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ORIGINAL ARTICLE

Grade IV renal trauma management. A revision of the AAST renal injury grading scale is mandatory

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Abstract
Introduction The AAST renal injury grading scale is currently the most important variable predicting the need for kidney repair or removal, morbidity and mortality after blunt or penetrating kidney injuries. The 2011 revised version included renal pelvis, uretero-pelvic junction and segmental vascular injuries as grade IV, limiting grade V to severe hilar injuries. However, patients requiring surgery cannot be properly identified because of hemodynamic instability due to grade IV renal injuries. This study proposes an add-on for the AAST grade IV renal injury scale to improve the management of these patients.
Method We searched the Medline and Scopus databases up to September 2014. Searches were not restricted by date, language or publication status. Pediatric studies were excluded.
Results 71 articles were found, 57 were pertinent, including 6 directly related to the topic. 3 risk factors were identified to be associated with surgery for hemodynamic instability: perirenal hematoma >3.5 cm, intravascular contrast extravasation and medial renal laceration. Presence of two or more of these criteria has been validated in two other studies to predict the need for intervention. Patients with >25 % devascularized fragments also have poor prognosis and should be treated more aggressively.
Conclusion These elements should be included in future classification reassessment to efficiently determine the time for surgery in grade IV renal traumas, generally leading to nephrectomy.

Keywords Renal trauma · AAST classification · Revision · Grade IV

Introduction

Renal trauma is rare (4.9 injuries/100,000 inhabitants yearly in the U.S.), but occurs in approximately 1–5 % of all trauma cases [1, 2]. This makes it a hot topic as seen by recently published European [3] and American [4] recommendations. The kidney is the most commonly injured genitourinary organ in trauma patients [5] in all ages, with a male to female ratio being 3:1 [6–8]. It is associated with youth as approximately 75 % of renal trauma patients are younger than 44 years. In developed countries, most renal traumas (82–95 %) are from blunt mechanisms, whereas penetrating mechanisms are more common in undeveloped countries, especially those with civil unrest [9].

It should be recalled that renal trauma can be acutely life threatening, due to major bleeding from parenchymal injuries, or in association with other organ injuries (liver, spleen, or gut), leading to rapid renal exploration. Most cases are benign or of moderate severity and can be managed conservatively. Treatment includes supportive care with bed rest, analgesics and observation, and repeated imaging [10].

Over the past 20 years, advances in imaging technology, especially computerized tomography, have resulted in more

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accurate non-surgical staging. This has allowed more renal injuries to be managed conservatively. Furthermore, super selective angioembolization techniques have been developed to embolize sub-segmental arteries: this has proved to be an effective adjunct in treating active hemorrhages while preserving a modest amount of functioning parenchyma [11, 12].

Twenty-six classifications for renal injuries have been presented in the literature over the past 60 years [13]. Among them, the organ injury scaling committee of the American Association for the Surgery of Trauma (AAST) developed a renal injury scaling system that is now widely used [14]. However, use of this classification scale in clinical practice remains difficult and is being questioned [15–17].

The aim of this study was to review literature data on this subject, recall the pros and cons of this classification, and the changes that have been proposed.

Methods

Electronic searches were performed using Medline (Pubmed via http://www.ncbi.nlm.nih.gov/pubmed) and Scopus databases (ScienceDirect via http://www.sciencedirect.com/) with the following keywords: kidney, renal trauma and classification. All articles between 2010 to October 2014 were included in the study. 57 pertinent articles were retrieved, and additional papers referenced in bibliographies, but not initially retrieved from Medline or Scopus, were also examined.

Results and discussion

Based on recommendations [3, 4], clinicians should perform diagnostic imaging with intravenous contrast-enhanced computed tomography in stable blunt trauma patients with gross haematuria or microscopic haematuria, and systolic blood pressure <90 mmHg (recommendation: grade B, scientific presumption). These criteria should allow early and accurate detection and staging of significant renal injuries.

A standardized classification system to describe renal injury severity is paramount to trauma research and communication. Currently, the AAST renal injury grading system is the most widely used to classify and standardize renal injuries [14]. It is based on surgical findings and is useful to predict clinical outcomes in patients with renal trauma [18–22].

It is composed of 5 grades (I–V) arranged in order of increasing severity according to injury depth and renal vascularity and collecting system involvement (Fig. 1).

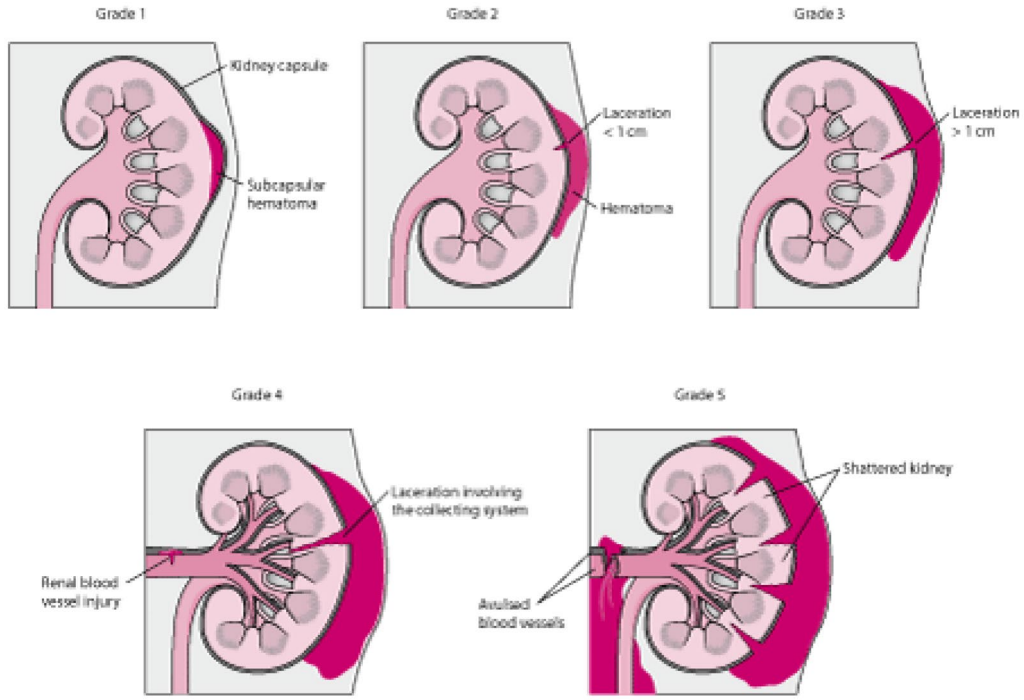
It correlates well with CT findings [16, 18], has been validated and is the most important variable to predict the need for kidney repair or removal [19]. It can also predict morbidity after blunt or penetrating injury [20] and mortality after blunt injury [21–23].

However, many authors have acknowledged that the current scale does not correctly classify certain high-grade injury subtypes [24], and different outcomes within each grade have been shown to exist. Recently, there have been several proponents of modifying the original AAST grading system to accurately describe renal injuries and incorporate new CT findings to better predict injuries requiring urgent haemostatic intervention.

In 2011, Buckley and McAninch [25], based on 25 years renal trauma experience, proposed a modification to the AAST grading system. The major changes included classifying renal pelvis, uretero-pelvic junction and segmental vascular injuries in grade IV injuries of the grading system thus limiting grade V cases to severe hilar injuries (main renal injuries or vein thrombosis). Using this new grading system, the authors then re-graded all of their 3580 renal trauma cases and found statistically similar numbers of grade IV and V injuries as well as renal salvage and nephrectomy rates. Nevertheless, this simplified AAST scale does not really impact renal trauma management, as it is still not possible to easily identify the small subset of patients who will ultimately require intervention for hemodynamic instability. Furthermore, others think that thrombotic vascular injuries should be categorized as low risk injuries because they do not require acute intervention.

Thus, Dugi et al. [26], from Parkland Hospital (USA), reviewed patient records with grade III and IV renal injuries that came to their trauma center and identified, blinded to clinical outcomes, computerized tomography findings associated with the need for urgent intervention for haemostasis. A large perirenal hematoma greater than 3.5 cm, intravascular contrast extravasation and medial renal laceration were important risk factors associated with the need for urgent haemostatic intervention. Patients with a 0 or 1 risk factor were at 7.1 % risk for intervention while those at level 2 or 3 were at 66.7 % risk. These characteristics could lead to reassessment of AAST grade IV renal injuries into grade IVa (low risk-cases, likely to be managed non-operatively) and IVb (high-risk cases, likely to benefit from angiographic embolization, renal repair or nephrectomy). However, this retrospective study mostly concerned patients with grade III injuries; grade IV injuries represented less than one-third of the cohort.

These data have been externally validated by Hardee et al. [27] on their own trauma series. Vascular extravasation (OR 16.4, 95 % CI 2.6–179.8, $p < 0.001$) and perinephric hematoma greater than 3.5 cm (OR 8.4, 95 % CI 1.4–52.5, $p = 0.0099$) were associated with intervention, while a



Grade *	Description of injury
1	Contusion or non-expanding sub-capsular haematoma No laceration
2	Non-expanding peri-renal haematoma Cortical laceration < 1 cm deep (without urinary extravasation)
3	Cortical laceration > 1 cm deep (without urinary extravasation)
4	**Laceration :** through corticomedullary junction into collecting system Or **Vascular :** segmental renal artery or vein injury with contained haematoma, or partial vessel laceration, or vessel thrombosis
5	**Laceration :** shattered kidney Or **Vascular :** renal pedicle avulsion

*Advance one grade for bilateral injuries up to grade 3.

Fig. 1 AAST renal injury grading scale

medial laceration was not ($p = 0.454$). Patients with 1 or less, 2 and 3 risk factors had an intervention rate of 2.9, 18 and 50 %, respectively ($p < 0.001$).

Figler et al. [28] also have validated these risk factors: among patients with blunt grade IV renal injury, the presence of $\geq$2 high-risk criteria (perirenal hematoma size, intravascular contrast extravasation, and medial or complex laceration) effectively predicts the need for intervention for hemodynamic instability, and can be used to identify patients who require intensive monitoring.

Long et al. [29] have attempted to predict non-operative approach outcomes of urinary extravasation following grade IV blunt renal trauma. Among patients with a urinary leak, endoscopic, ureteral stent placement and open surgery were required in 37.5 and 15.2 %, respectively. On multivariate analysis, fever >38.5 °C and ureteral clot

obstruction were independent predictors of the need for ureteral stent placement. The only predictor for open surgery was the percentage of devitalized parenchyma. Thus, they concluded that urinary extravasation following blunt renal trauma can be successfully conservatively managed. On the contrary, given the poor prognosis of devitalized tissue, patients with >25 % devascularized fragments could be separated among grade IV injuries in the revised AAST classification.

Moreover, Malaeb et al. noted that renal segmental vascular injury (SVI) following blunt abdominal trauma was not part of the original AAST injury grading system. Recent recommendations classify SVI as grade IV injury, but they hypothesized that SVI should be given a less critical grade than the classic deep laceration extending into the collecting system (G4L). Retrospectively, patients with SVI and G4L injuries admitted to their trauma center were recorded, and the need for surgical intervention, length of stay, kidney salvage, and delayed complication rate were statistically compared between the two groups. In the G4L group, 19.3 % of patients underwent major interventions (nephrectomies, renorrhaphies, angioembolizations) and 29.5 % underwent minor interventions (ureteral stent or percutaneous drain). Only 1.8 % of patients in the SVI group needed angioembolization, and no minor interventions were done. The kidney salvage rate was 86 % following SVI versus 67 % following G4L. Despite a small cohort, this study suggested a revision of the AAST grading system, since adding SVI as grade IV injury potentially increases the heterogeneity of grade IV injuries, and decreases the ability of the AAST scale to predict outcomes and need for nephrectomy [30].

Despite these different studies, there has been no formal revision of the AAST injury scale since 2011. Nevertheless, these changes could be soon adopted, as they have already been included in recommendations in different countries, like Australia and New Zealand [31].

Conclusion

The significant improvements in imaging technology and the resulting contemporary understanding of the natural history of renal trauma have been particularly important in directing the shift from renal injury surgical management to a mostly conservative management. If the AAST renal injury grading scale proposed by Moore et al. [14], and modified by Buckley and McAninch in [25], is very useful for predicting clinical outcomes in patients with renal trauma, it is not necessarily accurate for predicting injuries that require urgent haemostatic intervention.

Several proposals have been made to improve this classification: no changes were suggested for grade 1, grade 2 or grade 3 renal trauma, but regarding grade 4 injuries, three risk factors would be associated with intervention for renal hemorrhage and may serve as useful prognostic indicators for renal trauma. Also, patients with >25 % devascularized fragments present poor prognosis. These elements should be incorporated into future reassessment of this classification system.

Conflict of interest P. Chiron, E. Hornez, G. Boddaert, M. Dusaud, Y. Bayoud, B. Molimard, F.R. Desfemmes, X. Durand declare that they have no conflict of interest.

Compliance with ethical requirements P. Chiron, E. Hornez, G. Boddaert, M. Dusaud, Y. Bayoud, B. Molimard, F.R. Desfemmes, X. Durand declare that this article is consistent with ethical requirements.

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