

Contemporary treatment of renal trauma in Canada

Ron Kodama, MD, FRCSC

Division of Urology, Department of Surgery, University of Toronto, Toronto, ON, Canada

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Introduction

This section will summarize the current management of high-grade renal injuries. It is not meant to be an all-encompassing review of the topic but will highlight important diagnostic and treatment principles.

Renal trauma occurs in approximately 1% of all patients admitted to a trauma unit.^{1,2} Approximately 80% of those renal injuries are secondary to blunt injury.³ The kidneys are the most common genitourinary organ (approximately 40%) to be injured in patients involved in traffic accidents. Interestingly, in one series, the testes are the second most injured organs after the kidneys in motorcycle or bicycle accidents. Ureteric injuries in blunt injuries are uncommon (<1%).⁴ Recently, Mann et al published their contemporary experience of managing renal trauma in a Canadian level 1 trauma unit.⁵

Classification of renal trauma

Renal injuries are classified according to the American Association for the Surgery of Trauma (AAST). For many years, the 1989 classification was used.⁶ In this grading system, high-grade renal injuries (Grade 3 and above) were defined by the depth of laceration, involvement of the collecting system, and whether the main renal artery/vein were involved. Grade 4 injuries included injuries to the collecting system and main renal artery and vein with contained hemorrhage. Grade 5 injuries included a “shattered kidney” or renal hilum avulsion. Unfortunately, renal injuries do not always follow the grading system. Devascularization of the renal parenchyma, segmental arterial hemorrhage, and multiple lacerations into the collecting system often occur in these high-grade injuries. The definition of a shattered kidney was ambiguous in the AAST 1989 grading system.

Buckley et al⁷ proposed a revision of this grading scale to better define Grade 4 and 5 injuries and help overcome these deficiencies. In this grading scale, all segmental vascular injuries and collecting system injuries (including uretero-

pelvic junction [UPJ] avulsion and renal pelvis lacerations), regardless of the number, were classified as Grade 4 injuries. Grade 5 injuries were exclusively defined as only main hilar vessel injuries. In their series of patients, the renal salvage rate and nephrectomy rate were identical when the injuries were reclassified from the 1989 system to their revised proposal. Moreover, Dugi et al,⁸ further expanded and classified high-risk Grade 3–4 injuries requiring intervention by the size of the perirenal hematoma (>3.5 cm), the site of the laceration (medial worse than lateral), and the presence of intravascular contrast extravasation (VCE) seen on the portal-venous phase of the computed tomography (CT) scan. Kidneys having two or all three of these high-risk factors required a higher rate of intervention (66% compared to 7% if only one was present). Similarly, in another retrospective study, patients with Grade 4 injuries with two or more of these high-risk features were 25% more likely to require intervention.⁹

Recently, there has been an update to the AAST classification (Table 1).¹⁰ The new AAST classification appears to take into account the proposed changes of Buckley et al. A Grade 5 injury still has a “shattered kidney” in the classification, which has been defined as the “loss of identifiable parenchymal renal anatomy.” The author still has concerns on the exact definition of a Grade 5 injury, however, taken literally, this would be interpreted as the severest form of renal parenchymal injury.

Indications for imaging

The indications for CT scanning in suspected renal injuries are well-known. These include patients with blunt abdominal injury with gross hematuria; patients with microscopic hematuria associated with the presence of shock (<90 mmHg); and patients with penetrating trauma to the abdomen, flank, or upper chest. Other indications include a history (rapid deceleration or previous known urological renal abnormality) or physical exam (flank or upper abdominal skin bruising, lower rib or thoracic/upper lumbar vertebral fracture) that may direct the clinician to suspect a renal injury. It must be remembered that hematuria (microscopic or gross) may not be present, even in patients with major renal injuries. In the majority of these cases, CT abdominal scanning is done for

Table 1. Kidney injury scale – 2018 revision

AAST grade	AIS severity	Imaging criteria (CT findings)	Operative goals	Pathological criteria
I	2	– Subcapsular hematoma and/or parenchymal contusion without laceration	– Non-expanding subcapsular hematoma – Parenchymal contusion without laceration	– Subcapsular hematoma or parenchymal contusion without parenchymal laceration
II	2	– Peri-renal hematoma confined to Gerota fascia – Renal parenchymal laceration ≤ 1 cm depth without urinary extravasation	– Non-expanding peri-renal hematoma confined to Gerota fascia – Renal parenchymal laceration ≤ 1 cm depth without urinary extravasation	– Peri-renal hematoma confined to Gerota fascia – Renal parenchymal laceration ≤ 1 cm depth without urinary extravasation
III	3	– Renal parenchymal laceration >1 cm depth without collecting system rupture or without urinary extravasation – Any injury in the presence of a kidney vascular injury or active bleeding contained within Gerota fascia	– Renal parenchymal laceration >1 cm depth without collecting system rupture or without urinary extravasation	– Renal parenchymal laceration >1 cm depth without collecting system rupture or without urinary extravasation
IV	4	– Parenchymal laceration extending into urinary collecting system with urinary extravasation – Renal pelvis laceration and/or complete ureteropelvic disruption – Segmental renal vein or artery injury – Active bleeding beyond Gerota fascia into the retroperitoneum or peritoneum – Segment or complete kidney infarction(s) due to vessel thrombosis without active bleeding	– Parenchymal laceration extending into urinary collecting system with urinary extravasation – Renal pelvis laceration and/or complete ureteropelvic disruption – Segmental renal vein or artery injury – Segment or complete kidney infarction(s) due to vessel thrombosis without active bleeding	– Parenchymal laceration extending into urinary collecting system – Renal pelvis laceration and/or complete ureteropelvic disruption – Segmental renal vein or artery injury – Segment or complete kidney infarction(s) due to vessel thrombosis without active bleeding
V	5	– Main renal artery or vein laceration or avulsion of hilum – Devascularized kidney with active bleeding – Shattered kidney with loss of identifiable parenchymal renal anatomy	– Main renal artery or vein laceration or avulsion of hilum – Devascularized kidney with active bleeding – Shattered kidney with loss of identifiable parenchymal renal anatomy	– Main renal artery or vein laceration or avulsion of hilum – Devascularized kidney – Shattered kidney with loss of identifiable parenchymal renal anatomy

Vascular injury is defined as a pseudoaneurysm or arteriovenous fistula and appears as a focal collection of vascular contrast that decreases in attenuation with delayed imaging. Active bleeding from a vascular injury presents as vascular contrast, focal or diffuse, that increases in size or attenuation in delayed phase. Vascular thrombosis can lead to organ infarction. Grade based on highest grade assessment made on imaging, at operation, or on pathologic specimen. More than one grade of kidney injury may be present and should be classified by the higher grade of injury. Advance one grade for bilateral injuries up to Grade III. AAST: American Association for the Surgery of Trauma; AIS: abbreviated injury scale; CT: computed tomography.

the workup of multiorgan trauma and thus the renal injury is not missed.¹¹ All other forms of acute imaging are inferior to CT, including intravenous pyelography (IVP) and ultrasound. A one-shot IVP may be used to determine the presence of a contralateral kidney prior to nephrectomy if the patient has no preoperative imaging. However, 80% of trauma surgeons either perform no tests or only palpate for the presence of a contralateral kidney prior to opening and exploring the retroperitoneum for an expanding retroperitoneal hematoma.^{12,13}

Dual-phase CT scanning is the gold standard for staging renal injuries. Ideally, all CT scans should be supervised by a radiologist to determine whether a urographic phase needs to be performed. Physicians should be aware of their centre's CT scanning protocols in the trauma patient. In our institution, the abdomen is routinely scanned at 70 seconds after the IV bolus (portal venous phase). However, if an

abdominal arterial bleeding source (including kidney injury) is suspected, an arterial phase can be added. Not all renal injuries require a delayed pyelogram phase scan. We typically do a delayed scan in Grade 3 and higher injuries or if there is significant fluid around the renal pelvis or hematoma around the kidney.

Treatment

The vast majority of renal trauma, even high-grade injuries ($>$ Grade 3) may be managed conservatively.^{13,14} This includes bedrest and frequent abdominal examinations, as well as the monitoring of vital signs and degree of hematuria. Frequent monitoring of the hemoglobin during the first 24–48 hours should also be performed. Bedrest is often continued until the hemoglobin is stable and the hematuria has stopped.



Fig. 1. Grade 4 renal injury with vascular contrast extravasation. Angioembolization of two sites of arterial bleeding. No further urological intervention required.

The need for early (within 24 hours), urgent intervention is based almost solely on the patient's hemodynamic stability.

Another patient factor is concomitant injuries, which may influence timing and choice of intervention. Damage-control surgery is a well-established technique to stabilize the severely injured patient. As a urologist, one should be familiar with the surgical techniques that are available and applicable.^{15,16}

Also important is resource availability. Patients managed in a community hospital may not have interventional radiology, other surgical subspecialties, or intensive care units readily available.

The final variable affecting outcome is the experience of the surgeon. Patients treated in a non-trauma centre are more likely to undergo nephrectomy compared to those managed in trauma centres.³ There are many recently published algorithms and guidelines and, in general, all state the same principles of investigation and management.^{13,17-19} However, these are guidelines only and one must keep in mind the other factors (resource and surgeon) that may dictate the treatment and final outcome.

Treatment by stage

Grade 1–2 injuries

These patients can be managed expectantly.

Grade 3 injuries

These patients can be generally managed expectantly. In the small subset of patients who are actively bleeding, angioembolization should be performed depending on the hemodynamic stability of the patient and availability of interventional radiology. Exploratory renal surgery can be performed with renorrhaphy; however, depending on surgeon experience, the patient may ultimately have a nephrectomy.^{1,14}

Grade 4 injuries (Figs. 1, 2, 3)

Patients who has VCE on their CT scan can be treated with angioembolization if their clinical status permits. These patients may also be in the angiography suite for control of other sources of bleeding (spleen, pelvis). Patients who are taken immediately to the operating room for bleeding and found to have a rapidly expanding retroperitoneal hematoma will require exploration with either renorrhaphy or nephrectomy. In those severely injured patients who have undergone damage-control packing, angioembolization may be considered if the interventional radiology team can be mobilized in advance. Factors on initial CT that may predict the need for intervention include the size of the peri-renal hematoma (>3.5 cm), the presence of VCE, a laceration depth >2.5 cm, and >3 lacerations. These patients require close monitoring; however, only 14% of these high-grade (Grade 3–5) renal injured patients required intervention.¹³

Urinary extravasation can be managed expectantly in the majority of Grade 4 injuries. The question of reimaging is important. Most guidelines suggest reimaging these injuries at 48–72 hours. Limiting the number of CT scans should be considered in young patients to decrease their accumulative radiation dose. Typically, these patients are subjected to multiple CT scans during their trauma workup and management.²⁰⁻²²

At our institution, reimaging with CT is not pursued unless a patient's clinical condition changes. Ultrasound is often used to determine whether there is a significant urinoma and this may help determine the need for further CT imaging. This includes signs or symptoms of continued bleeding or sepsis as reported by others.²³ The rate of ureteral stent intervention or percutaneous drainage for urine leak or infection has been reported to be up to approximately 23%.^{14,24,25} Patients who have suffered multiorgan abdominal/pelvic injuries are often rescanned for other reasons and it is important that the urologist be part of the trauma/ICU consulting team. The presence of urinary contrast extravasation at 24–48 hours

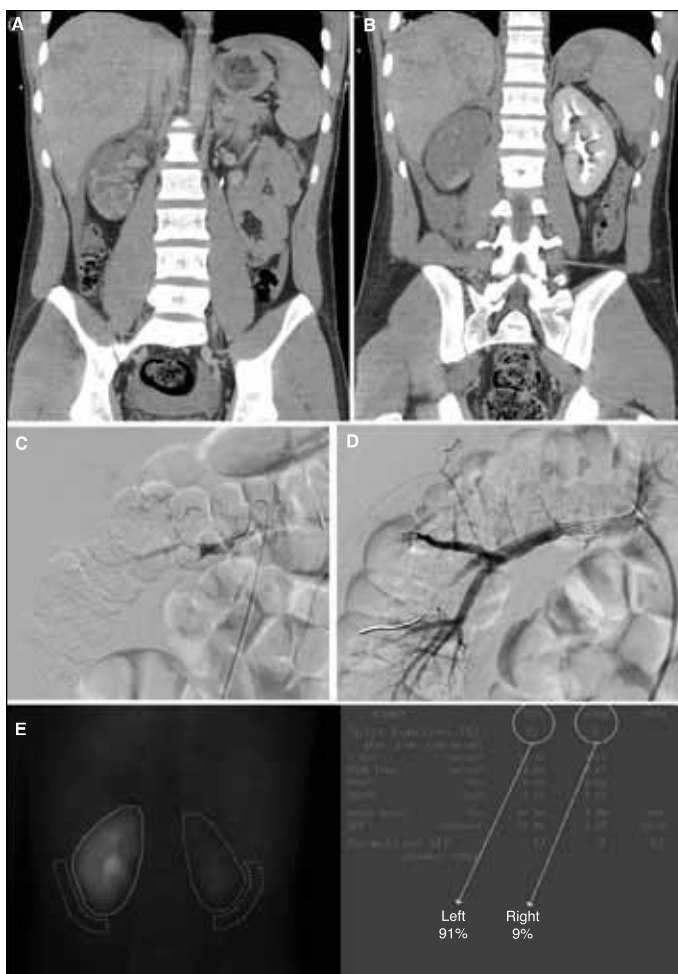


Fig. 2. Grade 4 renal injury with patchy perfusion to kidney. Patient underwent vascular stenting procedure. Followup renal scan performed shows 9% function to kidney.

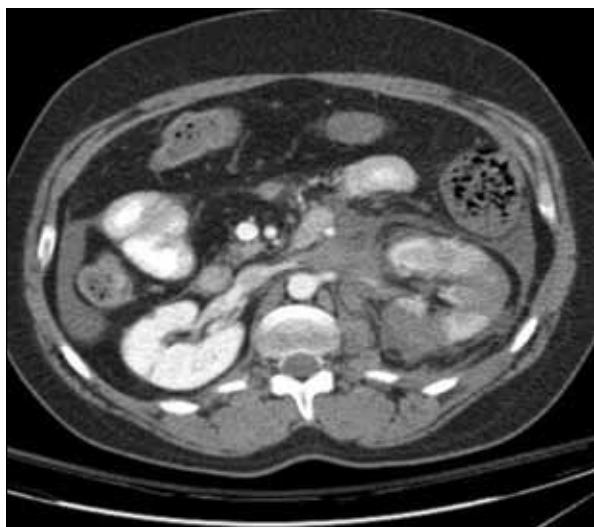


Fig. 4. Grade 5 renal injury: peri-hilar hematoma with left renal vein injury and segmental infarcts from renal artery injury. Managed conservatively.

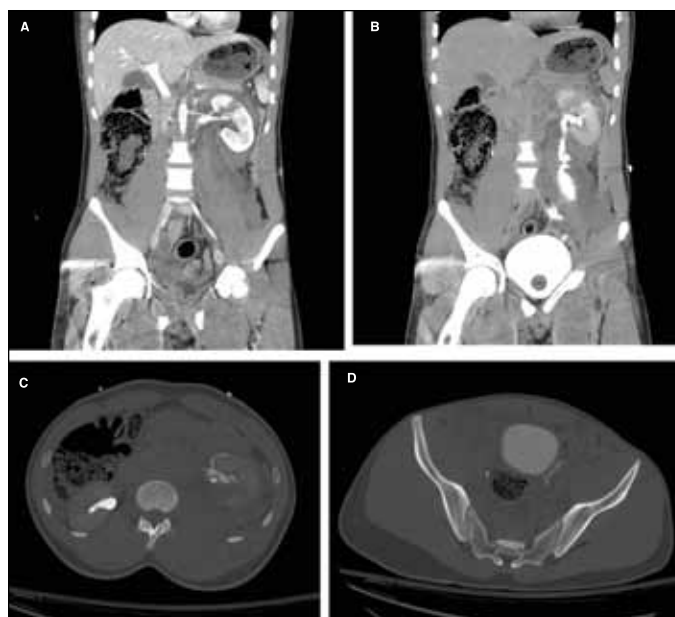


Fig. 3. Patient with Grade 4 renal injury with urinary extravasation. Using computed tomography windows, area of extravasation was from lower pole calyx. Distal ureter can be seen. Treated conservatively, no stent required.

would not be unexpected in some high-grade collecting system injuries. We do not normally intervene in asymptomatic patients on CT findings alone. There is a theoretical concern that stenting the urinary tract may introduce infection into the hematoma. Also, in those patients with multiple Grade 4 lacerations, it may be difficult to reliably place the coil of the stent in the collecting system rather than in the parenchyma.

Overall, Grade 4 injuries in the stable, non-bleeding patient can be initially managed conservatively. Results have shown that renal salvage is higher compared to exploration; however, those managed conservatively may require minimally invasive intervention.^{3,14,26}

Grade 5 injuries (Fig. 4)

According to the 2018 AAST staging system, these patients have avulsion of the renal hilum or have active bleeding with a devascularized kidney. Although the new staging system defines a shattered kidney as one that has lost identifiable renal anatomy, the author finds this definition unclear. Nevertheless, in the new system, a Grade 5 injury would represent the most serious degree of parenchymal injury. Depending on the patient's clinical situation, he/she can be managed by angioembolization or nephrectomy.

Firearms and stabbings are the most common cause of penetrating injuries in Canada.²⁷ In 2013, approximately 1/3 of homicides were caused by firearms and in 2016, this number had increased to approximately 40%.²⁸ As in blunt injuries, if these patients are well-staged, a conservative approach can be taken.^{5,29,30} In those who undergo

laparotomy without preoperative staging, the need for renal exploration again depends on the same factors (bleeding, expanding or pulsatile hematoma). However, zone 2 retroperitoneal hematomas from penetrating trauma are generally explored by trauma surgeons but lateral hematomas may be observed since they are away from the renal hilum.¹³

Long-term complications of renal injuries include hypertension from ischemia (arterial or page), pseudoaneurysms, and arteriovenous fistulas.

Conclusion

Over the last few decades, there has been a paradigm shift in the management of renal trauma from an operative to a conservative approach. The reason for this is multifactorial. The absolute need for urgent intervention, however, has remained the same: bleeding and hemodynamic instability.

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This paper has been peer reviewed.

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Correspondence: Dr. Ron Kodama, Division of Urology, Department of Surgery, University of Toronto, Toronto, ON, Canada; ron.kodama@sunnybrook.ca