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# Predictors of outcomes in conservative management of high-grade renal trauma

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## Abstract

**Background** Management of high-grade renal trauma is debatable, with the recent evidence embracing a conservative approach in the management of even grade 5 renal injuries. The study aimed to analyze the clinical profile of patients with high-grade renal trauma, assessing their management strategies, outcomes, complications, and need for ancillary procedures.

**Methods** A retrospective analysis of prospectively maintained data was performed involving blunt abdominal trauma patients with high-grade renal injuries (Grade 4 and 5) presenting to our hospital from January 2018 to December 2022. Patient data analyzed included demographics, clinical presentation, injury characteristics, complications, ancillary procedures, and mortality rates. All patients underwent renal functional assessment using an isotope renogram scan at the 3-month follow-up. Data collected were entered into a database and subjected to descriptive analysis using Jamovi version 2.3.28.

**Results** The study included 45 patients with a mean age of 29 years and a male-to-female ratio of 41:4. Most patients ( $n=42$ ) were managed conservatively. Thirty-eight patients had grade 4 injuries, and seven had grade 5 injuries. Twenty-six patients suffered renal parenchymal injuries alone, three patients had renal vascular injuries alone, and 16 patients had both parenchymal and vascular injuries. Grade 5 renal injury ( $p < 0.001$ ), vascular high-grade injury ( $p < 0.001$ ), angioembolization ( $p < 0.001$ ), and blood transfusions ( $p = 0.021$ ) were significantly associated with the incidence of poorly functioning kidney in high-grade renal trauma patients managed conservatively. Multinomial logistic regression analysis revealed angioembolization ( $p < 0.001$ ), poorly functioning kidney post-trauma ( $p < 0.001$ ), and blood transfusions ( $p < 0.001$ ) were significantly associated with high-grade renal vascular injuries compared to high-grade renal parenchymal injuries.

**Conclusion** Conservative management is advisable for high-grade renal trauma in hemodynamically stable patients. High-grade vascular injuries are more severe than parenchymal injuries and correlate with poorer renal functional outcomes. Grade 5 renal injury, predominantly vascular high-grade injury, and the requirement for angioembolization and blood transfusions serve as significant predictors of poorly functioning kidneys post-trauma. Urologists should consider these predictors when counseling patients regarding potential outcomes following conservative management of high-grade renal trauma.

**Keywords** Renal trauma, AAST renal injuries, High-grade renal trauma, Grade 4 renal injury, Grade 5 renal injury, Conservative management, Poorly functioning kidneys, Angioembolization

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## 1 Background

Renal trauma comprises approximately 10% of all traumatic abdominal injuries [1, 2]. Traumatic renal injuries are graded per the American Association for the

Surgery of Trauma (AAST) renal injury scale, and grades 4 and 5 represent high-grade injuries [3]. Managing low-grade renal injuries (grades 1–3) is well established and employs a conservative approach. However, the management of high-grade renal trauma is debatable, with recent evidence embracing a conservative approach in the management of even grade 5 renal injuries. This paradigm shift in management approach is a result of the rising popularity and availability of minimally invasive procedures, such as selective angioembolization, along with improvements in critical care for trauma patients [4]. Surgical exploration is reserved for patients with hemodynamic instability [5].

Despite the inclination towards a conservative approach, concerns persist regarding the potential risks associated with conservative management of high-grade injuries, including delayed hemorrhage, prolonged hospital stay, urinomas, and abscess formation. This study was conducted to analyze the clinical profile of patients with high-grade renal trauma, assessing their management strategies, outcomes, complications, and need for ancillary procedures.

## 2 Methods

A retrospective analysis of prospectively maintained data was conducted at a university teaching hospital, analyzing data of patients with renal trauma from January 2018 to December 2022. Ethical approval for the study was obtained from the institutional ethics committee, along with permission to access select patient records. Inclusion criteria consisted of patients with high-grade renal injuries (grades 4 and 5) secondary to blunt abdominal trauma, diagnosed with abdominal and pelvic contrast-enhanced computed tomography (CECT). Patients with low-grade renal injuries, penetrating abdominal trauma and incomplete medical records were excluded from the study. Follow-up data from 1-year post-injury was collected.

Patient demographic details such as age and gender were collected. Clinical details included hemodynamic status, need for supportive therapy, and blood transfusions. In addition, ancillary procedures were assessed, such as selective arterial embolization for persistent bleeding and double-J stenting for urine leaks at presentation or follow-up. Injury characteristics analyzed included the side and mode of injury, grade of renal injury according to the AAST scale, and associated visceral injuries. Complications and mortality rates (both at the time of initial hospital admission and within the first 30 days after the injury) were also analyzed.

All patients underwent scheduled follow-up according to the institutional protocol at 1 and 3 months post-trauma, with differential renal functional assessment

using a Dimercapto Succinic Acid (DMSA) scan at the 3-month follow-up. We defined poorly functioning kidneys as those having a differential renal function of <15%. These data were extracted from electronic medical records and paper charts for analysis. Data collected were entered into a database and subjected to descriptive analysis using Jamovi version 2.3.28.

## 3 Results

The study included 45 patients with a mean age of 29 years, and a male-to-female ratio of 41:4. Patient demographics, clinical Presentation, and management details have been summarized in Table 1.

At presentation, 40 patients were hemodynamically stable, while five were hemodynamically unstable and required inotropic and other supportive therapies. Of these unstable patients, two stabilized hemodynamically within the first 24 h after initial supportive therapy. The majority of patients ( $n=42$ ) were managed conservatively, with no cases requiring retroperitoneal exploration, though three patients underwent exploratory laparotomy for associated hepatic and splenic injuries with hemodynamic instability. Although mortality occurred in 2 patients postoperatively who underwent exploration, it was not attributed to renal trauma but rather to associated high-grade hepatic and splenic injuries, which necessitated exploration.

22 out of 38 patients with grade 4 injuries required blood transfusions compared to all seven with grade 5 injuries requiring blood transfusions ( $p=0.032$ ). Angioembolization was needed in 3 patients with Grade 4 ( $n=38$ ) injuries and three patients with Grade 5 ( $n=7$ ) injuries ( $p=0.012$ ). Double-J stenting was performed in 4 patients with grade 4 injuries with urinary extravasation. Follow-up isotope renography with DMSA revealed poorly functioning kidneys in 3 patients with grade 4 injuries and five with grade 5 injuries ( $p<0.001$ ).

Analysis of factors associated with a poorly functioning kidney post-trauma revealed that grade 5 renal injury ( $p<0.001$ ), predominantly vascular high-grade injury ( $p<0.001$ ), the need for angioembolization ( $p<0.001$ ), and the need for blood transfusions ( $p=0.021$ ) were significantly associated with the incidence of poorly functioning kidney in high-grade renal trauma patients managed conservatively (Table 2).

Multinomial logistic regression analysis of vascular and parenchymal injuries revealed that the need for angioembolization ( $p<0.001$ ), the incidence of poorly functioning kidney post-trauma ( $p<0.001$ ), and the need for blood transfusions ( $p<0.001$ ) were significantly associated with high-grade renal vascular injuries compared to high-grade renal parenchymal injuries (Table 3).

**Table 1** Patient demographics, clinical presentation, and management

Characteristics	Frequency (n)	Mean ± SD (range)
Age		29 years (6–65)
Male:female ratio	41:4	
Mechanism of injury		
Road traffic accidents	35	
Fall from a height	10	
Side of injury		
Left	22	
Right	18	
Bilateral	5	
Grade of injury		
Grade 4	38	
Grade 5	7	
Type of injury		
Parenchymal	26	
Vascular	3	
Parenchymal and vascular	16	
Associated with other visceral injury		
Liver injury	10	
Splenic injury	10	
Liver and splenic injuries	8	
None	17	
Hemodynamic status at presentation		
Stable	40	
Unstable	5	
Need for exploration		
Conservative	42	
Need for retroperitoneal exploration	0	
Exploration for associated visceral injuries	3	
Need for blood transfusion as per grade of injury		
Grade 4 (n = 38)	22	<b>p = 0.032</b>
Grade 5 (n = 7)	7	
Need for angioembolization as per grade of injury		
Grade 4 (n = 38)	3	<b>p = 0.012</b>
Grade 5 (n = 7)	3	
Need for double-J-J stenting as per grade of injury		
Grade 4 (n = 38)	4	<b>p &lt; 0.001</b>
Grade 5 (n = 7)	0	
Poorly functioning kidney on follow-up (as per grade of injury)		
Grade 4 (n = 38)	3	<b>p &lt; 0.001</b>
Grade 5 (n = 7)	5	
Mortality		
Attributed to renal trauma	0	
Attributed to associated visceral injuries	2	

**Table 2** Association of various parameters with poorly functioning kidneys on follow-up

Parameters	Poorly functioning kidney		p-value
	Yes (n=8)	No (n=37)	
Grade of renal injury			
Grade 4	3	35	<b>p &lt; 0.001</b>
Grade 5	5	2	
Type of renal injury			
Parenchymal	0	26	<b>p &lt; 0.001</b>
Vascular	3	0	
Parenchymal and vascular	5	11	
Angioembolization (yes)	5	1	<b>p &lt; 0.001</b>
Hemodynamic instability	1	4	p = 0.890
Need for blood transfusion (yes)	8	21	<b>p = 0.021</b>

#### 4 Discussion

Renal trauma is a commonly encountered clinical scenario, particularly in road traffic accidents with blunt abdominal trauma. Effective decision-making in its management is crucial. There is a consensus on conservatively managing Grade 1–3 renal injuries. However, the approach to high-grade renal trauma (Grades 4–5) is debated, particularly regarding the role of surgical exploration [6]. Over the past decade, there has been a paradigm shift towards more conservative management for high-grade renal injuries [7]. This shift towards conservative management reflects an optimal understanding of our goals in managing renal trauma: preserving life, reducing morbidity, and optimizing renal function.

In our study, all patients experienced blunt abdominal trauma, predominantly from road traffic accidents, with falls from height being the second most common cause. All patients were managed conservatively without the need for retroperitoneal exploration, supporting the current evidence favoring conservative management in high-grade renal trauma. A recently published systematic review on high-grade renal trauma concludes that there is strong evidence in favor of conservative management, especially for hemodynamically stable patients. Compared to operative management, this approach is

associated with a low risk of mortality and a reduced probability of requiring nephrectomy [7].

Renal trauma seldom occurs in isolation and often coincides with other abdominal visceral injuries [8]. In our study, 28 patients had concomitant hepatic or splenic injuries or both. Most of these patients, who were hemodynamically stable, were managed conservatively. Three patients required exploratory laparotomy due to hemodynamic instability and were unresponsive to supportive therapy, predominantly attributed to high-grade liver and splenic injuries. The evidence underscores hemodynamic instability as a principal factor for surgical exploration, necessitating a shift from conservative management [9]. However, none of our cases warranted retroperitoneal exploration, thereby reassuring the efficacy of conservative management of high-grade renal injuries.

Renal trauma is graded based on both parenchymal (laceration) and vascular injuries. We analyzed the factors associated with each through logistic regression to identify clinical differences that could affect management and outcomes. Our analysis revealed that high-grade renal vascular injuries were significantly associated with the need for angioembolization, a higher incidence of poorly functioning kidneys post-trauma, and an increased requirement for blood transfusions compared to high-grade renal parenchymal injuries. This indicates that vascular injuries are more severe than parenchymal injuries, leading to poorer renal functional outcomes and necessitating more active immediate post-traumatic management, including blood transfusions and ancillary procedures such as angioembolization, thereby placing the patient at a higher risk.

The role of angioembolization in managing high-grade renal trauma with active bleeding is increasingly important for hemodynamically stable patients, often eliminating the need for surgical exploration. It has very high reported success rates, reaching up to 94% in selected patients with grade 4 or 5 blunt renal artery trauma [10]. In our study, angioembolization was needed in three patients with grade 4 injuries and three patients with grade 5 injuries, with a significantly higher need for grade 5 injuries than grade 4. Our findings also revealed that patients with high-grade renal trauma who underwent

**Table 3** Multinomial logistic regression analysis of vascular and parenchymal injuries

Comparison groups	Variables	Univariate analysis		Multivariate analysis	
		Log OR (95% CI)	P	Log OR (95% CI)	P
Vascular–parenchymal	Angioembolization	10.25 (–81.24–101.74)	0.82	16.9 (15.13–18.66)	<b>&lt; 0.001*</b>
	Blood transfusion	0.85 (–1.67–3.37)	0.51	–21.12 (–22.33 to –19.92)	<b>&lt; 0.001*</b>
	NFK status	11.36 (–68.5–91.29)	0.78	46.62 (45.41–47.82)	<b>&lt; 0.001*</b>
	Hemodynamic stability	–1.04 (–874.2–872.1)	0.99	–1.38 (–12.83–10.07)	0.81

angioembolization have a higher likelihood of long-term renal function loss compared to those who did not require the procedure. This could be explained by the fact that angioembolization was performed on the main renal vessels rather than super selective angioembolization in our patients, as they suffered high-grade renal vascular injuries.

Looking at functional outcomes after conservative management of high-grade renal injuries, our study identified several factors significantly associated with a poorly functioning kidney post-trauma. These factors included grade 5 renal injury, predominantly vascular high-grade injury, the need for angioembolization, and the need for blood transfusions. We believe these factors can predict functional outcomes post-conservative management in high-grade injuries, and urologists should be aware of them to provide adequate patient counseling on potential outcomes.

Limitations of our study include its retrospective design in a single center, which can limit the validity of the findings when considered in a larger population. The significant disproportion between the number of patients with grade 4 and grade 5 injuries limits the comparability between these groups, as they are not evenly matched. Lastly, the study's limited sample size may limit its external validity. Therefore, prospective studies with larger sample sets are warranted to further validate the findings and assess renal trauma's impact on patients' health-related quality of life.

## 5 Conclusions

Our findings indicate that conservative management is advisable for high-grade renal trauma in hemodynamically stable patients. High-grade vascular injuries are more severe than parenchymal injuries and correlate with poorer renal functional outcomes. Grade 5 renal injury, predominantly vascular high-grade injury, and the requirement for angioembolization and blood transfusions serve as significant predictors of poorly functioning kidneys post-trauma. Urologists should consider these predictors when counseling patients regarding potential outcomes following conservative management of high-grade renal trauma.

### Abbreviations

AAST	American Association for the Surgery of Trauma
CECT	Contrast-enhanced computed tomography
DMSA	Dimercapto succinic acid

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None to disclose.

### Author contributions

All the authors have read and approved the manuscript; study concept and design: Surag KR, Kasi Viswanath Gali, Abhishek Goli; analysis and interpretation of data: Surag KR, Abhijit Shah, Anshuman Singh, Krishnakanth AVB; drafting of the manuscript: Surag KR, Kasi Viswanath Gali, Abhishek Goli; critical revision of

the manuscript for important intellectual content: Anupam Choudhary, Arun Chawla, Padmaraj Hegde.

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### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Declarations

#### Ethics approval and consent to participate

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki, and approval for the study was obtained from the institutional ethics committee of Kasturba Medical College and Kasturba Hospital ((IEC1: 67/2023), along with permission to access select patient records. Informed consent was waived since this was a retrospective study.

#### Consent for publication

Given that this study is retrospective in nature, all patients previously provided consent for the access and utilization of their medical records for research purposes upon admission. Furthermore, as this study is retrospective, the ethics committee has waived the requirement for additional consent for publication.

#### Competing interests

The authors declare that they have no competing interests.

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### References

- Moore EE, Shackford SR, Pachter HL, McAninch JW, Browner BD, Champion HR, Flint LM, Gennarelli TA, Malangoni MA, Ramenofsky ML, Trafton PG (1989) Organ injury scaling: spleen, liver, and kidney. *J Trauma Acute Care Surg* 29(12):1664–1666
- Wessells H, Suh D, Porter JR et al (2003) Renal injury and operative management in the United States: results of a population-based study. *J Trauma* 54:423–430. <https://doi.org/10.1097/01.TA.0000051932.28456.F4>
- Santucci RA, McAninch JW, Safir M, Mario LA, Segal MR (2001) Validation of the American association for the surgery of trauma organ injury severity scale for the kidney. *J Trauma Acute Care Surg* 50(2):195–200
- Bryk DJ, Zhao LC (2016) Guideline of guidelines: a review of urological trauma guidelines. *BJU Int* 117:226–234. <https://doi.org/10.1111/BJU.13040>
- Anselmo da Costa I, Amend B, Stenzl A, Bedke J (2016) Contemporary management of acute kidney trauma. *J Acute Dis* 5:29–36. <https://doi.org/10.1016/J.JOAD.2015.08.003>
- McGuire J, Bultitude MF, Davis P et al (2011) Predictors of outcome for blunt high grade renal injury treated with conservative intent. *J Urol* 185:187–191. <https://doi.org/10.1016/J.JURO.2010.08.085>
- Prihadi JC, Hengky A, Lionardi SK (2024) Conservative management in high-grade renal trauma: a systematic review and meta-analysis. *BJU Int*. <https://doi.org/10.1111/BJU.16343>
- Petrone P, Perez-Calvo J, Brathwaite CEM et al (2020) Traumatic kidney injuries: a systematic review and meta-analysis. *Int J Surg* 74:13–21. <https://doi.org/10.1016/J.IJSU.2019.12.013>
- Bozeman C, Carver B, Zabari G et al (2004) Selective operative management of major blunt renal trauma. *J Trauma* 57:305–309. <https://doi.org/10.1097/01.TA.0000092683.35028.03>
- Chow SJD, Thompson KJ, Hartman JF, Wright ML (2009) A 10-year review of blunt renal artery injuries at an urban level I trauma centre. *Injury* 40:844–850. <https://doi.org/10.1016/J.INJURY.2008.11.022>

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