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High-Grade Blunt Renal Trauma: A Single Centre Experience

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Abstract

Introduction: *The approach to managing renal injuries has increasingly favoured non-surgical methods. Blunt trauma is responsible for 80% to 90% of these injuries. The majority are classified as low-grade (American Association for the Surgery of Trauma - AAST grades I and II), typically managed conservatively through observation with minimal complications. However, nephrectomy is still frequently performed in cases of high-grade renal trauma (HGRT).*

Materials & Methods: *We prospectively gathered data on all adult (≥18 years of age) patients presenting with high grade blunt renal trauma (grade IV & V). A centralized database platform was used for data collection. Computed tomography scan findings were used to grade the renal injuries.*

Results: *Between January 2020 and December 2024, 78 adult patients with grade IV and V blunt renal injuries were treated at our hospital. The average age was 35.42 years (±11.43), and the majority were male (64 out of 78, or 82.05%). Of these, 50 had grade IV injuries, while 28 had grade V injuries. Nearly half (48.71%) of the patients with high-grade renal trauma also sustained injuries to other abdominal organs. Those with grade V injuries presented with notably lower systolic blood pressure and haemoglobin levels compared to those with grade IV injuries. Blood transfusions were required in 40 patients (51.28%), and 16 patients (20.5%) received platelet transfusions within the first 24 hours of admission. Renal angiography followed by angioembolization was carried out in 12 cases. Abdominal surgery was performed in 16 patients (20.5%) to address renal and/or other abdominal injuries. Nephrectomy was necessary in 3 patients with grade IV and in 6 patients with grade V trauma.*

Conclusions: *Approximately 80% of patients with grade IV and V renal injuries can be effectively and safely treated using conservative or non-operative management. However, around 20% still require surgical intervention due to renal or associated abdominal complications. The rate of nephrectomy remains notable at 11.53%, with vascular injuries to the kidney being the leading indication for the procedure.*

Keywords: **Renal trauma; Renal injury grading; Wounds and injuries; Trauma centre; Single centre.**

Introduction Most blunt renal injuries result from motor vehicle collisions, falls from significant heights, or physical assaults. These incidents expose the kidneys to high-impact forces and rapid deceleration, increasing the risk of trauma [1]. Blunt mechanisms are responsible for 80% to 90% of renal injuries, while penetrating trauma accounts for the remaining 10% to 20% [2,4]. Renal involvement is seen in 1% to 5% of all trauma cases and represents about 24% of solid organ injuries [2,4]. The vast majority - around 78% to 82% - classified as minor (American Association for the Surgery of Trauma, AAST grades I-II), tend to resolve on their own, and are usually managed conservatively with minimal long-term effects [5,8].

The AAST Organ Injury Scaling system is the most widely adopted classification method for renal trauma [9]. This grading system has been validated in several studies as a reliable predictor of outcomes such as the need for surgery or embolization and the likelihood of nephrectomy [11]. The classification was revised: grade IV now includes vascular lesions like arteriovenous malformations and pseudoaneurysms, while grade V encompasses kidneys that are devascularized with active bleeding or completely shattered, resulting in the loss of normal renal structure [12].

For patients who are hemodynamically stable and whose injuries have been properly staged, conservative (non-surgical) management remains the standard of care for AAST grades I through IV, regardless of the injury mechanism [13,14]. Even some high-grade injuries (grades IV and V) can be effectively managed without surgery when carefully evaluated and selected [15,18]. Notably, conservative treatment for severe renal trauma has not been shown to increase hospital stay duration; in fact, it may lead to shorter admissions and better kidney preservation outcomes [19,20].

Accurately and promptly identifying patients who require intervention is crucial in the management of renal trauma [5] analyzed data from 14 Level-1 trauma centers across the United States to assess current practices in managing high-grade renal trauma (HGRT) and to examine clinical factors linked to nephrectomy in these cases. Their study included 431 adult patients with HGRT, 79% of whom were male, with blunt trauma accounting for 71% of injuries. The injuries were categorized as grade III in 236 cases (55%), grade IV in 142 (33%), and grade V in 53 (12%). Laparotomy was performed in 169 patients (39%). Overall, 300 patients (70%) received expectant management, 47 (11%) underwent conservative or minimally invasive treatment, and 84 (19%) required renal-related open surgery-of whom 55 (67%) had nephrectomies. The nephrectomy rates were 15% for grade IV and 62% for grade V injuries. Penetrating injuries had significantly higher American Association for the Surgery of Trauma grades and higher rates of nephrectomy. Multivariate analysis identified renal injury grade and penetrating trauma as the only independent predictors of nephrectomy.

In our prospective study, we gathered data on patient demographics, injury details, treatment approaches, and short-term outcomes in adults (aged 18 and above) presenting with grade IV and V blunt renal injuries at our institution. Treatment strategies were grouped into three categories: expectant, conservative/minimally invasive, and open surgical management. Descriptive statistics were used to summarize the management approaches employed for renal trauma.

Materials & Methods

This study was designed as a prospective observational study to gather data on all adult (≥18 years of age) patients presenting with high grade blunt renal trauma (HGRT) admitted to our hospital between the period January 2020 to December 2024. The study was taken up after obtaining institutional review/ethical board approval. Patients were excluded if they were younger than 18 years, had low-grade renal injuries (AAST grade I, II or III), underwent an urgent open surgery in an outside hospital without clinical and imaging data available, or were deceased upon arrival at the emergency department of our hospital.

A centralized database platform was used for data collection. The following data was gathered: patient's demographics, admission and discharge/death dates, mechanism of injury (blunt: road traffic accidents, falls, sport-related, assault), Injury Severity Score (ISS), admission vital signs (systolic blood pressure (SBP), heart rate (HR), temperature, nadir SBP in first 4 hours after admission), Glasgow Coma Scale (GCS), number and type of blood products received in the first 24 hours, admission laboratory values (haematocrit), renal injury grade (IV/V), concomitant injuries and corresponding AAST grades if applicable, renal-related interventions (angiography/ angioembolization, nephrectomy, partial nephrectomy, renorrhaphy, renal packing, ureteral stenting, nephrostomy tube placement, perirenal drain placement), initial and follow-up imaging studies, complications, and readmission. Data was reviewed at multiple stages and quality checks were performed regularly to assure accurate and complete data entry.

Computed tomography scan (Figure 1 and 2) findings were used to grade the renal injuries as well as other abdominal injuries and the injuries were graded based on the AAST Organ Injury Scale for renal trauma. [9] In patients undergoing immediate/ emergency surgery, surgical findings were used to grade renal injuries in the absence of imaging studies. The management of these patients were categorised under the following categories:

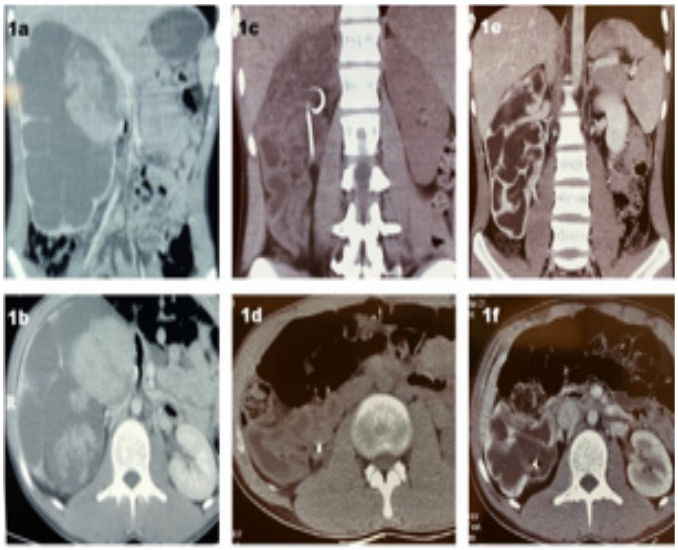

Figure Legends

Figure 1a & b. CT scan done on the day of injury shows Rt. renal injury Grade IV.

1 c & d. CT scan done on day-3 shows no increase in the size of haematoma or peri-renal collection. The Pt. underwent DJ stenting for drainage of blood and obstructed UPJ.

1e & f. CT scan done after one month shows improvement in renal function.

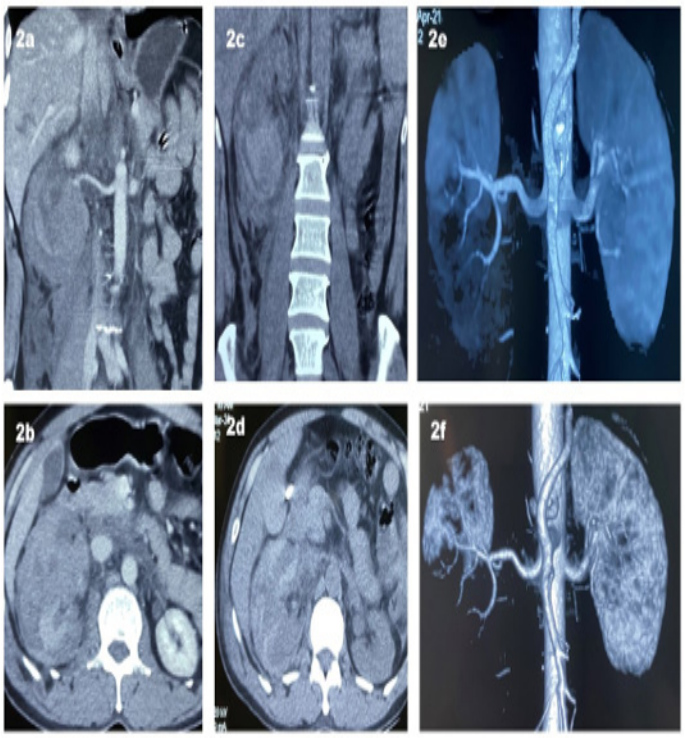

Figure 2a & b. CT scan done in a Pt. (33-year-old) with Grade IV injury, on admission.

2c & d. CT scan done on day-3 shows no increase in the size of haematoma.

2e & f. CT scan done one month later shows good perfusion of the kidney.

Expectant management

Refers to observation of the patient, including bed rest, serial haemoglobin check, follow-up imaging-no renal-related interventions (i.e., no endoscopic, minimally invasive, or open interventions or surgeries).

Conservative/minimally invasive management

Refers to performing renal angioembolization or renal vascular stent placement, endoscopic (e.g., ureteral stenting) or percutaneous procedures (e.g., nephrostomy tube or perirenal drain placement).

Open surgical management

Refers to renal-specific procedures performed during laparotomy, such as nephrectomy, partial nephrectomy, renorrhaphy, or renal packing to control bleeding.

Immediate intervention

Was defined as any procedure carried out within 4 hours of hospital admission. Shock was characterized by an initial or lowest recorded systolic blood pressure below 90 mm Hg within the first 4 hours after arrival. Tachycardia was defined as a heart rate exceeding 100 beats per minute at admission. A massive transfusion was considered when a patient received more than 10 units of packed red blood cells (PRBCs).

Concomitant injuries

Included any of the following: trauma to solid organs (liver, spleen, pancreas), gastrointestinal tract, spinal cord, bladder, major blood vessels, or pelvic fractures.

Patient data were reported using counts and percentages for categorical variables, and as mean values with standard deviations (SD) for continuous variables.

Results

A total of 78 adult patients presented to our hospital with grade IV and V blunt renal injuries during the period Jan 2020-Dec 2024. Patient's characteristics, clinical/laboratory findings at the time of admission, and management options were as shown in (Table 1 and 2). The overall mean age was 35.42±11.43 years. Of the seventy-eight patients, 64 (82.05%) were male. The male to female ratio was 4:1.

The mechanism of injury was due to road traffic accident in 61 (78.2%), fall from height in 14 (17.94%) and physical violence in 3 (3.84%). The mean injury symptom score (ISS) was 27.14±3.90 in patients with grade IV renal injury and 27.92±4.43 in patients with grade V injuries. Fifty of the 78 patients had grade IV and the remaining 28 had grade V renal injuries. Thirty-eight (48.71%) of the patients with HGRT had concomitant abdominal organ injuries mainly liver 16 [20.5%], spleen 12 [15.38%], mesentery 6 [7.69%], small bowel 2 [2.56%], and bladder 2 [2.56%]. Other injuries included skeletal injuries in 17 (21.79%), spine injuries in 3 (3.86%), head injury in 7 (8.97%), and facial injuries in 12 (15.38%). Overall, 32 (41.02%) patients presented with shock at the casualty. Patients with grade V renal injuries had significantly low systolic blood pressure and low haemoglobin percentage at the time of admission when compared with grade IV renal injuries.

All the 78 patients were admitted and started on expectant management with intravenous fluids, bed rest and serial haemoglobin checks. Forty (51.28%) of the 78 patients needed blood transfusions and 16 (20.5%) needed platelet transfusions within the first 24 hours following admission (Table 2). Renal angiography with angioembolization was performed in 12 (15.38%) patients (grade IV-9 and grade V-3) and the indication was persistent low systolic blood pressure in-spite of adequate transfusions. The bleeding stopped and the blood pressure was maintained in all of these patients. Two other patients with grade IV injuries underwent cystoscopy, evacuation of blood clots from bladder and double J stenting on the injured side. One of these patients had a ureteropelvic junction obstruction with grade IV injury and the other one had renal collecting system injury.

Table 1: Demographics of patients with grade IV and V HGRT (n=78).

Sr. No.	Variables	Grade IV (n=50)	Grade V (n=28)	*p* value
1	Age means (SD) years	34.78±11.30	36.57±11.57	0.5077
2	BMI (SD) Kg/m^2	27.14±3.90	26.14±6.75	0.41
3	Male gender n/%	40 (80%)	24 (84%)	0.843
4	ISS, mean (SD)	26.14±6.40	27.92±4.43	0.193
5	HR on admission mean n (40%) beats/min	92.84±7.77	94.67±5.44	0.2714
6	SBP on admission, mean (SD) mmHg	110.22±6.90	100.68±4.3	**0.0001**
7	Shock n (%)	14 (28%)	18 (64%)	0.049
8	Haemoglobin on admission mg/dL	12.4±1.76	10.82±1.67	**0.0002**
9	GCS score mean (SD)	12.8±2.66	12.71±3.04	0.897
10	Concomitant abdominal injuries n (%)	17 (34%)	21 (75%)	**0.0474**
11	Comorbidity n (%)	6 (12%)	4 (15%)	0.799
12	Renal injury side - left	23 (46%)	17 (61%)	0.484
13	Right	27 (54%)	11 (39%)	0.457

Table 2. Management of Grade IV & V renal injuries.

Sr. No.	Variables	Grade IV (50)	Grade V (28)	*p* value
1	Whole blood transfusions in first 24 hrs n (%)	21 (42%)	19 (67.85%)	0.22
2	Platelet transfusions in first 24 hrs n (%)	8 (16%)	8 (28.5%)	0.29
3	Expectant management n (%)	33 (66%)	15 (53.57%)	0.59
4	Conservative management n (%)	11 (22%)	3 (10.7%)	0.29
	Renal angioembolization n (%)	9 (18%)	3 (10.7)	0.45
	Ureteric Stenting n (%)	2 (4%)	-	-
5	Open exploration n (%)	6 (12%)	10 (35.71%)	**0.048**
	Nephrectomy n (%)	3 (6%)	6 (21 42%)	0.073
	Renorrhaphy n (%)	2 (18%)	-	-
6	Hospital Stay mean (SD) days	9.2±4.11	11.3±4.957	**0.046**
7	Mortality n (%)	3 (6%)	2 (7.14%)	0.85

Surgical exploration of abdomen was performed in 19 (%) patients for renal injuries and or other abdominal injuries. Nephrectomy was performed in 3 patients with grade IV and 6 patients with grade V injuries **(Figure 3)**. Complete hilar disconnection was seen in 5, main renal artery disconnection in 1 and massively bleeding shattered kidney in 3 patients. Five (6.41%) patients died due to multiple injuries, massive bleeding and associated skeletal and head injuries. Patients with grade V renal injuries had significant risk to undergo surgical exploration as well as stayed in hospital longer than patients with grade IV injuries.

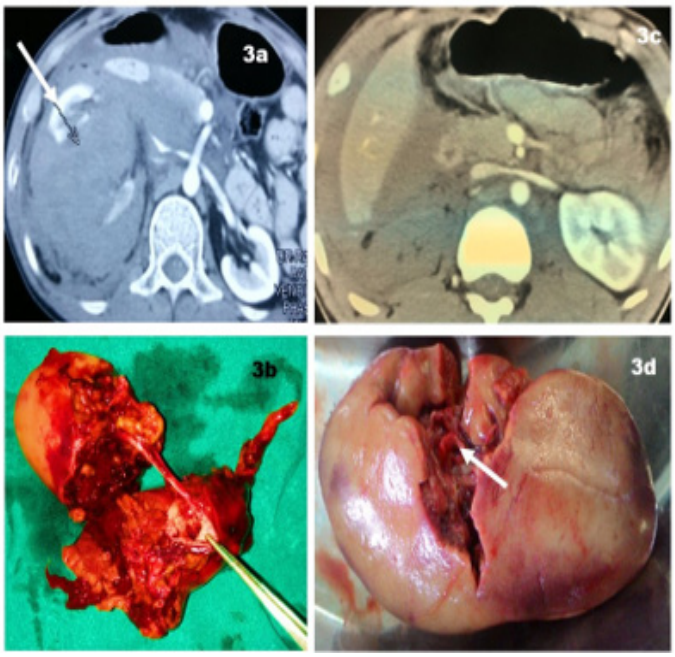

Figure 3a. CT scan done in a 55-year-old male pt. shows Grade V injury to the Rt. kidney and no perfusion of the Rt. kidney. Areas of contrast leak suggestive of renal artery injury seen.

3b. Operative specimen of the same pt. shows a devascularized shattered kidney.

3c & 3d. CT scan done in a 20-year-old male shows Grade V injury on the Rt. side with no perfusion of the kidney. Operated specimen shows complete avulsion of the renal hilum.

Discussion

Currently, expectant or conservative management is the standard treatment for low-grade renal trauma, and this approach is also recommended for most high-grade injuries in hemodynamically stable patients [7,8,14,5] found that approximately 80% of high-grade renal trauma (HGRT) cases could be effectively managed non-operatively or with minimally invasive techniques. Despite this, nephrectomy remains the most frequent surgical procedure performed after HGRT, occurring in 15% of grade IV and 62% of grade V injuries [5]. Similarly, McClung et al. reported nephrectomy rates of 4.5% for grade III, 24% for grade IV, and 57% for grade V injuries [21]. Data from the New England Trauma Consortium showed a 21% nephrectomy rate (43 out of 206) for grade IV and V injuries [22]. The severity (grade) of renal trauma and whether the injury was caused by penetrating trauma were the strongest predictors of nephrectomy.

Contrast-enhanced CT scans-capturing both immediate and delayed phases—are considered the most reliable imaging modality for evaluating renal trauma. These scans provide detailed visualization of complex injuries such as urinary extravasation, active arterial bleeding, and severe parenchymal or vascular damage, thereby improving decision-making regarding non-operative management [1].

Specific CT findings that may indicate severe injury include:

1. Medial hematoma, suggesting vascular involvement;
2. Medial urinary extravasation, indicative of renal pelvis or ureteropelvic junction avulsion;
3. Complete lack of parenchymal enhancement, pointing to renal artery occlusion;
4. Two or more features such as a large hematoma (>3.5 cm), medial renal laceration, or active vascular contrast extravasation-characteristic of an AAST grade IVb injury [13].

Noted that patients with grade IVb injuries were nine times more likely to require surgical or angiographic intervention than those without such features [23]. Also emphasized that contrast extravasation on CT was strongly predictive of the need for angioembolization. Today, renal arteriography and angioembolization are increasingly utilized in diagnosing and managing severe renal trauma [24]. When performed promptly, angioembolization can effectively control bleeding without the need for open surgery, and its use is expanding. It is crucial that the procedure is carried out without delay, with the patient monitored and stabilized on the way to and within the angiography suite. Super-selective embolization (Figure 4) offers a targeted, minimally invasive option that may help avoid unnecessary surgery and preserve renal function. A recent survey revealed that many urologists are open to using angioembolization for managing grade IV and V injuries [25].

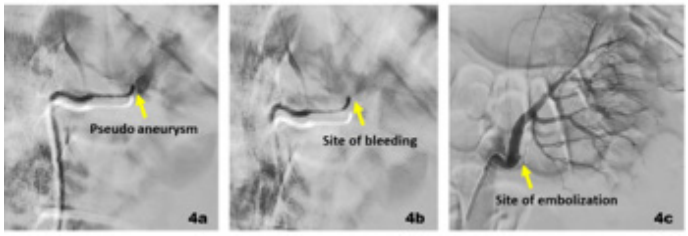

Figure 4a. Renal angiography in a 36-year-old male with Grade IV renal injury with massive bleed. Due to injury of lower polar artery.

4b. Shows the site of bleeding.

4c. post-embolization angiography shows a well-defined upper polar vessel with no bleeding from the lower polar vessels.

Nonoperative management has become the standard of care in hemodynamically stable, well-staged patients with AAST grades I to IVa renal injuries, regardless of mechanism [13,14]. Experts also agree that patients with grades IV and V injuries could be managed without renal operation if carefully staged and selected [15,18]. All patients with high-grade injuries selected

for nonoperative management should be closely observed with serial haematocrit readings and vital signs. Routine follow up CT imaging for Grade IV–V renal injuries is prudent at 48 to 72 hours post injury, to evaluate for a troublesome urinoma, collection or hematoma [1]. Should bleeding persist or delayed bleeding occur, angiography with selective embolization of bleeding vessels can obviate surgical intervention.

Hemodynamic instability with no or transient response to resuscitation, expanding/pulsatile renal hematoma (usually indicating renal artery laceration), suspected renal vascular pedicle avulsion, and ureteropelvic junction avulsion remain the absolute indications for exploration [1,8,9]. Relative indications include the presence of urinary leakage accompanied by substantial loss of renal parenchymal blood supply, renal trauma associated with injuries to the colon or pancreas, arterial blockage, and urinary extravasation resulting from damage to the renal parenchyma [1,13,14]. Our study showed that 51.28% of patients with grade IV & V renal injuries needed blood transfusions as well as platelets replacement within 24 hours of admission to the hospital.

Patients with grade V injuries had significantly low systolic blood pressure and haemoglobin levels than patients with grade IV injuries. In our study 15.38% of patients with HGRT needed to undergo renal angiography and angioembolization so as to control bleeding [26]. found increasing use of angioembolization for grade IV and highly select V injuries, with hemodynamic instability and grade being independent predictors of surgical treatment [27]. reported on a pseudoaneurysm rate of 2.5% among all grades of renal trauma with successful angioembolization in 84.6% of patients [28]. noted that Endovascular stents were being used with success during angiography in patients with acute renal artery thrombosis occurring from intimal flaps.

Conclusions

Nearly 80% of patients with HGRT (grade IV & V) renal injury can be safely managed by expectant and conservative management. Clinical factors, such as hemodynamic instability and metabolic acidosis, are associated with nephrectomy for high-grade renal injury; however, higher renal injury grade trauma remains the strongest predictor of nephrectomy.

Compliance with Ethical Standards

Conflict of Interest: The authors declare conflict of interest as None.

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