CHAPTER 9

UPPER URINARY SYSTEM TRAUMAS

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Urogenital traumas constitute 10% of all traumas. In recent years, the development of technology and the widespread use of ultrasonography and computed tomography have made it easier to detect urinary tract injuries. The approach to trauma patients has improved in parallel with technological innovations. The approach to urogenital traumas constantly evolves, mainly due to better diagnostic tools and trauma care. Today, with the help of advanced radiological techniques, most patients with solid organ injuries can be treated with close follow-up without surgery. Examining the abdomen and genital organs can give an idea about retroperitoneum and pelvic organ injuries. Fractures of the lower ribs are often associated with renal injuries, and pelvic fractures often accompany injuries to the bladder and urethra (1).

RENAL TRAUMAS

Etiology

The kidneys are less affected by trauma than other abdominal organs due to their location in the retroperitoneal region, the fatty supporting tissue provided by Gerota's fascia, and their proximity to the ribs. Renal traumas are seen together with other organ injuries at a rate of 80-95% (2). The kidney is the most frequently injured organ in genitourinary traumas (3).

The initial evaluation should include control of hemorrhage and shock, with resuscitation as needed. Intravenous access and insertion of a urethral catheter may be required for resuscitation (1).

Kidney traumas are classified into two main groups blunt and penetrating traumas. Iatrogenic injuries are very rare. Although blunt kidney traumas (71-95%) are common, penetrating traumas are reported more frequently in some countries where individual violence is high (4,5). The etiology of blunt kidney traumas is 63% motor vehicle injuries, 43% falls from height, 11% sports injuries, and 4% non-vehicle traffic accidents (1). In penetrating trauma, gunshot wounds (65%) are the most common etiologic factor, followed by stabbing (35%). Most

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kidney traumas are low-grade and suitable for conservative follow-up (6).

The best indicator of urinary tract trauma is microscopic hematuria or macroscopic hematuria. The presence of microscopic hematuria is pathognomonic. However, microscopic hematuria can be seen in minor injuries; macroscopic hematuria in significant injuries or urinary system injuries can occur without hematuria (6).

CLASSIFICATION IN KIDNEY TRAUMAS

The American Society for Trauma Surgery (AAST) organ damage scale evaluates kidney traumas (7, 8).

AAST KIDNEY INJURY GRADING SCALE

Grade*	Description of injury
1	Subcapsular non-expanding hematoma or parenchymal contusion without parenchymal laceration.
2	Non-expanding perirenal haematoma confirmed to Gerata fascia.
	Renal parenchymal laceration < 1 cm depth without urinary extravasation.
3	Renal parenchymal laceration > 1 cm depth without collecting system rupture or urinary extravasation.
4	Parenchymal laceration extending into the urinary collecting system with urinary extravasation.Renal pelvis laceration and/or complete ureteropelvic disruption. Segmental renal vein or artery injury.
5	Shattered kidney with loss of identifiable parenchymal renal anatomy. Main renal artery or vein laceration or avulsion of the renal hilum. Devascularized kidney with active bleeding.

RADIOLOGICAL IMAGING

Imaging aims to grade renal damage and investigate whether there is damage to the contralateral kidney and other organs. The patient's hemodynamic status determines the imaging technic. Imaging should be performed immediately after the first evaluation in patients with no severe general condition. In unstable patients, it may be necessary to intervene without imaging. In cases where macroscopic or microscopic hematuria is accompanied by hypotension, imaging should be performed in the presence of findings suggestive of kidney trauma, such as rapid deceleration trauma history or concomitant injury (9, 10). Contrast-enhanced computed tomography (CT) is the first imaging method preferred in renal traumas.

Parenchymal lacerations and extravasation of contrast-enhanced urine are easily identified. Injuries can be revealed to the intestine, pancreas, liver, spleen, and other organs. The size and extent of the retroperitoneal hematoma are evaluated. CT has replaced intravenous pyelography (IVP). It is ideal to be applied in 3 phases. These phases;

1. In the arterial phase, vascular damage and active radiopaque extravasation,
2. Parenchymal contusion and lacerations in the nephrographic phase,
3. In the late phase (5th min), injuries of the collecting system and ureter can be observed (11, 12).

Ultrasonography (USG) shows hematoma size in kidney injuries. It may fail to visualize renal laceration and urinary extravasation. USG is mainly used in the follow-up of patients planning for conservative treatment of renal trauma. (13).

Conservative Treatment

A hemodynamically stable patient can be followed and treated without intervention if there is grade 1 to 3 renal injury according to AAST criteria. Although opinions support the need for surgical intervention in grade 4 and 5 injuries, there are contrary views. It has been reported that if the patient's hemodynamics is stable, they can be followed up and treated (15).

It is supported that even stab and gunshot wounds can be treated conservatively. It has been reported that post-traumatic urinoma can be treated with a stent and urinary diversion with a 98% success rate without surgical intervention (16).

The patient should be immobilized until the macroscopic hematuria resolves. Periodic imaging studies should be performed in patients with parenchymal damage. Delayed renal hemorrhages can be seen in 25% of cases, even if grade 2 to 4 injuries spontaneously resorb (17).

Surgical exploration

The main goal in the surgical treatment of kidney injuries is to control life-threatening bleeding and save the kidney. There are definite and relative indications for surgical treatment.

Definitive Surgical Indications;

a. Persistent renal bleeding,

b. Expanded perirenal hematoma,

c. Pulsatile perirenal hematoma.

Relative Surgical Indications;

a. Urinary extravasation,

b. Presence of necrotic tissue

c. Late diagnosed arterial damage,

d. Segmental arterial damage and inability to complete staging.

The recommended approach in acute kidney injuries is the midline transabdominal approach. On the side with retroperitoneal hematoma, without opening the Gerota's fascia, the renal pedicle can be reached directly by blunt dissection from the posterior parietal peritoneum adjacent to the aorta, medial to the inferior mesenteric vein or adjacent to the psoas muscle, by blunt dissection (18).

In some series, it has been reported that up to 94% of other organ injuries occur in penetrating traumas (19).

RENAL RECONSTRUCTION

A complete examination of the renal region includes removal of dead tissue, ligation of bleeding vessels, watertight closure of the collecting system, repair of parenchymal defects, and placement of drains.

NEPHRECTOMY INDICATIONS

Total nephrectomy is indicated if the contralateral kidney is intact, the renal injury is extensive, and the repair attempt is risky for the patient's life (19).

COMPLICATIONS

Urinary extravasation can lead to urinoma, perinephric infection, and kidney loss. Ureteral stent placement is often sufficient in cases of extravasation that do not regress with appropriate antibiotic therapy and good follow-up. Percutaneous drainage is the first to consider if the extravasation does not regress and causes abscesses around the kidney despite these treatments. Bed rest and hydration are the first treatment options for late bleeding, seen in the first four weeks after the operation. However, if the bleeding continues, it is usually brought under control by angiography, determining the location of the bleeding and embolizing it (20).

Hypertension is the most common late complication. This complication is due to renovascular injury, compression of the renal parenchyma by hematoma or extravasated urine, or post-traumatic arteriovenous fistula. The underlying mechanism is renin-angiotensin system stimulation due to renal ischemia. In addition, complications such as bleeding, hydronephrosis, stone formation,

chronic pyelonephritis, and pseudoaneurysm may be observed late (20). Follow-up after discharge should be done with physical examination, urinalysis, necessary radiological evaluation, blood pressure follow-up, and serum markers of kidney functions (21).

URETERAL TRAUMA

Ureteral traumas rarely occur due to their small size, mobility, and being surrounded and protected by vertebrae, bony pelvis, and muscles. Ureteral injuries constitute approximately 1-2.5% of urinary tract traumas. The most common (about 80%) cause is iatrogenic, mostly seen in the distal ureters (22). Injuries that may develop in open, laparoscopic, and endoscopic operations can be missed peroperatively. Unnoticed ureteral injuries occur more frequently than reported and may leave serious sequelae (23). Iatrogenic ureteral injuries can occur by many mechanisms, such as ligation, crushing with a clamp, thermal injury, partial or complete incision, and ischemia due to devascularization (24). Ureteral trauma is also encountered in gynecological operations and may occur in colorectal surgeries, especially in abdominoperineal and lower anterior resections (25, 26). In urological operations, it occurs most frequently (71.6%) during ureterorenoscopic interventions (27).

A quarter of ureteral injuries are of external origin; approximately 1/3 of them are due to blunt, and 2/3 of them are due to penetrating trauma. In general, ureteral injury occurs in less than 4% of penetrating traumas and less than 1% of blunt traumas. The ureteral injury should be suspected in penetrating abdominal injuries, especially firearm injuries, since 2-3% of the ureters may also be affected. External ureteral traumas are observed more frequently in the proximal ureters; 70% occur in the upper, 8% in the middle, and 22% in the lower ureter (21, 28, 29). It should be kept in mind that in blunt traumas caused by the deceleration mechanism, the ureters may rupture at the ureterovesical junction or, more often, at the level of the renal pelvis (21).

DIAGNOSIS

Acute ureteral injury has no specific symptoms or clinical signs. Especially in penetrating trauma such as gunshot wounds or blunt injuries, the suspicion of ureteral trauma leads to the diagnosis. The presence of hematuria as a clinical symptom is a weak indicator of trauma since it is observed in only half of the ureteral traumas (29).

The retroperitoneal region should be carefully evaluated in trauma patients who underwent intraoperative exploratory laparotomy. Delayed diagnosis of ureteral injury causes more extended hospital stays and increased nephrectomy rates (30).

Isolated ureteral injuries may be overlooked. Upper urinary tract obstruction, urinary fistula, and sepsis may occur in these patients. Women who develop flank pain, vaginal urine leakage, or septic symptoms after gynecological pelvic surgery should be evaluated for ureter or bladder injury without delay. Intravenous indigo carmine or methylene blue is recommended to evaluate ureteral injury during surgery. It can be given intravenously and by injecting it into the renal pelvis with a fine 27G needle, and urine with a blue dye coming from the damaged area helps to detect the injury site, especially in partial lacerations (31).

In patients with ongoing serous fluid drainage from the operation area and suspected ureteral injury after a previous surgical intervention, creatinine analysis from the drain fluid may allow early detection and further investigation and treatment of a possible urinary leakage (32).

IMAGING

Ureteral injuries may give radiological findings of upper urinary tract obstruction. In some cases, ureteral injury manifests as radiological contrast agent extravasation. It can be assessed by IVP with 2 milligrams (mg) of contrast material per kilogram. The fact that CT is preferred more in multiple traumas has increased the number of diagnoses made with this method (Table 1) (33).

Table 1: Injury severity scale for ureter (adapted from AAST)
GRADE 1 Hematoma only
GRADE 2 Laceration< 50% of the circumference
GRADE 3 Laceration>50% of the circumfrence
GRADE 4 Complete tear< 2 cm of devascularization
GRADE 5 Complete tear> 2 cm of devascularization

TREATMENT:

After diagnosis, it can be treated by providing urinary diversion with a ureteral stent or nephrostomy tube. The stent can be placed antegrade or retrogradely by ureterorenoscopic using fluoroscopy and radiopaque contrast. To reduce stent reflux, bladder catheterization should be performed during voiding for two days until mucosal healing begins. The ureteral stent should be kept for at least

three weeks, and the patient should be followed up with a dynamic renogram and IVP for 3-6 months. If stricture develops, endourological or open surgical techniques should be intervened as soon as possible (34). When a grade 2-3 injury is encountered during emergent surgical exploration due to iatrogenic injury, primary closure of the ureteral tips over the stent and placement of a drain in the injury area may be recommended (35).

In cases where the ureters are ligated iatrogenically, the ligation should be opened, and the viability of the ureters should be checked. If there is any doubt about viability, ureteroureterostomy or ureteral reimplantation should be performed (36). Complete injuries are grade 3-5 injuries. Open or laparoscopic methods should repair it. Complete injuries can be repaired by laparoscopic methods due to the development of laparoscopic techniques and devices in recent years (37).

BASIC PRINCIPLES OF A SUCCESSFUL REPAIR:

1. Debridement of ureteral ends until viable tissue is reached
2. Spatulization of ureteral ends
3. Stent placement
4. Watertight reconstruction of the ureter with absorbable sutures
5. Drain placement 6. Isolation of the injury site with peritoneum or omentum

Depending on the injury site, treatment options may vary. The earlier the diagnosis, the lower the morbidity and mortality rate. Treatment options according to the injury site in the ureter are summarized below (38).

Upper 1/3 ureter: Ureteroureterostomy, Transureteroureterostomy, Ureterocalicostomy

Middle 1/3 ureter: Ureteroureterostomy, Transureteroureterostomy, Boari flap, and reimplantation

Lower 1/3 ureter: Direct reimplantation, Psoas Hitch, Boari Flap

The ileum is the most commonly used intestinal segment due to complete ureteral injury. The use of the appendix and narrowed ileal segment (Monti procedure) is not recommended. The surgical success rate is around 80% (39).

Autotransplantation is the last option before nephrectomy in cases where significant tissue loss is accompanied, and other attempts are unsuccessful (21, 40).

Nephrectomy: Late-stage nephrectomy can be performed in cases of poor renal function, ileal ureter, and pan-ureteric stenosis where other interventions

are inadequate or ureteral fistula that is resistant despite previous intervention. It should be kept in mind that it is the surgical method to be applied as the last option in cases where all other procedures failed (21, 39, 40). With nephrectomy, the risk of urinary leakage, urinoma, sepsis, and graft infection that can be caused by ureteral injury is reduced (41)

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