International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 7; Issue 7(A); July 2018; Page No. 13902-13908
DOI: http://dx.doi.org/10.24327/ijcar.2018.13908.2500

Review Article

CONSERVATIVE MANAGEMENT OF RENAL TRAUMA RENAL TRAUMA, A LITERATURE REVIEW AND PRACTICAL CLINICAL GUIDELINE

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A R T I C L E I N F O

Article History:

Received 10th April, 2018
Received in revised form 18th May, 2018 Accepted 26th June, 2018
Published online 28th July, 2018

Key words:

Diagnostic imaging; follow-up; guideline; non-operative management; renal trauma

A B S T R A C T

A literature search was conducted utilizing Medline, and; articles published between 2000 and 2016 were included.
About 10% of all injuries seen in the emergency room involve the genitourinary system to some extent. Many of the injuries are subtle and difficult to define and require great diagnostic expertise. 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.2
Renal trauma is increasingly being managed conservatively with an expanding role for interventional radiology techniques. Accurate assessment and resuscitation are vital in the initial management

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.

Methods

A literature search was conducted utilizingMedline, and; articles published between 2000 and 2016 were included.
Search terms used included: 'renal trauma, kidney injuries complications.

The foundation of nonoperative management for renal trauma goes back at least 50 years.1 About 10% of all injuries seen in the emergency room involve the genitourinary system to some extent. Many of the injuries are subtle and difficult to define and require great diagnostic expertise. 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.2

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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%). **3** 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/penis, 28% kidney); however, most patients were young men (152 men, 47 women; mean age, 30.4years), a fairly typical In an epidemiologic study of 57,367 trauma patients over 1 year, 284 (0.5%) had genitourinary injuries. 4 Expectant (nonoperative) management of renal injuries has gained much support in past decades. A trial of expectant management has been advocated for most adult blunt renal parenchymal injuries, 5 many renal stab wounds,6,7 and selective renal gunshot wounds.3,6,8 Intervention still must be reserved for hemodynamic instability due to renal bleeding, incomplete renal injury staging, renal pelvic or ureteral injury, and certain renovascular injuries.

Epidemiology of Uro Genital 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).

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.1 The principle etiologies were road traffic accidents (41%), other accidents (26%), sexual activities (8%), and violence (6%). 92% 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%).3,6,8

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%.

Patient assessment

Assessment of the trauma patient should follow the standard Advanced Trauma Life Support (ATLS) approach involving a primary and secondary survey.

Renal injury should be considered given the mechanism of injury (e.g. rapid deceleration/direct blow to the flank) or examination findings of haematuria, flank pain/bruising, rib fractures or penetrating flank/abdominal wounds. The haemodynamic status of the patient is key in deciding on the most appropriate management strategy.

Particular attention should also be given if there is a history of concurrent renal disease, previous renal surgery or pre-existing renal abnormalities (e.g. solitary kidney, PUJ obstruction, polycystic kidneys or calculi) as these may alter subsequent management.9

Initial assessment in order of importance includes

1. Airway with cervical spine protection;
2. Breathing;
3. Circulation and control of external bleeding;
4. Disability or neurologic status;
5. Exposure (undress) and environment (temperature control).

Resuscitation may require intravenous (IV) lines and urethral catheterization in seriously injured patients. In males, before the Foley catheter is inserted, the urethra is carefully inspected for the presence of any blood.A detailed history and description of the accident is obtained. In cases of gunshot wounds, the type and caliber of the weapon needs to be determined because high-velocity projectiles cause much more extensive damage than low-velocity ones.

The development of modern trauma care has evolved from the close association of surgery and casualty management in times of war.

Many important concepts, including prehospital transport, volume resuscitation, wound management, enteric injury management, and critical care, have been advanced as a result of observations during military conflict.

These management principles have been refined in the civilian sector and have led to advances such as primary repair of colonic injuries rather than colostomy and early revascularization of ischemic limbs rather than amputation.**10**

Renal Trauma

The expectant management of renal injuries relies on the assessment of the hemodynamically stable patient using computed tomography (CT) and unstable patients using laparotomy and intraoperative one-shot intravenous urography. The urologic examination focuses on the abdomen and genitalia. Fractures of the lower ribs are often associated with renal injuries to the retroperitoneum, whereas pelvic fractures can be accompanied by bladder and urethral injuries.

Hematuria is the best indicator of traumatic injury to the urinary system. Microscopic hematuria (>5 red blood cells per high-power field), heme-positive urine dipstick, and gross hematuria are the strongest indicators of genitourinary injury. The combination of systemic shock (systolic blood pressure <90 mm Hg) and microscopic hematuria is strongly associated with severe renal injuries. The best urine sample for assessment of hematuria in the trauma patient is the first aliquot of voided or catheterized specimen because later samples are often diluted by diuresis.

Federle Classifications

Category I

This category includes minor injury to the kidney such as renal contusion, intrarenal and subcapsular haematoma, minor laceration with limited perinephric haematoma without extension to the collecting system or medulla, and small subsegmental cortical infarct.

Category I corresponds to Grade I and II of the AAST renal injury severity scale.

Renal contusion is usually small and appears as small non-enhancing areas within the renal parenchyma without extension into the collecting system. A small subcapsular haematoma appears as a hypodense lesion flattening the renal capsule

Category II

This category consists of major injury of the kidney, including major renal laceration through the cortex extending to the medulla or collecting system, with or without urine extravasation and segmental renal infarct. Category II corresponds to Grade III of the AAST renal injury severity scale.

Category III

Category III lesions are catastrophic injuries, which include multiple renal lacerations and vascular injury involving the renal pedicle. Category III corresponds to Grade IV of the AAST renal injury severity scale. Multiple renal lacerations or a shattered kidney would appear as multiple clefts extending through the renal parenchyma and collecting system.

With a shattered kidney, devitalised fragments can occur due to a lack of vascular supply (nonenhancing segments). A devitalised fragment may be obscured by a large perinephric

haematoma and a large perinephric haematomawould appear as a large hypodense perinephric collection.

If there are multiple devitalised fragments, severe impairment in renal excretion would be observed.

Vascular injury includes renal artery thrombosis, renal artery avulsion or renal vein thrombosis. Renal artery thrombosis results from severe deceleration that causes tearing of the tunica intima. The intimal flap would cause thrombosis of the renal artery.11.

Initial Imaging

Four-phase CT of the abdomen and pelvis with non-contrast, arterial-, nephrographic-, and pyelographic-phased images is generally considered the 'gold standard' initial imaging method in renal trauma 12-13,14,15,16,17.

The American College of Radiology has made useful recommendations as to when other imaging methods may be appropriate.

CT: CThas a major role in the investigation of renal trauma and is currently the imaging modality of choice. Categorising the renal injuries according to the Federal classification or the AAST renal injury severity scale is very helpful in the management of injured patients.

Ultrasonography: Experience with the evaluation of suspected acute renal traumatic injury by ultrasound has been primarily from Europe.18

In well-trained and experienced hands, renal lacerations and hematomas can be reliably identified and delineated.

Limitations of ultrasound include an inability to distinguish fresh blood from extravasated urine and an inability to identify vascular pedicle injuries or segmental infarcts. Only with close color and pulsed Doppler interrogation can a vascular injury be diagnosed.

Grading of renal injuries is performed using the American Association for the Surgery of Trauma organ injury severity scale.

Table 1 American Association for the Surgery of Trauma organ injury severity scale for kidney

Grade[1]	Type	Description
I	Contusion	Microscopic or gross hematuria, urologic studies normal
	Hematoma	Subcapsular, nonexpanding without parenchymal laceration
II	Hematoma	Nonexpanding perirenal hematoma confined to renal retroperitoneum
	Laceration	<1 cm parenchymal depth of renal cortex without urinary extravasation
III	Laceration	>1 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	Completely shattered kidney
	Vascular	Avulsion of renal hilum, devascularizing the kidney

A classification and grading system for renal injuries (***Fig. A and B***) has helped in proper identification and better communication of the extent of injury between different members of the trauma team.

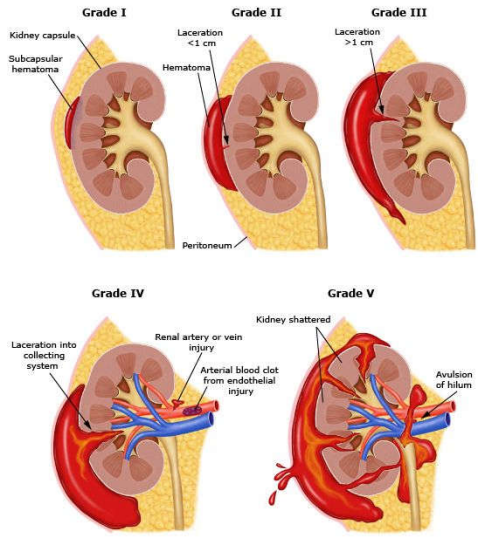

Fig. A

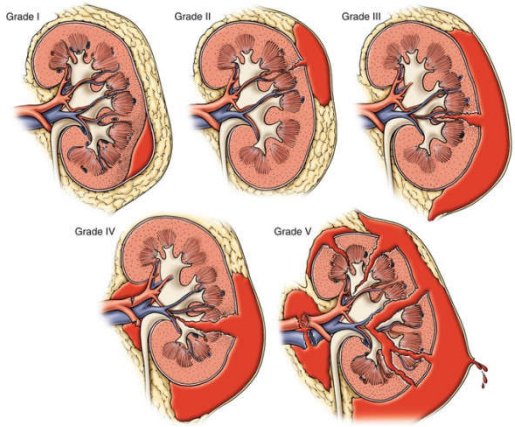

Fig.B

Use of appropriate imaging studies enables the trauma team to appropriately stage the extent of the renal injury. All blunt trauma patients with gross hematuria and those patients with microscopic hematuria and shock (systolic blood pressure <90 mm Hg any time during evaluation and resuscitation) undergo renal imaging, usually computed tomography (CT) with IV contrast. Adult patients with microscopic hematuria and without shock can be followed clinically without imaging studies because an extremely low percentage of these patients (<0.0016%) have significant renal injury.19 In contrast, pediatric patients with blunt trauma and microscopic hematuria require an imaging modality (CT scan or ultrasound). Children have a high catecholamine output; therefore, shock is not a good predictor of the degree of renal injury.

Patients are treated with bed rest until the gross hematuria resolves.

Repeat CT scans are used if the patient has a clinical event such as a decrease in serum hematocrit, fever, flank pain, or other concerning incident. Surgical intervention is mandatory for shock secondary to renal bleeding, expanding retroperitoneal hematoma, transfusion requirements exceeding 3 U/day of packed red blood cells associated with hemodynamic instability, renal pelvic or ureteral injury, and certain renovascular conditions such as renal artery stenosis. Some surgery in hemodynamically stable patients can be performed in a delayed fashion if desired. Despite the variability in different medical centers' comfort level with the management of renal trauma, most would advocate that grade I

and many grade II injuries can be managed conservatively. The reports have varied for the treatment of grade III and IV parenchymal injuries, but most favor a conservative approach, especially in the most modern series. Even some grade V parenchymal injuries have been managed nonoperatively.20
Renal surgery should be reserved for hypotension due to exsanguination.21, 22-23

Renal injury is observed in 10 % of cases of abdominal trauma, and the majority (80 percent to 90 percent) of these are attributable to blunt trauma.

Intravenous urography and ultrasonography of the abdomen were previously the modalities of choice in the imaging of renal injuries. However, computed tomography (CT) is currently the imaging modality of choice in the evaluation of blunt renal injury, since it provides the exact staging of renal injuries.

CT Scanning Protocol in Renal Trauma

For a complete assessment of renal injuries, CT is performed in multiple phases.

It is usually done as part of the CT abdomen and pelvis protocol for abdominal injuries.

The corticomedullary phase is performed from the dome of the diaphragm to the pelvis, approximately 60 seconds after an intravenous injection of nonionic iodinated contrast media (iohexol 300 mg I/ml) at 2 mg/kg via the antecubital vein.
This phase would identify any renal contusion, laceration, perinephric haematoma and arterial injury.

Other associated injuries to the liver, spleen, pancreas and intraperitoneal haemorrhage could also be assessed. However, collecting system injuries may be missed if an excretory phase is not performed.24

Penetrating Renal Trauma

Stab injuries have more evidence to support conservative management. A South African group performed a prospective randomized trial of conservative treatment of select patients with renal stab wounds who showed no signs of hypotension, peritoneal injury, or intravenous pyelogram abnormality.25

In a study of 1856 patients with abdominal gunshot injuries, 42%, who were hemodynamically stable and without peritoneal signs, qualified for an observation protocol involving serial abdominal examinations and the avoidance of laparotomy.26

In the 21st century, obligatory exploration is also no longer the rule for renal gunshot wounds, with patient selection based on hemodynamic stability being most important.27, 28, 29, 30, 31

The absolute indications for renal exploration continue to be life-threatening hemorrhage from a renal source with associated instability, pulsatile perirenal hematoma (which is suggestive of a grade V vascular injury), and active extravasation of intravenous contrast. 32,33,34,35,36,37,38,39,40,41

Arterial Thrombosis

Major deceleration injuries can result in stretching on the renal artery and tearing of the vessel intima, resulting in thrombosis of the main renal artery or its segmental branches and thus causing infarction of the renal parenchyma. Prompt diagnosis and the time till operation of a unilateral complete arterial thrombosis is vital to salvaging the kidney.42

Delayed bleeding

One of the feared complications of observing renal injuries is delayed intraabdominal hemorrhage. Most episodes are related to increased patient activity.

The average renal re-bleeding rate can be as great as 20%,43, 44, 45, 46.

The treatment of these episodes, when significant, is angiographic embolization47,48or delayed renorrhaphy, only when absolutely necessary.

Damage Control

Damage control in the management of multiorgan trauma is a well-established principal in severelyinjured patients.Rotondo MF, J Trauma 1993

The underlying objective is patient survival at all costs. Typically, these patients are critically ill and an abbreviated laparotomy is performed to rapidly control life-threatening bleeding or injuries and the patient is temporarily closed and resuscitated in an intensive care unit setting.

Reports concerning damage control in urology are limited.

Damage control was conceived by trauma teams concerned about the risk of lengthy operations on seriously injured patients with hypothermia, acidosis, and coagulopathy. 49

Damage control principles include the control of significant hemorrhage by abdominal packing and subsequent stabilization of the patient in the intensive care unit. Formal operative repair of abdominal injuries is performed later.50

Indications for Nephrectomy

When proximal vascular control is initially achieved before all renal explorations, nephrectomy is required in <12% of cases.21 When primary vascular control is not achieved and massive bleeding encountered, in the rush to control bleeding, a kidney that could have been salvaged is unnecessarilysacrificed. Overall, nephrectomy is required when the patient is persistently hemodynamically unstable,and thus is a life saving maneuver.

Other indications for nephrectomy are grade 5 injuries that are deemed irreparable, such as major vascular pedicle injury, particularly on the right.51

Complications after renal Trauma

Complications which follow renal trauma are dependent upon the grade of the initial renal injury and the method of management. In most cases, resulting complications are usually of minimal long-term morbidity, can be successfully managed by endourologic and percutaneous techniques, and do not significantly prolong the mean days of hospitalization.52, 53.

Early complications, those that occur within one month of injury are urinoma, delayed bleeding, urinary fistula, abscess, and hypertension. Prolonged urinary extravasation is the most common complication after renal trauma.1, 25 Urinomas occur in <1% of renal trauma cases. Small, uninfected, and stable collections do not require intervention. Larger collections are usually successfully managed by the endoscopic or

percutaneous placement of a ureteral/nephrostomy tube. Delayed renal bleeding most commonly occurs within 2 weeks of injury. When bleeding is heavy or symptomatic, transfusions, angiography and superselective embolization19 may be required.

Urinary fistulas can occur in association with an undrained collection or from large segments of devitalized renal parenchyma. Abscesses of the retroperitoneum are associated with ileus, high fever and sepsis. Most collections can be easily drained percutaneously. The extent of the abscess and the presence of loculations are well delineated by CT imaging. Hypertension in the early postoperative period is usually renin-mediated, transient, and does not require any treatment.

Late complications after renal trauma are hydronephrosis, arteriovenous fistula, pyleonephritis, calculus formation and delayed hypertension. Scarring in the region of the renal pelvis and ureter after renal trauma can result in urinary obstruction and subsequently lead to stone formation and chronic infections. Arteriovenous fistula more commonly occur after a renal stab wound and can present with delayed bleeding.54

Renal reconstruction versus nephrectomy

Renorrhaphy is possible in the majority of cases in experienced hands and the current nephrectomy rate at exploration is around 13%.55, 56

However, in high-velocity gunshot injuries nephrectomy is often required. Renorrhaphy involves debridement of non-viable parenchyma followed by meticulous haemostasis of parenchymal vessels using a monofilament, absorbable suture. A formal partial nephrectomy may be required. The collecting system is then closed separately with a similar suture, although not all surgeons do this and instead some opt for a single suture to approximate the parenchymal edges. The defect can then be covered with a pedicled omental flap if required, for example,in cases where the renal capsule is not preserved.

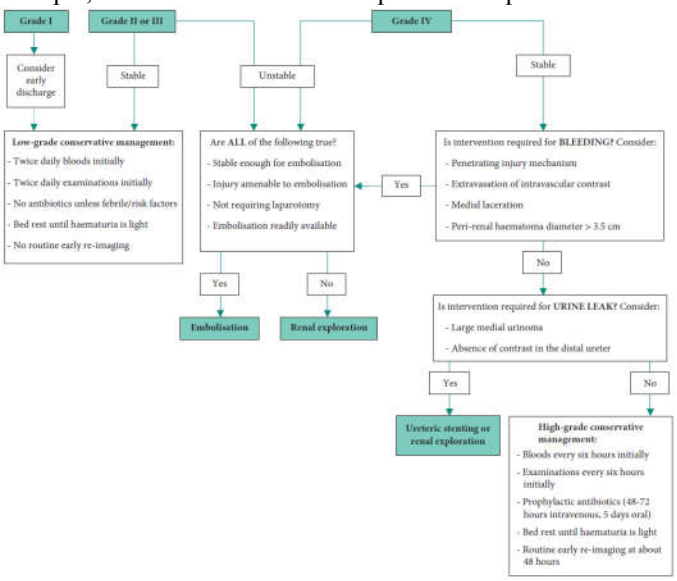

Fig C Algorithm for managing grade I to IV renal trauma.

Thromboprophylaxis

Trauma patients are known to be at high-risk of venous thromboembolism (VTE), and this risk can be reduced significantly with mechanical and pharmacological thromboprophylaxis 57.

Follow-up Imaging

The purposes of follow-up imaging are to exclude development of new pathologies, and to show adequate healing of known injuries. Pathologies of particular importance include pseudo-aneurysms, arteriovenous fistulae, and hydronephrosis. Pseudo-aneurysms and arteriovenous fistulae are the commonest causes of secondary haemorrhage 58,59,60, and occur almost exclusively in injuries of grade ≥III5,8,60.

CONCLUSIONS

Assessment of the trauma patient should follow the standard Advanced Trauma Life Support (ATLS) approach involving a primary and secondary survey.

Renal trauma is increasingly being managed conservatively with an expanding role for interventional radiology techniques. Accurate assessment and resuscitation are vital in the initial management.

Imaging with CT is critical to the accurate grading of the injury and helps guide subsequent treatment.It is important to keep an index of suspicion for renal trauma as given by the mechanism of the injury or in Poly-trauma.

However, there remains a role for laparotomy and renal exploration in the haemodynamically stable patient where intervention can be life-saving.

Disclosure*:* The authors declare no conflicts of interest.

Acknowledgment

Many thanks to Z Hosseini PhD student, for checking and statistics.

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How to cite this article:

Pazooki D *et al* (2018) 'Conservative Management of Renal Trauma Renal Trauma, A Literature Review and Practical Clinical Guideline', *International Journal of Current Advanced Research,* 07(7), pp. 13902-13908.
DOI: http://dx.doi.org/10.24327/ijcar.2018.13908.2500

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