Renal Trauma

Editor and Contributor:
Bernard Fallon, MD
Professor of Urology
Department of Urology
University of Iowa Hospitals and Clinics
Iowa City, IA

Table of Contents

Introduction ........................................ 2
Evaluation of Renal Injury ..................... 2
Classification and Management of Renal Trauma .......... 4
Pediatric Renal Injuries ......................... 8
Conclusion ........................................ 10
References ....................................... 10

Cover Illustration by Kathryn K. Johnson

NOTE FROM THE PUBLISHER:
This publication has been developed without involvement of or review by the American Board of Urology.
INTRODUCTION

Although urogenital trauma is relatively rare, urologists should be familiar with the management of genitourinary injuries, as trauma surgeons may be unfamiliar with the anatomy and surgery of the urinary tract. This manual reviews the evaluation of renal injury as well as describes the classification and management of renal trauma. A future manual will discuss ureteral injuries and management of ureteral trauma.

EPIDEMIOLOGY OF UROGENITAL TRAUMA

Epidemiologic data for renal trauma are highly variable. This variability can be partly attributed to the different etiologies of renal injury (ie, blunt or penetrating). In addition, some studies describe renal trauma as experienced during war, whereas others relate to renal injury as a result of daily life (eg, motor vehicle accidents, gunshot wounds, stab wounds), adding to the variability in reported statistics. A German study reported that of 385 patients who suffered urogenital trauma, 83% were male. The principle etiologies were road traffic accidents (41%), other accidents (26%), sexual activities (8%), and violence (6%). Renal injuries accounted for 51% of cases, while the remaining injuries were evenly divided between the bladder, urethra, penis, and scrotum and its contents. Half of these patients had associated intra-abdominal or pelvic injuries. Overall, approximately 40% of these injuries were deemed to be severe.

Although road traffic accidents are the principal civilian cause of urogenital trauma, these injuries are nevertheless relatively rare in such accidents, with only 199 cases occurring in a registry of 43,056 victims of road traffic accidents (0.46%). Of these 199 cases, the kidney was most commonly injured (43%) followed by the testis or scrotum (32%), bladder (11%), penis (9%), and urethra or adrenal gland (5%). Interestingly, a major difference was reported in the type of genitourinary injury in motorists (65% kidney, 16% bladder) compared with motorcyclists (64% testis/scrotum/bladder, 28% kidney); however, most patients were young men (152 men, 47 women; mean age, 30.4 years), a fairly typical sex and age distribution compared with other studies. In a study based on the National Trauma Data Bank, 74% of patients who experienced renal trauma were male, and 74% were aged younger than 40 years.

In an epidemiologic study of 57,367 trauma patients over 1 year, 284 (0.5%) had genitourinary injuries. Ninety-two percent of patients were male (mean age, 25 years). The most common injuries were to the kidney and scrotum (33% and 32%, respectively) followed by the testis (7%), urethra (6%), and bladder (3%). Associated injuries were common, with 40% of patients having extremity injury; 22% had intra-abdominal injury, and 18%, 13%, and 7% had injuries to the chest, vertebrae, and head and neck, respectively. The mortality rate in these patients was 4.2%.

In a report from the Croatian war (1991–1993), 588 of 24,865 hospitalized patients suffered 629 urogenital injuries (2.4%). The majority of the injuries were due to shells and mines (66%), 26% were from bullets, and 8% were blunt injuries. Of these patients, 76% had injuries to other organs. The distribution of injuries was: kidney, 40%; genitals, 30%; bladder, 17%; ureter, 8%; and urethra, 5%. In a study of 35 patients who experienced urogenital injury during the Gulf War (1991), 12 (34%) had injuries to the kidney, 2 to the ureter, 4 to the bladder, 7 to the penis/urethra, and 10 to the testis or scrotum. Over half of these injuries were from gunshots. Eighty-one percent of these patients had associated penetrating wounds of the abdomen requiring laparotomy, while 31% had associated chest injuries and 31% had lower limb injuries. The distribution of these injuries was similar to those of the Vietnam War, where 35% of injuries were to the upper urogenital tract and 65% to the lower urogenital tract.

EVALUATION OF RENAL INJURY

CASE 1 PRESENTATION

A 27-year-old construction worker falls from a height of approximately 10 ft and is transported by ambulance to a local hospital. He complains of pain in the right flank area and in his right lower leg. He never
lost consciousness and has no apparent head or chest injuries. The patient is found to have tenderness in his right flank with an external bruise. Urinalysis reveals microscopic hematuria. Intravenous pyelography (IVP) is performed, which demonstrates delayed function of the right kidney. Plain radiography of the right leg reveals a fractured right fibula. A cast is placed on the patient’s right leg, and he is transported to a university hospital for further evaluation of his apparent right renal injury.

- What is the approach to evaluation of renal injury? When is imaging required?

In the patient with potential renal trauma, injuries to other organs must also be suspected. The site and mechanism of injury is usually known, and this information will direct the investigations appropriately. Careful physical examination must be carried out as well. In renal injury, urinalysis may reveal gross or microscopic hematuria (73% and 24%, respectively). Appropriate radiologic assessment of the head, chest, and limbs should also be performed.

**IMAGING OF THE UPPER URINARY TRACT**

It is generally accepted that blunt trauma patients who have gross hematuria or microscopic hematuria and a systolic blood pressure less than 90 mm Hg require upper urinary tract imaging. These patients have a 12.5% risk of major renal injury, whereas those with microscopic hematuria and normal blood pressure have only a 0.2% risk and do not require urologic imaging. Other indications for imaging are severe flank tenderness, rib or vertebral fractures, and acute abdomen. Patients with severe deceleration trauma, which may result in considerable shear stress to the kidney and subsequent renovascular injury, should be imaged even in the absence of hematuria. As many as 36% of patients with shear stress to the kidney may not have hematuria. In addition, patients with penetrating trauma and microscopic or gross hematuria should be imaged. Patients who are hemodynamically unstable should be managed in the emergency department (ED) and, if they cannot be stabilized, should be moved to the operating room for renal exploration, perhaps without any initial renal imaging.

**Computed Tomography**

Abdominal investigation is preferably performed by triple contrast helical computed tomography (CT), which has been found to have 97% sensitivity and 98% specificity for diagnosing peritoneal penetration, as well as a high degree of accuracy for diagnosing organ injury.

Likewise, CT has become the standard for evaluation of potential blunt renal trauma. CT rapidly provides the best and most information regarding the abdomen and retroperitoneum and sufficiently illustrates the severity of a renal laceration or contusion as well as the extent of perirenal hematoma and the presence/absence of extravasation. Early and delayed scanning can be performed to ensure that the collecting system and ureters are visualized and that extravasation is not missed. The renal vasculature can be seen and arterial injury may be diagnosed by visualizing an arterial stump, with no contrast in the involved kidney. The absence of hematoma on CT scan indicates arterial thrombosis from tearing of the intima. Significant perihilar hematoma may indicate arterial or venous avulsion, possibly with continuing dangerous hemorrhage.

**Intravenous Pyelography**

IVP is useful in situations where CT is not available. Unfortunately, the quality of the study may be poor in the trauma patient, especially if the patient is hypotensive. Nevertheless, IVP can confirm the presence of 2 kidneys and provide useful information relative to the function in both. Extravasation of contrast may be seen, and filling defects in the collecting system may indicate blood clots. If one or both kidneys are nonfunctioning, CT must be performed to better illustrate the anatomy. If CT is unavailable, the patient may need angiography to rule out significant arterial injury.

In unstable patients, a “single-shot” IVP may be obtained in the ED or operating room to rapidly evaluate for the presence of 2 kidneys and the possibility of significant injury. This is done with a scout film and another film 10 minutes after the intravenous injection of 2 mL/kg of contrast material. In a review of 50 patients who received single-shot IVP, a single urologist evaluated the films and gave an average score of 3.84 for quality and 3.96 for usefulness (1 being the worst, 5 being the best). Single-shot IVP may help to avoid unnecessary renal exploration, as was the case in 16 (32%) patients in the study by Morey et al.

**Angiography**

CT has essentially replaced angiography in the evaluation of severe renal injuries. However, angiography has assumed a more important role in the control of renal bleeding, as conservative management and embolic treatment of other intra-abdominal injury have become more common. A midstream aortogram is initially performed to confirm the presence of 2 kidneys and to illustrate the number and branches of arteries. Selective catheterization of bleeding sites is then
performed to control bleeding. Angiography is successful in more than 90% of cases, with only 10% of patients having complications (eg, sepsis, urinary fistula, renal infarction).

**Ultrasonography and Retrograde Pyelography**

With sensitivity as low as 22%, ultrasonography is not ideal to evaluate for acute renal trauma. Nevertheless, it is increasingly being used for the rapid evaluation of patients with multiple injuries, as a focused abdominal sonogram for trauma (FAST) scan can evaluate 6 sites for free fluid within a few minutes. Based on these results and clinical indicators of bleeding, a decision can be made to proceed with a more thorough radiologic assessment or with immediate surgical management.

Retrograde pyelography is too cumbersome to be used in the seriously injured patient, but it is helpful to diagnose the presence and location of ureteral, ureteropelvic junction, and renal pelvic injuries in a stable patient.

**CASE 1 RESOLUTION**

The patient undergoes an abdominal CT approximately 2 hours after his injury. The scan confirms a normal left kidney and demonstrates a delay in contrast excretion from the right kidney and a laceration in the lateral margin, extravasation of contrast medium, and a large perirenal hematoma (Figure 1). The patient’s vital signs are stable and, based on CT scan results, a decision is made to manage the patient conservatively.

**CLASSIFICATION AND MANAGEMENT OF RENAL TRAUMA**

**CASE 2 PRESENTATION**

A 37-year-old man is involved in a motor vehicle accident and presents to the ED approximately 1 hour later. The patient’s blood pressure is 110/72 mm Hg, heart rate is 110 bpm, hemoglobin is 11.2 g/dL, and hematocrit is 35%. Gross hematuria is noted, and a Foley catheter is placed. The patient has severe left flank and back pain and extreme tenderness of the left upper quadrant, left flank, and costovertebral angle. A FAST scan is performed by the trauma surgeon and is negative for fluid in the abdomen, pelvis, and pericardium. CT of the chest is normal, but CT of the abdomen and pelvis reveals a fractured third lumbar vertebra and multiple large lacerations of the left kidney, contrast extravasation, and a large perirenal hematoma (Figure 2).

- How is renal injury classified? What is the approach to management?

**CLASSIFICATION OF RENAL TRAUMA**

The American Association for the Surgery of Trauma (AAST) developed the Organ Injury Scale to grade the severity of organ trauma. The AAST Organ Injury Scale for the kidney is listed in Table 1 and illustrated in Figure 3. This scale has been validated by several
studies, the largest of which is based on a study evaluating a cohort of patients with renal injury in the National Trauma Data Bank. In this study, hospital records of 742,774 trauma patients were reviewed, and 8465 cases of renal injury (1.2%) were found. Eighty-one percent of these injuries resulted from blunt trauma. On univariate analysis, AAST grade was associated with an increased risk for nephrectomy, dialysis, and death for both blunt and penetrating trauma (Table 2). On multivariate analysis, grade of injury was an independent predictor of nephrectomy, dialysis, and death for blunt renal trauma, while nephrectomy was the only outcome predicted for penetrating trauma.

Several studies have found predictors for nephrectomy in renal trauma. Wright et al. found that patients with blunt and penetrating trauma had nephrectomy rates of 4% and 21%, respectively, and hospital mortality was 10% and 16%, respectively. A total of 6892 patients had blunt renal trauma; of these patients, 328 had surgery, of which 284 (87%) had nephrectomy. Of 1573 patients who had penetrating injury, 570 had surgery, 333 (58%) of which underwent nephrectomy. On univariate analysis, patients with gunshot wounds were 6 times as likely to need nephrectomy as those with stab wounds. Other predictors for nephrectomy were shock, 

Table 1. American Association for the Surgery of Trauma Organ Injury Scale for the Kidney

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Contusion</td>
<td>Microscopic or gross hematuria, urologic studies normal</td>
</tr>
<tr>
<td></td>
<td>Hematoma</td>
<td>Subcapsular, nonexpanding without parenchymal laceration</td>
</tr>
<tr>
<td>II</td>
<td>Hematoma</td>
<td>Nonexpanding perirenal hematoma confined to renal retroperitoneum</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>&lt; 1 cm parenchymal depth of renal cortex without urinary extravasation</td>
</tr>
<tr>
<td>III</td>
<td>Laceration</td>
<td>&gt; 1 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravasation</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration</td>
<td>Parenchymal laceration extending through renal cortex, medulla, and collecting system</td>
</tr>
<tr>
<td>V</td>
<td>Laceration</td>
<td>Completely shattered kidney</td>
</tr>
<tr>
<td></td>
<td>Vascular</td>
<td>Main renal artery or vein injury with contained hemorrhage</td>
</tr>
</tbody>
</table>


*Advance one grade for bilateral injuries up to grade III.
Renal Trauma

Injury Severity Score, nonrenal abdominal exploration, and major vascular injury. For both blunt and penetrating injury, AAST grade was a significant predictor for nephrectomy. The fact that nonrenal abdominal exploration is a predictor for nephrectomy might suggest that some patients undergo nephrectomy because the abdomen is already open for laparotomy. However, this is refuted in a study by Davis et al.\textsuperscript{19} which found that there was no difference in associated injury rates among options for renal management in 97 patients. In this study, the predictors of nephrectomy were AAST grade, Injury Severity Score, Glasgow Coma Scale score, shock, and transfusion rate within the first 24 hours.

Santucci et al.\textsuperscript{16} found that renal surgery in trauma cases increased by a factor of 15 for each AAST grade and that nephrectomy increased by a factor of 7 for each grade. Although the AAST scale is well-validated, some modifications may be required in relation to hematoma size in grades I and II, as it seems to be correlated with surgery rates, and in differentiating the extent of multiple lacerations and vascular injuries in grades IV and V.

### MANAGEMENT OF RENAL TRAUMA

In most cases, the nonoperative approach is now standard of care for lower grades of renal trauma (grades I–III) and is encouraged by many authors in grade IV and even grade V injuries.\textsuperscript{20} Conservative management consists of hospital admission (or intensive care unit admission if the patient is not stable); observation with frequent monitoring of vital signs, hemoglobin levels, and urine output; and administration of intravenous fluids.

In their analysis of an 18-state database, Wessells et al.\textsuperscript{21} reported that of 523,870 patients hospitalized for trauma from 1997 to 1998, 6231 (1.2%) suffered renal injury. The mechanism of injury was blunt in 71%, penetrating in 16%, and unknown in 13% (82.5% were classified as minor and 17.5% as major). Of these 6231 cases, the majority were managed conservatively (89%). Thus, only 704 of the patients underwent renal surgery, with 61% undergoing nephrectomy. Of note, nephrectomy rates vary according to the severity of injury to the kidney, the need for surgery due to associated injuries, and the etiology of injury.

In a single-center study by Santucci and McAninch,\textsuperscript{22} 113 of 2483 renal injuries were grade IV, and 80% of patients had associated injuries, which were typically explored by the trauma team. Conservative management was used in 22% of renal injuries, 69% had renorrhaphy, and 9% had nephrectomy. Nephrectomy or renorrhaphy was performed in 53% of the blunt trauma patients, 91% of those with stab wounds, and 100% of patients with gunshot wounds. In the same series, 3% of grade III injuries and 86% of grade V injuries resulted in nephrectomy.\textsuperscript{22}

### Table 2. Univariate Analysis of AAST Grade and Adverse Outcome

<table>
<thead>
<tr>
<th>AAST Grade</th>
<th>Nephrectomy RR</th>
<th>Dialysis RR</th>
<th>Death RR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Blunt (n = 289)</td>
<td>Penetrating (n = 333)</td>
<td>Blunt (n = 33)</td>
</tr>
<tr>
<td>I (n = 4663)</td>
<td>Ref</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>II (n = 1540)</td>
<td>2.9</td>
<td>0.9</td>
<td>1.4</td>
</tr>
<tr>
<td>III (n = 1031)</td>
<td>12</td>
<td>8.4</td>
<td>1.5</td>
</tr>
<tr>
<td>IV (n = 832)</td>
<td>83</td>
<td>28</td>
<td>5.3</td>
</tr>
<tr>
<td>V (n = 413)</td>
<td>205</td>
<td>37</td>
<td>6</td>
</tr>
</tbody>
</table>

Note: grade I injury was the point of reference (Ref).


AAST = American Association for the Surgery of Trauma; RR = relative risk.

*Data precludes meaningful analysis.

### Table 3. Management of 80 Patients with Gunshot Wounds, by Severity of Injury

<table>
<thead>
<tr>
<th>Severity of Injury</th>
<th>Nonoperative</th>
<th>Renorrhaphy</th>
<th>Nephrectomy</th>
<th>Vascular Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low grade</td>
<td>12</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Intermediate</td>
<td>4</td>
<td>16</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>High grade</td>
<td>1</td>
<td>2</td>
<td>24</td>
<td>5</td>
</tr>
</tbody>
</table>

Twenty-four of the 113 patients with grade IV injuries had postoperative renal scans, usually early after surgery. The mean function on the repaired side was 36%. The authors postulated that this percentage would be higher if vascular reconstruction cases were excluded and if scans were done at later intervals.

A study by Kansas et al. of an inner-city trauma center reported penetrating trauma in 2163 of 5276 trauma cases over a 6-year period. Of these cases, 123 involved the kidney, and management of 80 cases of penetrating gunshot wounds to the kidney were reviewed (Table 3). It should be noted that again most of the patients were initially explored by the trauma team.

The high operative and relatively high nephrectomy rates in grades III through V renal trauma can partly be attributed to the fact that trauma surgeons initially manage these patients but also to the type of injury and the high rates of associated severe injury. However, there is evidence that in blunt grade IV cases, renal exploration and nephrectomy rates, hospital stays, and complication rates can be diminished by a more conservative management approach (Table 4). The complications reported in the series listed in Table 4 were mainly delayed bleeding, urinoma, and abscess, with rates ranging from approximately 10% to 20%.

AAST grade IV stab wounds (Table 5) and gunshot wounds can also be managed successfully without surgery. In the studies listed in Table 5, only 10 of 338 patients required delayed surgery, all for bleeding. Data are similar for gunshot wounds to the kidney, with low rates of delayed surgery and nephrectomy. It appears that renal salvage rates are higher for grade IV injuries when the kidney is not explored, which is not surprising given that a percutaneous renal procedure for stones or other indications may be considered tantamount to a grade IV injury.

Grade IV or V injuries with major renal vessel injury usually require surgery. In a review of 89 patients with grade IV or V injuries, those with blunt injuries were more likely to have poor outcomes as compared with patients with penetrating injuries; 22% had no hematuria. Twenty-one patients were managed nonoperatively. Function less than 25% in the involved kidney as determined by renal scan, serum creatinine level greater than 2 mg/dL, late nephrectomy, and new hypertension were defined as poor outcomes. Results are outlined in Table 6. Per most authors, the recommendation for main renal artery injury or pedicle avulsion is immediate nephrectomy, as complete renal preservation was achieved in only 14% of such injuries.

### Table 4. Summary of Studies Evaluating Conservative Management in Patients with Blunt Grade IV Renal Injuries

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Patients</th>
<th>Managed Conservatively, %</th>
<th>Needing Delayed Surgery, %</th>
<th>Nephrectomy, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santucci et al.</td>
<td>11</td>
<td>100</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Mansi and Alkhudair</td>
<td>31</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Matthews et al.</td>
<td>29</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Husmann and Morris</td>
<td>50</td>
<td>82</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>Gibson et al.</td>
<td>34</td>
<td>82</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Thompson et al.</td>
<td>43</td>
<td>100</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

Adapted with permission from Santucci RA, Fisher MB. The literature increasingly supports expectant (conservative) management of renal trauma—a systematic review. J Trauma 2005;59:493.

### Table 5. Summary of Studies Evaluating Conservative Management in Patients with Grade IV Renal Stab Wounds

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Patients</th>
<th>Managed Conservatively, %</th>
<th>Needing Delayed Surgery, %</th>
<th>Nephrectomy, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armenakas et al.</td>
<td>200</td>
<td>56</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Eastham et al.</td>
<td>43</td>
<td>63</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Heyns and Van Vollenhoven</td>
<td>95</td>
<td>63</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

Adapted with permission from Santucci RA, Fisher MB. The literature increasingly supports expectant (conservative) management of renal trauma—a systematic review. J Trauma 2005;59:494.
Table 6. Outcomes in 89 Patients with Grade IV or V Renovascular Injury

<table>
<thead>
<tr>
<th>Renovascular Injury</th>
<th>Good Outcome, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade IV</td>
<td>77</td>
</tr>
<tr>
<td>Grade V</td>
<td>63</td>
</tr>
<tr>
<td>Blunt injury</td>
<td>64</td>
</tr>
<tr>
<td>Penetrating</td>
<td>80</td>
</tr>
<tr>
<td>Arterial repair</td>
<td>75</td>
</tr>
<tr>
<td>Immediate nephrectomy</td>
<td>80</td>
</tr>
<tr>
<td>Partial repair</td>
<td>84</td>
</tr>
<tr>
<td>Vein repair</td>
<td>100</td>
</tr>
<tr>
<td>No renal surgery</td>
<td>60</td>
</tr>
</tbody>
</table>


Indications for Renal Exploration

Although a nonoperative approach is recommended for most renal injuries, surgery may be necessary in some patients. Absolute indications for surgery include renal pedicle avulsion, main renal artery or vein injury, major branch injury with uncontrolled hemorrhage, and expanding hematoma. Relative indications for renal exploration include grade III and IV injuries in patients being explored for other reasons, although in such cases, the kidney may best be left alone, as indicated above. Other relative indications for exploration include renal pelvis or ureteropelvic junction injury with severe extravasation of urine with poor drainage.

If exploration is chosen, it is best to use a large midline abdominal incision, which provides access to all potential areas of injury. It is recommended that initial control of the pedicle be achieved through an incision in the posterior peritoneum over the aorta, medial to the inferior mesenteric vein. The need for early vascular control is questioned in a study by Gonzalez et al., in which 56 patients with penetrating renal trauma were randomized to early vascular control or no early vascular control prior to opening Gerota’s fascia. Results were essentially identical in the 2 groups in regards to operative time, transfusion rate, and nephrectomy rate. Regardless of whether or not early vascular control is chosen, the kidney should be explored through Gerota’s fascia, nonviable tissue and separated fragments should be débrided, and the collecting system should be repaired as well as possible. Stents can be used when there is significant injury to the renal pelvis; adequate exterior drainage must be provided. The renal parenchyma is closed with 2-0 polyglactin sutures, often using a gel-foam bolster. Gelatin matrix or fibrin glue may be used as sealants and may decrease bleeding.

CASE 2 RESOLUTION

The patient’s injury is classified as a severe grade IV renal injury based on CT results. He has no other major abdominal injury (a potential indication for exploratory laparotomy). His blood pressure drops and laboratory results reveal decreased hematocrit, indicating continued bleeding. Angiography is performed, which reveals 2 major renal arteries and significant separation of the 2 halves of the left kidney (Figure 4). Significant bleeding is noted in a segmental branch of each of the major arteries and the patient undergoes subsequent angoembolization of the vessels (Figure 4). The patient is admitted to the intensive care unit, where he is observed and stabilized. He recovers fully and is discharged on hospital day 10. One year later, a renal scan reveals some scarring in the central portion of the kidney, but 42% of overall renal function is retained (Figure 5).

PEDEATRIC RENAL INJURIES

Renal trauma principles in children are similar to those in adults. In a registry of 49,651 pediatric trauma cases, frequency of renal injury was 813 (1.6%). Of these cases, 28 resulted in nephrectomy and 21 of these were due to motor vehicle accidents. In a single-center study that evaluated 374 pediatric renal injuries, 89% were blunt and 11% were penetrating; 93% of the 333 blunt trauma cases were AAST grade I. Only 6 of the blunt trauma cases were surgically explored, and there were no nephrectomies. Of the 41 cases of penetrating trauma, 31 were explored, with only 1 nephrectomy. More than 50 red blood cells per high-power field were seen in 129 of 320 grade I injuries (40%) and in 42 of 54 injuries of higher grade (78%). In a study by Rogers et al., 79 children with renal injuries were reviewed; 10 had grade IV and 10 had grade V injuries. Nine of the grade IV patients were managed without exploration, and all 10 of the grade V injuries were explored, resulting in 7 nephrectomies. Overall, it appears that nonoperative management is successful in the majority of pediatric renal trauma cases and that indications for surgery are similar to those for adults. Radiologic evaluation is recommended only if there are more than 50 red blood cells per high-power field, as no significant injuries were found with lesser degrees of hematuria.

Often, there is question as to whether a child with a solitary kidney should participate in sports. In a survey...
Figure 4. Angiograms obtained from the case 2 patient demonstrating (A) 2 renal arteries and separation of the 2 halves of the kidney and (B and C) subsequent angioembolization of the bleeding segmental vessels in the lower and upper halves of the kidney.

Figure 5. Renal scan of the case 2 patient 1 year later showing 43% total renal function on the left side.
of 182 pediatric urologists, 68% recommended against contact sport participation. However, this recommendation can be debated, as many children participate in sports in spite of having other solitary organs. Evidence indicates that renal injury from team sports is rare. Only 6 of 193 pediatric renal injuries occurred during a team sport—none in patients with a solitary kidney and 1 in a patient with congenital ureteropelvic junction obstruction (which was later repaired). In another study of 68 cases of pediatric renal injuries, motor vehicle accidents were involved in 31 cases, while the remaining cases were attributed to falls (15), bicycling (8), hockey (3), football (1), and other causes (10). Five of the 8 renal injuries experienced during bicycling were grade IV or V, and 1 nephrectomy resulted. Therefore, based on available data, it seems reasonable to allow children with solitary kidneys to participate in team sports and other recreational activities.

CONCLUSION

Trauma to the upper urinary tract is relatively unusual. Trauma teams should include a urologist member, who may better understand the principles of renal anatomy and preservation. In addition to a thorough history and physical examination, imaging studies such as CT can help in the diagnosis and classification of renal injuries. In most cases, renal injuries can be managed conservatively, with surgical intervention reserved for patients who have renal pedicle avulsion, main renal artery or vein injury, major branch injury with uncontrolled hemorrhage, and expanding hematoma.

REFERENCES

TOPICS COVERED IN VOLUME 13
HOSPITAL PHYSICIAN UROLOGY BOARD REVIEW MANUAL

Part 1  Stress Urinary Incontinence in Women
Part 2  Seminoma
Part 3  Retroperitoneal Fibrosis

TIME TO PREPARE

For information on the American Board of Urology certification and recertification examinations, go to http://www.abu.org.