# Blunt Renal Trauma

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## Abstract

The pediatric patient is especially prone to blunt renal trauma due to the size and location of pediatric kidneys. No clear guidelines have been established for the management of these injuries in children to achieve the highest rate of renal salvage with low morbidity. Wide-ranging literature exists on this subject, but consists of vastly different management strategies. This review is written to summarize the different approaches to blunt renal trauma and highlight opportunities for further research.

**Keywords**
- angioembolization
- blunt renal trauma
- kidney
- nonoperative management
- pediatrics



## Introduction

In the pediatric patient, traumatic injury is the leading cause of death and blunt trauma is the most common mechanism of injury. Renal injuries account for 8 to 12% of pediatric blunt abdominal injuries. Children, more so than adults, are prone to sustain major renal injury due to blunt trauma given the relatively large size of pediatric kidneys and decreased protection in children.[1–3]

The primary goal after blunt renal trauma is to preserve renal function. However, no well established guidelines best suited to accomplish this goal have been published in the pediatric literature. Variable strategies for mode of imaging, role of angioembolization (AE), intensive care unit (ICU) observation, length of bed rest, relevance of hematuria, role of ureteral stenting, the incidence of sequelae, and follow-up imaging have been employed. A review of current evidence is presented here to show current strategies for management of blunt renal trauma in the pediatric population.

## Diagnosis

Hematuria typically plays a major role in the decision to obtain imaging in adult patients with blunt abdominal trauma. Some have proposed that in the presence of microscopic hematuria, hemodynamic stability, and low suspicion of major intra-abdominal injury, imaging may be unnecessary.[4] Conversely, it has been suggested that imaging in adult patients is only necessary in the setting of gross hematuria, microscopic hematuria with hemodynamic instability, high index of suspicion for abdominal injury, or significant deceleration injury.[5]

Similar criteria have previously been proposed to direct imaging in the pediatric population.[6–8] However, children tend to have a greater physiologic reserve than adults, and may not demonstrate early hypotension despite significant renal injury. Using hypotension and hematuria as screening criteria for imaging has been shown to miss several severe renal injuries.[8,9] Level of hematuria has also been examined as a screening tool for imaging in renal trauma. For instance, some studies have designated a low yield for the use of intravenous pyelography if there are less than 100 red blood cells per high power field.[10] Yet other series have designated 20 or 50 red blood cells as the cutoff for imaging.[11,12] In the pediatric population; however, it is important to realize that hematuria may be the presenting symptom of a congenital anomaly or highly vascular neoplasm, such as Wilms tumor. In fact, undiagnosed renal anomalies can occur in up to 19% of children undergoing computed tomography (CT) of the abdomen for trauma.[13] Given these possible diagnoses and the consequences for missed injury, we currently recommend imaging for any child with hematuria after trauma.

Historically, intravenous pyelography was the standard method of imaging in suspected blunt renal trauma. This

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has largely been supplanted by ultrasound and CT over the last two decades. Ultrasound may be useful as screening modality in patients that are hemodynamically unstable. However, the use of ultrasound as a diagnostic study can lead to missed diagnoses with regards to parenchymal kidney injury or collecting system injuries. CT, on the other hand, has been shown to have a negative predictive value of as high as 99.8% for all intra-abdominal injuries and is a superior method for diagnosing renal injuries in the pediatric population.[14–16] Furthermore, select findings on CT have been shown to help predict the need for intervention in renal trauma.[17] For these reasons, in a pediatric patient with concern for intra-abdominal injury and gross or microscopic hematuria, CT should be the initial imaging modality of choice. The American Association for the Surgery of Trauma injury scoring scale is based on CT findings and is shown in ►**Table 1**.

Given the concern for future malignant potential, increased cost, and noting that many renal injuries do not require any intervention, efforts to reduce exposure to unnecessary radiation is common in many pediatric centers. Scoring systems and algorithms to predict intra-abdominal injury in children has recently been utilized to safely decrease radiation exposure in the pediatric population while minimizing the risk of missed injuries.[18–20] Although no single algorithm has been prospectively validated, adoption of set guidelines at large trauma centers has led to a decrease in unnecessary radiation exposure in children.

## Management

### Operative Intervention

In the pediatric population, the vast majority of blunt renal trauma is managed nonoperatively,[21–28] with a renal preservation rate of up to 99%.[23–25] While it has generally been accepted that most grades I to III injuries can be managed safely with nonoperative intervention, high-grade renal injuries (grades IV–V) secondary to blunt trauma remain an area of controversial management. In a recent meta-analysis of grade IV renal injuries 72% were successfully managed nonoperatively. Only 19% of the patients in this study required an intervention and of those 95 patients, only 3 required nephrectomy.[28] A 20-year review of pediatric blunt renal trauma revealed only 8 of 164 (6.3%) patients required surgical intervention for renal trauma, all 8 of which were grade IV or V. In a separate review, considering only high-grade (IV–V) renal injuries, only 16.3% of patients required surgical intervention. Only two of these patients required immediate intervention.[26] Given these findings immediate operative intervention for pediatric renal trauma should be reserved for the rare case of hemodynamic instability, even with grade IV or V renal injuries. Indications for delayed intervention include continued bleeding, continued urinary extravasation, and recurrent infection.

### Angioembolization

AE as a treatment for bleeding solid organ injury in blunt trauma has been used for control of hemorrhage and organ preservation in adults since the 1990s.[29] The role of AE in the pediatric population is less well defined. In adults the blush sign or contrast extravasation (CE), indicating ongoing arterial hemorrhage, has been shown to predict nonoperative failure and is an indication for angiography in many centers.[30] This finding has been replicated specifically in adult renal trauma.[31] However, in a series of 86 pediatric abdominal CT available for review after blunt abdominal trauma, 6 were found to have CE associated with a splenic injury. Only one of six children required surgical intervention. In another series of 123 pediatric patients with splenic injury, 8 were found to have CE on CT. None of these patients required intervention and patients with CE did not have a higher transfusion requirement or mortality.[32] In contrast to this, a meta-analysis of pediatric spleen and liver injury revealed a lower failure rate of nonoperative management when AE was used as a treatment option.[33] No large series addressing CE in renal trauma in children has been published. However, data on the use of AE to treat renal trauma in the pediatric population has been published. In a review of 127 pediatric trauma patients, Kiankhooy et al[34] describe AE for seven solid organ injuries, three of which were renal injuries. All three patients had

**Table 1** The American Association for the Surgery of Trauma injury scoring scale kidney injury

| Grade | Type of injury | Description |
|---|---|---|
| I | Contusion | Microscopic or gross hematuria, urologic studies normal |
| | Hematoma | Subcapsular, nonexpanding without parenchymal laceration |
| II | Hematoma | Nonexpanding perirenal hematoma confined to retroperitoneum |
| | Laceration | $<$ 1.0 cm parenchymal of renal cortex without urinary extravasation |
| III | Laceration | $>$ 1.0 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravasation |
| IV | Laceration | Parenchymal laceration extending through renal cortex, medulla, and collecting system |
| | Vascular | Main renal artery or vein injury with contained hemorrhage |
| V | Laceration | Completed shattered kidney |
| | Vascular | Avulsion of renal hilum, which devascularizes kidney |

sustained grade IV injury and had declining hemoglobin levels despite transfusion. Renal preservation was successful in all three cases without long-term hypertension or renal insufficiency. The role of AE in children for blunt renal trauma is an area that needs further research; however, in centers with the available resources and experience, it has become a viable alternative to surgical intervention.

## Nonoperative Management

Clearly, the current literature reflects that the vast majority of blunt renal trauma can be managed, nonoperatively, with successful nonoperative rates well over 90%.[21–28,35] Nonoperative management guidelines for spleen and liver injuries have been articulated.[36] Certain aspects of these guidelines have been challenged recently,[37,38] but these guidelines are often extended to patients with blunt renal injury. These guidelines may not be directly applicable to renal trauma as spleen and liver being intra-abdominal organs have a greater potential space for adjacent blood loss. On the other hand, the kidneys are encapsulated within Gerota fascia within the retroperitoneum so the chance for life-threatening bleeding is theoretically lower. Our management protocol allows for ambulation when the patient is comfortable to do so. The presence of hematuria, while monitoring, is not a barrier to ambulation or discharge. A urinary catheter is not routinely placed unless the patient has difficulty in urinating. Antibiotics, urine culture, or urology consults are not routinely utilized. Patients are discharged when tolerating a regular diet and pain is controlled by oral pain medications.[35]

## Intensive Care Unit Observation

No consensus exists on the recommended length of ICU stay of blunt renal trauma, even in high-grade injuries. While there are no published guidelines in this area, the majority of series on pediatric blunt renal trauma do not report level of care with respect to length of stay.[24,28,35] In a series of 95 patients, the authors utilized a strategy of 24-hour admission to the ICU with at least 3 days in the hospital.[39] While this strategy produced a high rate of renal preservation (98.9%) and successful nonoperative management (94.7%), they failed to validate the length of stay as necessary. This approach was most likely borrowed from published guidelines on the management of pediatric liver and spleen injury.[36] Currently, there is strong evidence that the mandatory ICU stay is not necessary for stable patients with liver or spleen injury.[37,38] Given the high rate of renal salvage, the success of nonoperative management and retroperitoneal position within Gerota fascia of the kidneys, ICU admission for their renal injury is unnecessary in stable patients. Our current practice is to admit patients with blunt renal trauma to general observation unless the patient is hemodynamically unstable or has concomitant injuries mandating ICU admission. Completely asymptomatic patients with low-grade injury who are able to ambulate are discharged from the emergency department and followed up according to our prospective protocol.

## Bed Rest

The initial report using bed rest as a treatment option used strict in-hospital bed rest of 5 to 7 days and an additional 10 days to 2 weeks of rest at home.[40] The American Pediatric Surgery Association guidelines on bed rest for solid organ injury were proposed to be grade of injury plus 1 additional day.[36] A more recent series used gradual advancement of activity during a 4-day hospital stay.[39] Other studies have used a resolution of hematuria either gross or microscopic as a marker to guide length of bed rest.[41,42] A recent prospective trial attempted to address both issues of bed rest and hematuria as an indication for advancement to normal activity. A series of 70 patients were enrolled in a protocol that allowed for ambulation when the patient was comfortable doing so, and the presence of hematuria was not used to limit activity. Mean time to ambulation was 1.5 days and mean length of stay was 2.9 days. No patients developed delayed bleeding or required subsequent intervention after initial stabilization. Renal salvage rates with this approach were 98.6%. The success rate of this nonoperative approach was 97.2%. Hematuria was monitored at follow-up, but its presence seemed to have no effect on at least early outcomes.[35] Given the findings of this trial, we currently do not restrict patients to bed rest if they are comfortable enough to ambulate and we do not use hematuria to guide hospital length of stay.

## Ureteral Stenting

Collecting system injuries present an interesting issue in the era of nonoperative management of high-grade renal injuries. Internal drainage with a stent has been shown to produce good results by providing a low-pressure system for the drainage of the collecting system.[39,43,44] The question of patient selection in stenting, collecting system injury remains unsolved. A recent study found that medial CE from the collecting system on the initial CT was associated with a need for intervention.[17] In a study of high-grade injuries with collecting system involvement, 80% healed without the intervention and 20% underwent ureteral stent placement for continued CE.[44] In a prospective trial, 9 of 70 patients underwent follow-up ultrasound after concern for collecting system injury at initial CT. All patients were found to have a normal sonographic examination.[35] Complications of stent placement (infection, iatrogenic perforation, ureteral obstruction) are rare but must be balanced against the long-term goal of renal preservation.[44] Symptomatic urinomas and continued CE after 2 weeks appear to be the most often cited indications for ureteral stenting after high-grade blunt renal trauma.[39,44]

## Hypertension

The precise rate of postrenal injury, hypertension is difficult to define due to lack of comprehensive follow-up in these patients. Estimates range from 0 to 7.5%.[21] Annual blood pressure measurements have been recommended for monitoring.[39] A prospective 3-year evaluation of patients that sustain blunt renal injury is currently underway to elucidate the true incidence and severity of postinjury hypertension.

## Follow-Up

A definitive imaging follow-up regimen after blunt renal injury is not well documented. Some authors suggest a urologic workup at 1-year posttrauma.[3] More recently, it has been suggested that no routine follow-up imaging is necessary after low-grade injury (I–III). Some authors recommend reimaging in 24 to 36 hours for high-grade injuries after the trauma as it may influence the timing and need for intervention.[39,45] A recent study in the adult population revealed that in a series of 105 patients (24 high-grade injuries) only 5 patients developed complications and all were symptomatic.[46] This certainly calls into question the need for routine imaging in blunt renal trauma. Any question of renal function can be evaluated by a technetium-99m dimercaptosuccinic acid scanning. At our institution, we currently obtain renal ultrasounds at 2 to 6 months postinjury in patients with urinary extravasation or injuries concerning for collecting system stricture on initial CT, otherwise no repeat imaging is recommended. All patients with blunt renal injury at our institution are followed up with urinalysis 2 to 4 weeks after discharge, and repeated as indicated. Follow-up imaging is obtained for suspected urinary extravasation. Blood pressure is monitored twice yearly for 3 years.[35]

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