

## APPENDIX A: UROLOGICAL DIAGNOSIS AND TREATMENTS

Diagnosis	Treatment
<b>Hematuria</b>	<ul style="list-style-type: none"> <li>Place Foley catheter during trauma assessment unless contra-indicated such as blood at the urethral meatus or other evidence of urethral injury (pelvic fracture).</li> <li>Perform a retrograde urethrogram (RUG) before attempted catheterization when there is concern for a urethral injury.</li> <li>RUG – Obtain an oblique plain film of the pelvis with the patient’s bottom leg flexed at the knee and the top leg straight. Severely injured patients or those with suspected spine fractures can be left supine. Alternately, C-arm or fluoroscopy can be used. A 12Fr Foley catheter or catheter tipped syringe is inserted into the fossa navicularis, the penis placed on traction, and 20 mL of undiluted water soluble contrast injected under gentle pressure. Images are obtained. The study is considered normal only if contrast enters the bladder without extravasation.</li> <li>For an anterior urethral injury, plan on repair in the operating room (OR). For a posterior urethral injury, a supra-pubic catheter can be placed in the OR, or percutaneously in the emergency department (ED) for patients who do not need surgery and an appropriate kit is available. For partial urethral disruption by RUG, a single attempt with a well-lubricated catheter may be attempted by an experienced team member in the ED.</li> <li>If the catheter passes, and gross hematuria is noted, proceed with GU diagnostic evaluation for bladder injury or a renal/ureteral source. CT scan with delayed images and CT cystogram are appropriate imaging studies (see technique description following).</li> </ul>
<b>Renal Injury</b>	<ul style="list-style-type: none"> <li>Clinicians should perform diagnostic imaging with intravenous (IV) contrast enhanced computed tomography (CT) with delayed imaging in stable blunt trauma patients with gross hematuria or microscopic hematuria and systolic blood pressure &lt; 90mmHG or in any stable trauma patients with mechanism of injury or physical exam findings concerning for renal injury (e.g., rapid deceleration, significant blow to flank, rib fracture, significant flank ecchymosis, penetrating injury of abdomen, flank, or lower chest).</li> <li><b>Renal Injury Grading</b> <ul style="list-style-type: none"> <li>Grade 1: Sub-capsular hematoma</li> <li>Grade 2: Small parenchymal laceration</li> <li>Grade 3: Deeper parenchymal laceration without entry into collecting system</li> <li>Grade 4: Laceration into collecting system with extravasation; vascular injury with contained hemorrhage</li> <li>Grade 5: Shattered kidney or renal pedicle avulsion</li> </ul> </li> <li>Hemodynamically stable patients can be managed without surgical exploration in most cases.</li> <li>Hemodynamically unstable patients with no or transient response to resuscitation should have immediate intervention.</li> <li>Vascular repair is indicated for salvageable kidneys with renal artery or vein injury.</li> <li>Ureteral stenting may be needed for enlarging urinoma or persistent urinary extravasation with fever, pain, ileus, fistula, or infection.</li> </ul>
<b>Renal Exploration During Abdominal Operation</b>	<ul style="list-style-type: none"> <li>Stable perirenal hematomas found at time of exploration should not be routinely opened.</li> <li>Renal exploration should be performed at time of laparotomy for persistent bleeding, expanding hematoma, or a central hematoma suggesting a renal hilum injury</li> </ul>
<b>Nephrectomy</b>	<ul style="list-style-type: none"> <li>Total nephrectomy is immediately indicated in extensive renal injuries when the patient's life would be threatened by attempted renal repair.</li> <li>A common surgical approach is a lateral to medial mobilization of the kidney to expose the renal pedicle after incision of the peritoneal attachments of the colon to the lateral wall. While there is insufficient data to recommend initial vascular control of the renal pedicle through a mesentery window prior to exploration, this remains an acceptable principle for renal surgery.</li> <li>Damage control by packing the wound to control bleeding and attempting to correct metabolic and coagulation abnormalities, with a plan to return for corrective surgery within 24 hours is an option.</li> </ul>

Diagnosis	Treatment
<b>Renal Repair and Partial Nephrectomy Principles</b>	<ul style="list-style-type: none"> <li>• Non-surgical management can result in renal preservation even with high grade injuries. Renal repair is appropriate after gaining hemorrhage control and hemodynamic stability for potentially salvageable kidneys identified during exploration.</li> <li>• <b>Technique:</b> Complete renal exposure, debridement of nonviable tissue, hemostasis by individual suture ligation of bleeding vessels, watertight closure (absorbable suture), drainage of the collecting system, and coverage/approximation of the parenchymal defect.</li> <li>• Perform partial nephrectomy if reconstruction is not possible: the collecting system must be closed and the parenchyma covered with fat or omentum. Consider the use of hemostatic agents and tissue sealants if available.</li> <li>• Place ureteral stent for persistent urinary extravasation.</li> </ul>
<b>Ureteral Injuries</b>	<ul style="list-style-type: none"> <li>• Identification of ureteral injury requires a high index of suspicion. It should be evaluated with IV contrast enhanced CT with delayed imaging or direct inspection during laparotomy if preoperative imaging is not available.</li> <li>• Ureteral contusions can be managed by stenting or judicious excision of the injured area with primary anastomosis depending on its severity. Simple ureteral lacerations should be closed primarily.</li> <li>• Complete transections of the ureter proximal to the iliac vessels can be repaired using a tension free, end to end, spatulated anastomosis over a ureteral stent. Transections distal to the vessels should be managed with a ureteral reimplantation over a stent. A psoas hitch or Boari flap may be necessary in some cases.</li> <li>• In cases of inadequate ureteral length to re-anastomose or hemodynamic instability of the patient intraoperatively, a pediatric feeding tube or open ended ureteral catheter may be placed in the proximal ureter and brought out through the skin and placed to closed drainage. Reconstruction of the ureter can then be performed at a future date.</li> <li>• An ureteropelvic junction (UPJ) avulsion injury should undergo re-anastomosis of the ureter to the renal pelvis over a stent.</li> <li>• A drain should be considered after ureteral repair.</li> </ul>
<b>Bladder Injuries</b>	<ul style="list-style-type: none"> <li>• Perform retrograde cystography in patients with gross hematuria and a mechanism concerning for bladder injury, finding on exam or imaging concerning for bladder rupture, or pelvic ring fracture.</li> <li>• Retrograde cystography can be done by CT or plain film. For CT cystogram use diluted Conray to reduce scatter artifact from the contrast. A minimum of 300 ml is needed for an adequately study. Plain film images should include a scout film and an AP image with or without oblique views both with the bladder full and again after it is drained.</li> <li>• <b>Extraperitoneal</b> extravasation of contrast can be managed with Foley catheterization alone in most cases. Open repair is indicated for complicated ruptures that include pelvic fractures with exposed bone spicules in the bladder and concurrent rectal or vaginal lacerations that may lead to fistula formation. Patient's undergoing exploration for other indications that are appropriately stable and those with significant bladder neck involvement should be considered for closure. A transvesical approach can reduce disruption of the pelvic hematoma.</li> <li>• <b>Intraperitoneal</b> rupture requires open repair, two-layer closure with absorbable suture, and perivesical drain placement. A large caliber urethral catheter without suprapubic catheter is usually sufficient for bladder drainage. Patients with complex lower extremity, pelvic, or perineal injuries and those requiring prolonged immobilization may benefit from suprapubic catheter drainage as well.</li> <li>• Follow up cystography should be performed prior to catheter removal</li> </ul>

Diagnosis	Treatment
<b>Urethral Injuries</b>	<ul style="list-style-type: none"> <li>• <b>Diagnosis:</b> A RUG should be performed in any case of suspected urethral injury. For partial urethral tears, a single attempt at urethral catheterization with a well lubricated catheter may be attempted by an experienced provider.</li> <li>• <b>Anterior urethral injuries:</b> Primary repair of uncomplicated penetrating injury to the anterior urethra may be performed using fine absorbable sutures with careful mucosal to mucosal apposition over a urethral catheter. Immediate repair should not be performed in the setting of extensive tissue damage or urethral loss, patient instability, or surgeon inexperience. Bleeding from the corpus spongiosum can be controlled with site specific fine absorbable suture. Bladder drainage should be established by urethral catheterization or suprapubic drainage.</li> <li>• <b>Posterior urethral injuries:</b> These injuries are typically associated with pelvic fractures or deep penetrating trauma. Suprapubic urinary drainage with delayed reconstruction is the accepted treatment for the majority of cases. Endoscopic alignment may be attempted within the first several days after injury in a hemodynamically stable patient. Aggressive attempts at realignment should be avoided.</li> </ul>
<b>External Genitalia Injuries</b>	<ul style="list-style-type: none"> <li>• The primary goals in the management of genital injuries are hemorrhage control and tissue preservation.</li> <li>• Hemorrhage can occur from small arteries on the dorsal penile shaft and/or the spermatic cord. These vessels can be managed with precise cautery.</li> <li>• Large volume, low pressure, irrigation with normal saline should be performed with each surgical intervention. Delayed wound closure is appropriate for significant injuries with considerable tissue damage. Negative pressure wound dressings are well tolerated but often require creative placement techniques when applied to the genitalia. A non-adherent silicone or hydrophilic white foam dressing can be used to cover exposed testicles or freshly repaired corporal tissue when using a negative pressure dressing.</li> <li>• <b>Penile injury</b> may include the corpus spongiosum or corpus cavernosa, and can result in continued hemorrhage. These can be repaired by approximation of the tunical margins with absorbable sutures in a hemostatic fashion following irrigation and debridement of necrotic or devitalized tissue.</li> <li>• The glans is well vascularized and can generally be closed with interrupted absorbable suture.</li> <li>• <b>Scrotal injuries</b> are managed in a similar fashion as other soft tissue wounds. Small penetrating injuries can result in significant testicular damage. There should be a low threshold for surgical exploration in these cases. The scrotum should undergo irrigation and debridement with primary or delayed closure. Widely spaced absorbable suture and a Penrose drain can be used in lieu of a negative pressure dressing when delayed closure is required.</li> <li>• <b>Testicle injuries</b> can be diagnosed with physical exam or scrotal ultrasound. CT or sonography may also show evidence of foreign bodies or air in the scrotum or abnormality of one or both testes. Equivocal cases should be explored. Necrotic testicular tissue should be debrided and the capsule closed with absorbable suture. A tunical vaginalis flap can be used when the tunica albuginea is deficient for closure.</li> </ul>