiologists for further investigation and cautious observance.

The authors conclude that radiologists can classify the lesion and renal grading injury based on either the AAST grading system in 1989 or the revision of AAST in 2011. Primarily, the clinical results are not statistically different based on the data. However, the present study has limitation due to too small number of patients.

The average trauma score in the operative and interventional radiology management group is higher than that of NOM group. Even though survival rate of patients in operative and interventional radiology management group is lower than that of the NOM group, no statistically significant difference found due to small number of patients. The patients who have Ps of TRISS below 90.2% have death probability more than the patients who have Ps more than 90.2%. The authors conclude that renal trauma patients who

have Ps below 90.2 % be cautiously observed.

Conclusion

Renal grading classified by the original renal injury grading system in 1989 or the revision to AAST grading system in 2011 are not statistically different in aspect of management and clinical outcome. However, radiologists should recognize early detection and inform surgeons of several CT findings such as extraluminal contrast extravasation or vascular lesions which are still not addressed by the original AAST grading or the new grading system.

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What is already known on this topic?

There are two common renal injury classification systems; the original renal injury grading system created in 1989 by the American Association for Surgery of Trauma (AAST), and the Revision of current AAST Renal Injury Grading System in 2011. Some Radiologists use the original system and some use the current revision system to inform surgeons of the severity of renal injury. This situation makes surgeons feel confused about management decisions.

What this study adds?

1) The result of this study showed no statistical difference between two classification systems in respect of management and clinical outcomes. Radiologists can use both classification systems in order to inform surgeons with diagnostic confidence and clinical management decisions.

2) There are some CT findings that are not addressed by both classification systems such as extraluminal contrast extravasation or vascular lesions. The radiologists should promptly notify surgeons of cautious observation and early management.

Potential conflicts of interest

The authors declare no conflicts of interest.

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การศึกษาย้อนหลังการบาดเจ็บที่ไตและผลการรักษาเทียบเคียงกับระดับความรุนแรงการบาดเจ็บตาม AAST grading ที่โรงพยาบาลศิริราช

เลิศพงศ์ สมจริต, ทิตา วชิรโรจน์ไพศาล, นิธิดา ณ สงขลา, จตุรัตน์ กันต์พิทยา

วัตถุประสงค์: ศึกษาเปรียบเทียบการบาดเจ็บที่ไตตามระดับความรุนแรงของ AAST grading ปี พ.ศ. 2532 และปี พ.ศ. 2554 ในการตัดสินใจในการดูแลรักษาผู้ป่วยของศัลยแพทย์ที่โรงพยาบาลศิริราช และสร้างความมั่นใจให้กับรังสีแพทย์ในการระบุระดับความรุนแรงการบาดเจ็บที่ไตของผู้ป่วยได้อย่างเหมาะสม

วัสดุและวิธีการ: ศึกษาย้อนหลังผู้ป่วยที่มีการบาดเจ็บที่ไต 35 ราย ที่เข้ารับการรักษาในสาขาศัลยศาสตร์อุบัติเหตุ โรงพยาบาลศิริราช ตั้งแต่เดือนมกราคม พ.ศ. 2554 ถึงเดือนธันวาคม พ.ศ. 2559 ที่ได้รับการตรวจวินิจฉัยด้วยเอกซเรย์คอมพิวเตอร์และจัดระดับความรุนแรงการบาดเจ็บที่ไตตามระบบ AAST โดยใช้ข้อมูลประชากร ระดับความรุนแรงของการบาดเจ็บ วิธีการรักษา และผลการรักษาของผู้ป่วยแต่ละรายในการศึกษา

ผลการศึกษา: ผู้ป่วย 21 ราย ได้รับการรักษาโดยไม่ต้องผ่าตัด อีก 14 รายได้รับการรักษาโดยการผ่าตัด หรือโดยวิธีรังสีร่วมรักษา การบาดเจ็บรุนแรงระดับที่ 4 เป็นระดับความรุนแรงที่พบมากที่สุดของผู้ป่วยทั้งสองกลุ่ม ผู้ป่วยกลุ่มที่ได้รับการรักษาโดยไม่ต้องผ่าตัดพบว่ามี Injury Severity Score 18, Revised Trauma Score 7.73 และโอกาสการรอดชีวิตตาม TRISS 97.99% ในขณะที่กลุ่มที่รักษาโดยการผ่าตัดมี Injury Severity Score 23, Revised Trauma Score 7.64 และโอกาสการรอดชีวิตตาม TRISS 95.03% ตามลำดับ จากการศึกษาเปรียบเทียบการจัดระดับความรุนแรงการบาดเจ็บของทั้งสองระบบ ไม่พบความแตกต่างของระยะเวลาในการนอนโรงพยาบาล และจำนวนผู้ป่วยที่ต้องรักษาโดยการผ่าตัดอย่างมีนัยสำคัญทางสถิติ

สรุป: ไม่พบความแตกต่างอย่างมีนัยสำคัญทางสถิติของการจัดระดับความรุนแรงการบาดเจ็บที่ไตของผู้ป่วยทั้งสองระบบในปี พ.ศ. 2532 และปี พ.ศ. 2554 ทั้งในด้านการรักษาและผลการรักษา แต่จากการศึกษานี้แนะนำว่ารังสีแพทย์ควรแจ้งให้ศัลยแพทย์ทราบทันที หากตรวจพบว่ามีการรั่วของสารทึบรังสีออกมาจากหลอดเลือดจากภาพเอกเรย์คอมพิวเตอร์ เพื่อให้ศัลยแพทย์ทำการรักษาเพิ่มเติมให้ผู้ป่วยต่อไป แม้ว่าข้อกำหนดนี้จะไม่อยู่ในการจัดระดับความรุนแรงการบาดเจ็บทั้งสองระบบ