

Research Article

Predictors of nephrectomy in high-grade renal trauma patients treated primarily with conservative intent

EL-Ouardi Khalid*, Mouslim Othmane, Lakmichi Mohamed Amine, Dahami Zakaria, Moudouni Mohammed Said and Sarf Ismail

Urology Department, University Hospital Marrakech, Morocco

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*Corresponding author: EL-Ouardi Khalid, Urology Department, University Hospital Marrakech, Morocco, E-mail: khalidelouardi0@gmail.com

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Abstract

Background: For the majority of renal injuries, non-operative management is the standard of care with nephrectomy reserved for those with severe trauma. The aim of our study is to assess the characteristics of perinephric hematoma and other prognostic factors of surgical intervention for high-grade renal trauma independent of AAST OIS.

Materials and methods: A total of 119 patients with high-grade renal trauma from January 2005 to September 2021 were identified for analysis. Hospital records and diagnostic imaging were reviewed to identify the need for surgical intervention, including total and partial nephrectomy. Factors examined include patient age, gender, ISS (Injury severity score), AAST-OIS, laceration location, length and number, perinephric hematoma characteristics, intravascular contrast extravasation, and devitalized segment status. Descriptive statistics and binary logistic regression were performed as appropriate.

Results: The mean patient age was 31,39 and the mean ISS was 22,80. A total of 24 surgical interventions were required (20%) including partial and total nephrectomy. On univariate analysis, hypotension on admission, hematoma diameter, degree of devitalized fragment superior of 25%, and AAST OIS grade was associated with the need for surgical intervention. On multivariate analysis, only hypotension on admission ($p: 0,029$), hematoma diameter greater than 3,5 cm ($p: 0,021$), and AAST-OIS grade ($p: 0,010$) remained independently associated with surgical intervention.

Conclusion: Perinephric hematoma size remains among prognostic factors for surgical intervention that allow better stratification of renal lesions and its study allows a better management of high-grade renal trauma.

Abbreviations

AAST: American Association for the Surgery of Trauma; CT: computerized tomography; ICE: intravascular contrast extravasation; ISS: Injury Severity Score; OIS: Organ Injury Scale; OR: Odds Ratio; CI: Confidence Interval

Introduction

Kidneys are the most commonly injured genitourinary organ [1]. High-grade renal trauma is defined by the American Association for the Surgery of Trauma by the presence of

grades III, IV and V, they are rarer and found in 5% of cases on average [2].

Over the past decades, the management of kidney trauma has evolved with a clear transition to a minimally invasive conservative approach this is due to the development of minimally invasive treatment techniques such as angioembolization and endourology, improving imaging modalities, mainly computed tomography, and means of admission in emergencies and resuscitation [3].

According to the patient's initial clinical assessment on admission, his hemodynamic assessment as well as the grade



of his trauma, the course of action to be taken will be decided [4].

The aim of our study is to assess perinephric hematoma size as a strong prognostic factor of the need for surgical intervention in high-grade renal trauma.

Materials and methods

Study design

This descriptive and analytical retrospective single-center study was conducted between January 2005 and September 2021 inclusive, data were collected from adult patients with high-grade renal trauma defined as AAST grades III – V diagnosed and graded using computed tomography CT, treated in a conservative way in our structure.

Patients who underwent immediate surgery without prior imaging were excluded. Data were gathered on demographics, injury characteristics, radiologic variables, and management.

Definitions

Hypotension was defined as blood systolic blood pressure < 90 mmHg anytime during the first 4 hours from admission.

Vascular Contrast Extravasation (VCE) was defined as the presence of contrast accumulation outside of the renal parenchyma demonstrated on arterial or venous phase CT scan.

Hematoma Rim Distance (HRD) was measured on the axial CT planes and was defined as the longest perpendicular distance from the renal parenchymal border to the hematoma border within the boundaries of superior and inferior kidney margins.

The percentage of parenchymal devascularization was estimated based on the extent of persistent parenchymal infarcts seen as segmental or global lack of enhancement on contrast trauma CT scans and was dichotomized as < 25% or ≥ 25% as suggested in previous studies.

Management options were categorized as expectant, conservative / minimally invasive, and open operative.

Conservative treatment consisted of admission of the patients to a medical facility, with bed rest, hydration, antibiotic prophylaxis, and analgesics or transfusions if needed. All patients have benefited from monitoring of clinical and biological parameters and CT scans at D3 and D8 combined with all non-surgical interventions preserving the renal unit.

Failure of conservative treatment was defined by the need for invasive surgical interventions: total or partial nephrectomy.

Data extraction

The studied parameters included age, sex, laterality, mechanism of occurrence, associated lesions, ISS, clinical and laboratory signs at patient admission, blood transfusion, AAST grade, characteristics of perinephric hematoma, presence of vascular contrast extravasation, parenchymal

devascularization, treatment, duration of hospitalization and evolution.

We took into consideration assessing the abundance of the perirenal hematoma and comparing our patients, ' hematoma rim distance on CT scan.

Statistical analysis

Statistical analysis was performed using SPSS software version 19.0.

Values are reported as percentages for categorical variables and mean or median for continuous variables as appropriate.

In the bivariate analysis, the comparison of categorical variables used the Chi2 test, and the comparison of continuous variables used the Student t-test. Multivariate analysis using binary logistic regression was used to model prognostic factors for failure of conservative treatment of high-grade renal trauma. The variable of interest was (failure of conservative treatment of high-grade renal trauma).

Ethical considerations

We have received all patients' informed consent.

Results

Of the 131 traumas that were presented during the study period, 119 met the study inclusion criteria (Table 1). The mean patient age was $31,39 \pm 13,28$ years, 85% of the patients were male and the mean ISS was 22,80. Injuries were classified by AAST grade as grade III in 56 of the 119 patients (47%), grade IV in 54 (45%), and grade V in 9 patients (8%) (Table 1). The average size of the perinephric hematoma was $47.03 \pm$

Table 1: Demographics of patients in high-grade renal trauma cohort, and outcomes and interventions.

No. pts		119
Mean \pm SD pt age (range)		31.39 \pm 13,28 (15 - 68)
No. male (%)		101 (85%)
No. female (%)		18 (15%)
Sex ratio		5.6
Mean \pm SD Injury Severity Score		22,80 \pm 11,48 (9 - 59)
Injury mechanism	Traffic accident	44 (37%)
	Fall from a high	27 (23%)
	Stabbing assault	35 (29%)
	Work accident	7 (6%)
	Fight	4 (3%)
	Sport accident	2 (2%)
No. blunt trauma (%)		84 (71%)
No. penetrating trauma (%)		35 (29%)
No. AAST-OIS grade (%):	Grade III	56 (47%)
	Grade IV	54 (45%)
	Grade V	9 (8%)
Mean \pm SD perinephric hematoma diameter (cm) :		4.70 \pm 4.42 (0.4 -23)
No. perinephric hematoma location (%) :	upper pole	16 (13%)
	lower pole	63 (53%)
	mid-kidney	40 (34%)
No. devitalized fragment (%):		11 (9%)
Mean days hospital stay (range) :		16.1 (6 -75)
No. pts requiring surgical intervention (%):		24 (20%)



44.22 mm the most common injury mechanisms were traffic accidents in 37% of cases followed by stabbing assaults in 29% and a fall from a height in 23%.

Of the patients, 20% underwent a total of 24 surgical interventions (Table 1). 3 patients (2%) were classified as grade III, 14 patients (12%) as grade IV and 9 patients (6%) classified as grade V. The most common surgical intervention was total nephrectomy in 22 cases.

On univariate analysis the need for surgical intervention was associated with hypotension at admission (OR: 5,87, 95% CI 2,25-15,30, p : 0,001), hematoma diameter greater than 3,5 cm (OR: 6,22, 95% CI 2,13-18,13, p : 0,001), AAST OIS grade (OR: 2,33, 95% CI 1,66-4,16, p : 0,001) and the presence of devitalized fragment superior of 25 % (OR: 27,90, 95% CI 5,48-141,87, p : 0,004) (Table 2).

However, after multivariate binary logistic regression analysis only hypotension on admission (OR:0,296, 95% CI 0,099-0,885, p : 0,029), hematoma diameter greater than 3.5 cm (OR:0,253, 95% CI 0,070-0.815 , p : 0,021) and AAST-OIS grade (OR: 0,256, 95% CI 0,09-0,72, p : 0,010) remained independently associated with surgical intervention (Table 3).

Descriptive statistics showed that a hematoma diameter of 3.5 cm or less vs 3.5 cm or greater resulted in an intervention rate of 8 % vs. 35% (p = 0.021).

Discussion

Since its introduction in 1989, AAST OIS has proven to be valid for predicting patients requiring urological intervention, especially with the transition to a conservative attitude [5,6].

European guidelines recently defined the conservative management of renal trauma as all measures consisting of bed rest, clinical observation, and laboratory and radiological monitoring [7]. This attitude is considered a standard of management of severe kidney trauma with a success rate that varies between 80% and 100% [5,6,8].

To make AAST OIS more practical and accurate for making management decisions in high-grade renal trauma, Dugi, et al. [9] proposed to update this classification scheme, mainly for grade IV into grade IV low risk if 0 or 1 risk factor is present and grade IV high risk if 2 or 3 risk factors are present. They have included in the update as risk factors for surgical intervention: perinephric hematoma size greater than 3.5cm, vascular contrast extravasation, and the presence of medial laceration.

Figler, et al. [10], approved this substratification, in a study published in the American College of Surgeons in 2013 with a sensitivity of 71% and a specificity of 89%.

Perinephric hematoma is one of the important CT features that quantify the active bleeding of the kidney and its evolution over time. It is considered a prognostic factor of failure of conservative treatment of high-grade renal trauma according to several studies [2,9,11,12].

Ichigi, et al. [12] considered that the size of the hematoma is a good index to quantify the bleeding and assess the degree of vascular damage better than the AAST OIS, this latter is frequently dissociated from the intensity of the bleeding. Hematomas with a maximal diameter greater than 4 cm were associated with the need for urological surgical intervention.

Our study shows the same results, since the size of the perinephric hematoma greater than 3.5 cm was associated with nephrectomy in the univariate analysis (p value = 0.001) and multivariate analysis (p = 0.021, OR: 0.253, 95% CI: [0.070 -0.815]) with a surgical intervention rate of 35% vs. 8% for an hematoma diameter of 3,5 cm or greater vs. 3,5 cm or less.

However, the exact size that determines the need for surgery differs between studies: several groups found that hematoma size greater than 3.5 cm was associated with an intervention rate of 25.5% to 27%, while hematoma size below 3.5 cm was associated with an intervention rate of 3% to 4% [9,10].

Zemp, et al. [13], in a study published in 2017 in The Journal of Urology, concluded that the size of a hematoma greater than 6 cm provides better discrimination of patients requiring intervention (31.1% vs. 1.6%) compared to a smaller size of 4 cm (16.2% vs. 1.7%). This confirms that the size of the perirenal hematoma is a crucial element for decision-making in renal trauma.

More recently Keihani, et al. [14] concluded that vascular contrast extravasation and perinephric hematoma are two CT indices that can be used to decide the need for surgical intervention and can thus be incorporated into a revision of the AAST OIS for better management of high-grade renal trauma.

Table 2: Univariate associations relating to the need for surgical intervention.

	OR (95% CI)	p value
Age	0.99 (0.96 - 1.03)	0.82
Injury mechanism	1.87 (0.21 - 2.04)	0.89
Injury Nature	1.25 (0.48 - 3.28)	0.63
hypotension on admission	5.87 (2.25 - 15.30)	0.001*
Injury Severity Score	1.95 (0.91 - 2.05)	0.33
Associated Injuries	2.51 (0.97 - 6.47)	0.051
AAST grade	2.33 (1.66 - 4.16)	0.001*
Hematoma Diameter greater than 3.5 cm	6.22 (2.13 - 18.13)	0.001*
Hematoma Location	3.45 (2.76 - 3.98)	0.59
Medial laceration	1.62 (0.64 - 4.08)	0.29
Devitalized fragment sup of 25%	27.90 (5.48 - 141.877)	0.004*

*Significant (p < 0.05)

Table 3: Multivariate analysis relating to the need for surgical intervention.

	OR (95% CI)	p value
Hypotension on admission	0.296 (0.099 - 0.885)	0.029*
AAST grade	0.256 (0.090 - 0.720)	0.010*
Hematoma Diameter greater than 3.5 cm	0.253 (0.070 - 0.815)	0.021*
Devitalized fragment sup of 25%	0.321 (0.025 - 4.201)	0.387

*Significant (p < 0.05)



In their last edition (2021) of guidelines, the American Association of Urology [15] recommends surgical intervention in non-hemodynamically stable high-grade renal trauma with perinephric hematoma size greater than 4 cm and/or vascular contrast extravasation.

Our study is limited because of its retrospective nature. In addition, patients were followed in the hospital only and were unaware of any complications that might have required care beyond the acute hospital stay.

Conclusion

Perinephric hematoma size remains among prognostic factors for surgical intervention that allow better stratification of renal injuries. It should be incorporated into a revised AAST-OIS grading system for better management of high-grade renal trauma, but its value is not superior to patient clinical features.

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