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Review Article: Changing Management Concepts of Renal Trauma

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Abstract:
Background: *The management of renal trauma evolves with technological advances in medical practice.*
Aim: *To review the changing management of renal trauma and the impact of the changes in the developing world.*
Methods: *A Medline and Google scholar search was made from 1966 to March 2020 using the terms renal trauma and renal injuries. Appropriate citations were selected and the full length publications as much as possible were obtained. Details extracted included demographics, mechanisms of injury, clinical features, investigations, treatment and outcome.*
Results: *The anatomical location and size of the kidney confers it with some protection against trauma. The common causes are road traffic accidents, falls, assaults and armed conflicts. Associated injuries are common. Rarely spontaneous rupture occurs. Standard grading of renal injuries is by the American Association for Surgery of Trauma system. This classification has undergone significant revision with an aim to more conservative approach of management. Children, abnormal location, congenital anomalies and enlarged kidneys are more susceptible to blunt trauma. The injuries are common in the age group 20-30 years. There is male preponderance. Major diagnostic tool is Computerized Tomography(CT) scan. Grades I-III injuries are best treated conservatively. Grades IV-V injuries can also be treated conservatively in the selected cases. The major indications for surgery include haemodynamic instability, renal pedicle avulsion and associated intraabdominal injuries. Surgical treatment includes preservative and extirpative procedures. The mortality is largely due to associated injuries*
Recommendation: *A comparative study of the management of renal trauma in developed and developing countries is needed*
Keywords: *renal trauma, renal injuries, CT Scan, hematuria*

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I. Introduction

Renal trauma occurs in about 8-20% of all blunt and penetrating abdominal injuries[1,2]. The kidney is the third most commonly injured solid organ following blunt abdominal trauma [3]. There are regional differences in the mechanism and management options of renal injuries [4]. Factors which confer protection to the kidney from trauma include the size of the kidney, location in the bony cage of the ribs and the muscles of the posterior abdominal wall. The kidneys are located in the posterior abdominal wall, protected by the rib cage and spine postero-laterally and the anterior abdominal wall and the abdominal viscera anteriorly. Hence, it requires a large force to injure the kidney. This fairly large amount of force is responsible for the high incidence of associated injuries when the kidney is injured [5]

This report is a review of the mechanisms and current management of renal trauma with some discussion of the implications relevant in the developing world.

II. Materials and Methods

A Medline and Google scholar search from 1966 to December 2019 using the term ‘renal trauma’ and ‘renal injury’ was done to identify publications including reviews, prospective and retrospective studies on the subject. Information extracted from the publications included mechanisms of injury, age and gender of the victims, clinical features, investigations, treatment and outcome.

III. Mechanisms

Renal injuries may be from accidents, assault or of iatrogenic origin. Accidental blunt injuries may result from falls from heights [6,7,8] or road traffic injuries [7,9,10]. Iatrogenic renal injuries have been reported from uncommon procedures such as percutaneous nephrostomy [11], percutaneous angioplasty [12] and cardiac catheterization [13]. Iatrogenic loss of a kidney may result from exploration of a kidney that might otherwise be salvaged by non operative treatment [14,15]. Subcapsular haematoma from renal biopsies [16], chemical lumbar sympathectomy [17] and extra-corporeal shock-wave lithotripsy [18] may result in renovascular hypertension as in the Page kidney [19]. The mechanisms of renal trauma are broadly classified into blunt and penetrating injuries. Blunt trauma is further divided into direct and indirect trauma. Indirect trauma includes deceleration injuries. In adults and children, most renal injuries result from blunt abdominal trauma (BAT) [2,20-23]. Blunt trauma is commoner in less violent communities such as Poland [24,25]. In a retrospective study of 298 patients with renal trauma in a Military Medical University hospital in China, a presumed less violent society at the time of assessment, 91% of the injuries were due to blunt trauma [26]. Penetrating injuries are prevalent in the more violent societies such as USA, Canada and South Africa [27-29]. Studies in Nigeria show road traffic accidents and civilian violence as the predominant causes of renal trauma[30,31]. The term ‘high energy’ has been proposed to include being hit by clubs, helmets etc [4]. Deceleration(high velocity) injuries from road traffic accidents (horizontal deceleration) or falls from heights (vertical deceleration) occur from shearing forces when there is an abrupt change in velocity. These injuries affect mainly the renal pedicle [5,32,33].In a comparative study of adults and children involved in renal trauma [34], it was found that the main decelerating force was falls in children but road traffic accidents in adults. Penetrating injuries result from stabs [35] or missiles from gunshots wounds which may be high or low velocity [36].

Spontaneous rupture/haemorrhage has been reported [37,38] from sporting activities in young men [37] and in Wilms’ tumor [39]. Carlson et al reported sequential spontaneous bilateral rupture of the kidneys in a young man on long term haemodialysis resulting in acquired cystic disease of the kidneys [38]. Renal trauma from radiation as in total-body irradiation for bone marrow transplantation [40,41] has been recorded.

IV. Predisposing factors

Kidneys of children are more susceptible to severe injury than those of adults [34]**.** The reasons adduced include renal anomalies [42], the relatively large size of the kidney in relation to the rest of the body [43], unique anatomical features [44], lack of perinephric fat, pre-existing renal anomalies, pelvi-ureteric junction (PUJ) obstruction, weaker abdominal muscles and less ossified bony cage [43]. Renal anomalies especially with enlargement predisposes the kidney to injury from a rather minor force [21,32]. Enlargement may be from hydronephrosis [45], polycystic disease, pyonephrosis, pyelonephritis, amyloidosis and tumors [38,39]. The latter may sometimes be an incidental finding in an injured kidney [46]. Ectopic kidneys may also be vulnerable [47].

V. Pathology and Grading

Renal injuries are graded according to the American Association for the Surgery of Trauma (AAST) grading system which was first described in 1989[48]. This grading system which is based on gross pathology, was assessed in a prospective study and was found to be the most important variable predicting the need for renal exploration in renal trauma [49]. Buckley and colleagues in 2011 proposed a revision which stratifies all collecting system, renal pelvis and segmental vascular injuries into Grade IV, with only major devascularization as Grade V(Table 1) [50]. However, with improvement of Computed tomography technology with vascular assessment, the recent update of the AAST renal grading was done in 2018[51]. This incorporates “vascular injury”(i.e. pseudoaneurysm, arteriovenous fistula) into the imaging criteria for visceral injury[51].

Renal parenchymal injuries account for over 90% of renal injuries [4]. The lesions of the blood vessels include avulsion and thrombosis [37,48,52] as well as post traumatic renal artery dissection and stenosis [53]. Grading of renal trauma is done by computerized tomography (CT) scan preoperatively to guide decisions on treatment options. Renal exploration can modify the grade[50] and is considered most accurate for grading renal injuries when performed[54].

Table 1: Grading of renal injury on the American Association for the Surgery of Trauma organ injury scale

Grade*	Description
I	Contusions; haematuria ; normal urologic studies; non expanding subcapsular haematoma
II	Cortical laceration < 1cm; non expanding haematoma; confined perirenal haematoma
III	Cortical laceration > 1 cm; no collecting system disruption
IV	Laceration cortex to collecting system; renal pelvis injuries; segmental arterial and/or venous injuries
V	Shattered kidney; devascularised kidney ; main renal artery and /or vein injuries

* Advance one grade for bilateral injuries up to Grade III

Adapted & Modified from Buckley et al [50]

Table 2: Grading of renal injury on the American Association for the Surgery of Trauma organ injury scale (2018 revision)

Grade*	Description
I	Contusions; haematuria ; normal urologic studies; non expanding subcapsular haematoma
II	Cortical laceration < 1cm; non expanding haematoma; confined perirenal haematoma
III	Cortical laceration > 1 cm; no collecting system disruption
IV	Laceration cortex to collecting system; segmental renal artery or vein injury; avulsion of renal hilum, active bleeding into retropreritoneum
V	Devascularised kidney with active bleeding; avulsion of renal helium/laceration of the main renal artery or vein; shattered kidney

* Advance one grade for multiple/ bilateral injuries up to Grade III
Adapted & modified from Kozar et al[51]

As it requires rather minor trauma to injure an abnormal kidney, patients at risk of harbouring renal pathology are characterized by the association of renal injuries with mono-trauma, macroscopic hematuria and low impact velocity[55]. Such renal injuries are occasionally isolated. However, more commonly, there are associated injuries in blunt and penetrating renal trauma. The organs often associated with renal injuries include liver, spleen, colon, stomach; pancreas; diaphragm and duodenum [56-59]. Associated injuries are common in penetrating injuries [57,60]

VI. Clinical features.

Renal injuries occur more prevalently in the young (mean age 20-30 years) [54,59,60]. These are more exposed to trauma. Children are more susceptible than adults to renal injury from blunt abdominal trauma [34]. The kidney is the most commonly injured organ in children with blunt abdominal trauma [36]. Renal injuries occur more often in males than in females at all age groups [21,31,54,56,57,59]. This may be a reflection of the higher incidence of trauma among males compared to females in many reports [61]. However, a series on renal artery injuries reported 64% of the patients to be female [10].

Symptoms -A history of trauma is usually evident. This may include falls from heights, involvement in road traffic injuries, assaults or physical contact with a person or object. However, spontaneous rupture of the kidney often with an underlying abnormality or tumor has been reported [37,38]. Also a rather minor trauma which the patient cannot attribute to his / her predicament can be elicited.

Signs- Gross haematuria suggests significant renal trauma [37] but 'absence of haematuria does not exclude a serious renal injury' [62,63]. The degree of haematuria does not always correlate with the severity of the renal injury [7,57]. In severe haemorrhage the blood pressure may be low. The lowest systolic blood pressure is vital in the decision for either further investigations or surgical intervention [64]. Other physical findings may include loin mass and/or tenderness

A left sided preponderance was reported from Turkey in a series predominantly due to penetrating trauma [57].In a series of high-grade renal injuries in children, right sided injuries predominated over the left by 10:5 [65]. There is perhaps no predisposition of one side or the other. Renal artery injuries have been reported more on the left side than on the right. This has been explained by the protective natural course of the right renal artery under the inferior vena cava and duodenum [10,66].

VII. Investigations

Vital signs such as blood pressure and pulse rate are essential to evaluate and monitor the injured patient. Urinalysis is an important investigation regarding haematuria in a patient suspected to have renal injury but has its limitations. In monitoring renal trauma patients, serial estimations of haemoglobin concentration, urine colour, serum urea, electrolytes and creatinine as well as blood counts are essential. Abdominal examination should be done repeatedly for girth, signs of peritonitis and mass development. Diagnostic peritoneal lavage may be used when intrabdominal viscus rupture is suspected. Clinical evidence must be employed regardless of the lavage result. The investigation is invasive and nonspecific [48]. Laparoscopy may be used in cases suspected to have peritoneal penetration in tangential gunshot wounds. Such penetration may be an indication for laparotomy [28]

Specific guidelines have been sought to identify patients with suspected renal trauma who may benefit from further radiological investigations. It is emphasized that the decision for renal imaging should not be based on urinalysis alone but should include the clinical status of the patient, the history and mechanism of the injury [22]. There has been debate about whether the same criteria apply in adults and children. One study concluded that 'children with associated abdominal injuries and microscopic haematuria should undergo radiologic investigations [67]. Another studyconcluded that traumatic haematuria in children can be evaluated as in adults [46].

Suggested indications for radiographic evaluation in the renal injured patient include [64]:Penetrating trauma to the flanks regardless of degree of haematuria; Patients with blunt abdominal trauma and gross haematuria ; Patients with blunt abdominal trauma with microscopic haematuria and shock. However, recent guidelines indicate mandatory CT scan evaluation for all cases of renal trauma[51].

Plain radiographs in haemodynamically stable patients may include those of the abdomen and chest. An erect chest radiograph may show free air under the diaphragm in patients with ruptured hollow viscus. Associated fractures can be confirmed from appropriate exposures.

Ultrasound scan (USS) can be employed in both the stable and the unstable patients and can determine the presence of free peritoneal fluid. The investigation is non-invasive and rapid. These attributes recommend USS for screening of patients suspected to have renal trauma. In the context of blunt abdominal trauma, a specific study, focused abdominal sonography for trauma (FAST) scan is now in vogue to screen BAT patients [9]. USS also is valuable in the assessment of complications of renal trauma such as urinoma and renal abscess. However, it is insensitive for retroperitoneal blood and hollow organ injury [68]. Furthermore, it is observer-dependent.

Intravenous urography (IVU)has been largely abandoned but can be used in the absence of Computed tomography scan. It is usually done as an emergency pre- and intra-operatively as a single shot, high dose IVU [54]. In a patient that may be considered for nephrectomy, the investigation informs on the functional status of the contralateral kidney [54]. Absent renal uptake of contrast suggests a renal pedicle injury and requires immediate exploration [69]. However, other causes of non-uptake include traumatic renal artery thrombosis, poor renal perfusion from hypovolaemic shock and renal artery spasm [70]. Intraoperative (or on-table) IVU may be useful in a haemodynamically unstable patient undergoing an urgent laparotomy for trauma [54]. IVU is notorious for low yield in trauma [54,71,72] and there is a high rate of false-negative results [59,73]. In comparison with CT, IVU cannot detect nonurological injuries.Direct ante-grade injection of methylene blue into the collecting system may be used to identify ureteric injuries during renal exploration [54].

Angiography is a secondary tool to investigate patients suspected to have renovascular injury on IVU or CT scan [2,10]. In addition to lack of uptake in hilar avulsion, extravasation of contrast suggests lacerations. The procedure may also facilitate arterial embolization to control bleeding [9]. Angiography isbeing replaced by CT scan in the diagnosis and management of renal injuries [2].

CT Scan is adjudged to be the most comprehensive diagnostic tool for evaluation of victims of blunt trauma [8]. It is the investigation of choice, with a sensitivity of 100% reported in grade IV injuries in one study [50,74]. The trend to non operative management of Blunt abdominal trauma patients has been attributed to the successful staging of these injuries by CT scan [2,9]. CT is now the most widely employed investigative tool in renal trauma [20]. The use of CT scan identifies renal artery injuries than would otherwise have been missed [10]. Other lesions it can detect include parenchymal tears, perirenal haematomas and urinary and arterial extravasation and later, renal abscess [75] in addition to other solid intra-abdominal organs. It has been suggested that if conservative management of penetrating renal injury is contemplated, CT scan is necessary to serially evaluate and monitor the renal injury [28,74]. Modifications to the axial CT scan such as helical/spiral and multidetector scanners have improved the speed of this investigation [76]. Also, enhancing oral or intravenous contrast agents may be employed to increase accuracy of the study [77].

Magnetic resonance imaging (MRI) can detect even small amounts of peri and subcapsular haematomas, show the cause as well as monitor the course of bleeding [78]. It is useful in patients who are allergic to the contrast media employed to enhance the quality of CT scan [4,9]. However, it is not practical in the severely injured [8].

Radio-isotope renal scan with technetium 99m DMSA is useful in the follow up of patients with major renal trauma treated conservatively [56,60,79]and for relative cortical perfusion, quantification of parenchymal scar formation and determination of contributory renal function [80].

Investigations in renal trauma management may be diagnostic e.g. CT scan, IVU or prognostic e.g. scintiscan, IVU or USS. CT scan, MRI and laparoscopy have yet to be standard tools in the developing world. However, the other investigative tools listed above are eminently accessible. Judicious application of these investigative modalities and careful clinical observations should enable satisfactory management of most cases of renal trauma in the developing world environment. The routine combination of some of the above investigative modalities in centres of sophistication has been questioned from the economic perspective [81].

VIII. Treatment

The objectives in the treatment of renal injuries include salvage of the injured organ, prevention of infection and hypertension and reduction of mortality and morbidity, [28,57]. Over the years and based on clinical evidence, the management of renal trauma has evolved to a current preference for conservative nonoperative treatment in adults and children [7,9,37,50,70]. This applies to both blunt and penetrating injuries in the stable state with certain guidelines [82,83]. The increasing adoption of nonoperative treatment is encouraged by the availability of objective monitoring facilities like Ultrasound scan and multi slice CT scan [2,59].

The principles of management of the renal injured patient include bed rest for up to 14 days. The use of antibiotics to prevent infection that could result from the presence of urine extravasation, stasis in the injured renal tract and the presence of cannulas and catheters is advocated [20]. Pain relief should be employed bearing in mind not to sedate or render the patient incapable of proper serial clinical assessments. Urine monitoring is necessary for crude estimation of renal function and the progress or otherwise of haematuria.

In prospective studies of non-operative management in blunt abdominal trauma, independent risk factors for failure in renal injuries were positive FAST, need for blood transfusion and free fluid in the peritoneum by CT >300mls [2,3].

Table 3 Indications for Surgery (Renal exploration)

Haemodynamic instability [75,84,85]	
	Increasing rate of blood loss [84]
	Increasing abdominal swelling/Mass [85,86]
	Intraperitoneal trauma and peritonitis [2,87]
	IVU findings of nonvisualization of the injured kidney [69]
CT and US findings Grades IV and V renal injuries [9,84,86]	
Renal pedicle avulsion [9,48]	
	Severe hypertension [20]
	Renal abscess [60]

Failure of non-operative management prescribes surgical treatment. Indications for surgery in renal trauma(Table 3)may be classified as absolute including life threatening bleeding and renal pedicle avulsion or relative e.g. associated injuries [5]. There are several grey areas.

An important decision is when to abandon nonoperative treatment for renal exploration. The indications for exploration of the kidney include haemodynamic instability attributable to the kidney injury [20,86], expanding renal swelling [85,86] clinically or on USS or CT scan, associated intrabdominal injury including peritonitis which requires exploration on its merit [85] and Grades IV and V renal injuries including shattered kidney [84,86] as well as renal pedicle avulsion injuries [10,69] as indicated on CT scan or other imaging. Haemodynamic instability is determined by the rate of blood loss and need for blood replacement. Adults with systolic blood pressure <100 mm Hg and pulse rate >120 beats/min are considered to be haemodynamically unstable [20]

Lack of blood for replacement as often happens in the poorer environments reinforces the need for exploration. The IVU finding of non function of an injured kidney suggests renal artery disruption. This requires an urgent exploration if CT scan and angiography are unavailable for confirmation or further investigation. The finding of a retroperitoneal haematoma at laparotomy for trauma to another organ should lead to exploration of the haematoma unless the kidney was preoperatively staged to be amenable to conservative treatment. This practice has been advocated in order to identify such injuries as vascular fistulae [79,87]. Indications for surgery in penetrating renal injuries include severe blood loss, associated injuries or major renal trauma on CT scan as well as inadequate radiological investigations [5,14] and renal gunshot wounds [86,88]. In penetrating injuries of the kidney, opinion is divided between exploration for all cases [57,58,86] and selective exploration [59,79,89]. In one study, additional indications for laparotomy in a patient with renal injury included acute abdomen and denervated abdomen from spinal injuries [28]

Higher grade renal injuries have an increased chance of being subjected to exploration. This reached nearly 100% in one report on grade V injuries [50]. However, nonoperative treatment of grade 5 injuries has been reported in haemodynamically stable patients [14,90]

Surgical treatment

Two options in the surgical treatment of renal injury are preservative and extirpative. Preservative treatment is preferred. They are grouped together as nephron-sparing/renal salvage procedures which include partial nephrectomy, renorrhaphy using absorbable sutures and placement of a stent as in traumatic renal artery dissection [10,13,53]. Renal arterial embolisation is done as part of interventional radiology to control bleeding from the injured kidney [66,91,92]. Arterial and venous repairs may be done. The results are not encouraging partly because of irreversible renal damage from prolonged warm ischaemia time [93,94]. Stab renal wounds may be amenable to fibrin sealant [35] In renal salvage procedures in association with hollow organ repairs, separation of the renal injury by tissue interposition and use of drains is recommended [95].

Extirpative treatment is nephrectomy. The indications for nephrectomy include shattered kidney, renal hilar injury, renal vascular injury and haemodynamic instability attributable to renal injury [96]. In the presence of a functioning contra-lateral kidney, nephrectomy, instead of renal salvage, has been recommended for the kidney with significant vascular injury [10,60]. In adults with grade V injuries, immediate nephrectomy was found to be better than attempt at renal salvage with arterial repairs [60]. In the same study, children with grades IV and V treated with immediate nephrectomy or arterial repairs had a good outcome compared with expectant treatment. This contrasts with a recent report on high-grade renal injuries in children managed conservatively in which there was no late functional loss although the number was small[65]. Nephrectomy may be done for complications of renal trauma such as renal abscess [60].

There appears to be a higher nephrectomy rate in penetrating injuries than in blunt injuries [14,88]. Nephrectomy rate was initially high in grade V injuries reaching 90% in Grade V injuries in one study [97] and 100% in another [98]. However, recent studies show reduced nephrectomy rates to as low as 59% in grade V injuries[99,100,101]. In damage control situations, an otherwise salvageable kidney may have to be resected [10,28,58,96]. Nephrectomy may be chosen to obviate the occurrence of coagulopathy or hypothermia that may result from prolonged operation or multiple blood transfusions [5].

In the context of the developing world with poor investigative resources, perhaps, exploration in patients with clinical indications should be done in accord with the recommendations on patients who are inadequately investigated pre operatively because of the urgency of the situation [4]. Eke et al reported 14 nephrectomies out of 62 urologic trauma cases [102]. A more recent study in the same centre by Ekeke and Anyadike, reported only a single nephrectomy in 186 genitourinary trauma cases [30]. This may be due to more investigative modalities and increase in use of conservative measures.

Histopathology: Specimens removed at nephrectomy should be subjected to histopathological examination in spite of the gross appearance of the specimen. Occasionally a traumatized kidney harbours other disease conditions such as a malignancy [46]. Besides, the gross appearance may be misinterpreted for a different pathology [103].

IX. Complications/Follow up

Urine extravasation often results from Grades III-V renal injuries. This may resolve spontaneously in many patients, especially in blunt trauma injuries [70]. In a few cases, extravasation may lead to renal infection or accumulation of urine in or adjacent to the kidney (urinoma) [5]. Placement of drainage tube or ureteric stents [20,66]may occasionally be required. Associated complications of extravasation include UTI and renal abscess [70,101].

Secondary haemorrhage often occurs when a tamponading haematoma gives way to cause renal artery pseudoaneurysm or arterio-venous fistula (AVF) or gross haematuria [104]. It occurs between a week and a month of injury [105]. Treatment options range from masterly inactivity through angiographic embolization [91,92] to nephrectomy.

Hypertension is a complication of renal injury and may be associated with renal insufficiency [106,107]. It has been reported in 4-10% of renal-injured patients [90]. The causes of post traumatic renal hypertension include renal infarction, renal scarring, hydronephrosis, chronic renal infections, vascular injury and parenchymal compression [108]. Hypertension has been recorded as early as the 6th day following renal pedicle injury [108] but may develop decades after injury [109]. The incidence of post-traumatic renovascular hypertension is reduced in patients with renal artery injury managed nonoperatively with endoscopic stenting[110]. The mechanism for post traumatic renal hypertension in the presence of normal renal function is thought to be excess release of renin in renal ischaemia [111].Renalischaemia may result from compression of the renal parenchyma by perirenal haematoma, subcapsular urinoma [112] or from direct renovascular injury. The term Page kidney has been ascribed to 'hyperreninemic hypertension induced by renal ischaemia from compression of the renal parenchyma by a perirenal or subcapsular process' [112]. Page kidney occurs mainly in young persons,[18] but has also been reported in a newborn [113-115]. A renal AVF may cause renovascular hypertension [116]. Renal insufficiency may result from the trauma per se when there is loss of renal mass or from the effect of renal arterial embolization. Post traumatic renovascular hypertension in a patient with a solitary kidney may rapidly lead to renal failure [117]. Acute or chronic renal failure may also occur in renal trauma even after nephrectomy as the function of the remaining kidney deteriorates in function [60]. Loss of function may be due to scarring and renal tissue loss in high grade renal injuries [56].

Patients with renal trauma should therefore be followed up with checks on blood pressure and its medical treatment. However, there is worldwide reported low return of patients for follow-up [2,20,59,118]. Hypertension requires investigation of renal function by renal scintigraphy. If the injured kidney is found not to function, it should be removed. Nephrectomy of the damaged or nonfunctioning kidney is expected to resolve renal hypertension [119]. In the presence of a post-traumatic encapsulation of the kidney, capsulectomy has been recommended [120]. Nephrectomy may subsequently be done if hypertension is not relieved by capsulectomy.

Compensatory hypertrophy in a contralateral kidney may result when an injured kidney is removed or loses its function. This has implications of increased susceptibility to injury from minor forces. Other rare complications of renal trauma include renal artery pseudoaneurysm [121], renal abscess [75] and renal artery dissection [13,53] which may be treated with stenting.

There is significant morbidity in renal trauma regardless of operative or nonoperative treatment. Hospitalization is imperative. The most important factor in mortality from renal trauma is associated injuries rather than nephrectomy or other treatment[20,59,60,96]. Delays in treatment have also accounted for mortality in renal trauma [57] .

X. Conclusion

Blunt renal trauma is more prevalent than penetrating renal injuries. Associated injuries are high as the force required to injure the kidney is significant. Children can be managed along the same protocols as adults with more attention due to issues with communication.

Conservative management is universally preferred in minor (Grades I-III) injuries provided that imaging facilities such as CT scan are available. Surgical management is generally advocated for Grade IV and V injuries. However with appropriate CT Scan monitoring, conservative or minimal invasive treatments may be used.

A prospective or retrospective comparative multicentre study of the present practice in the developing and developed settings is needed with regards to the management of the renal injured patient.

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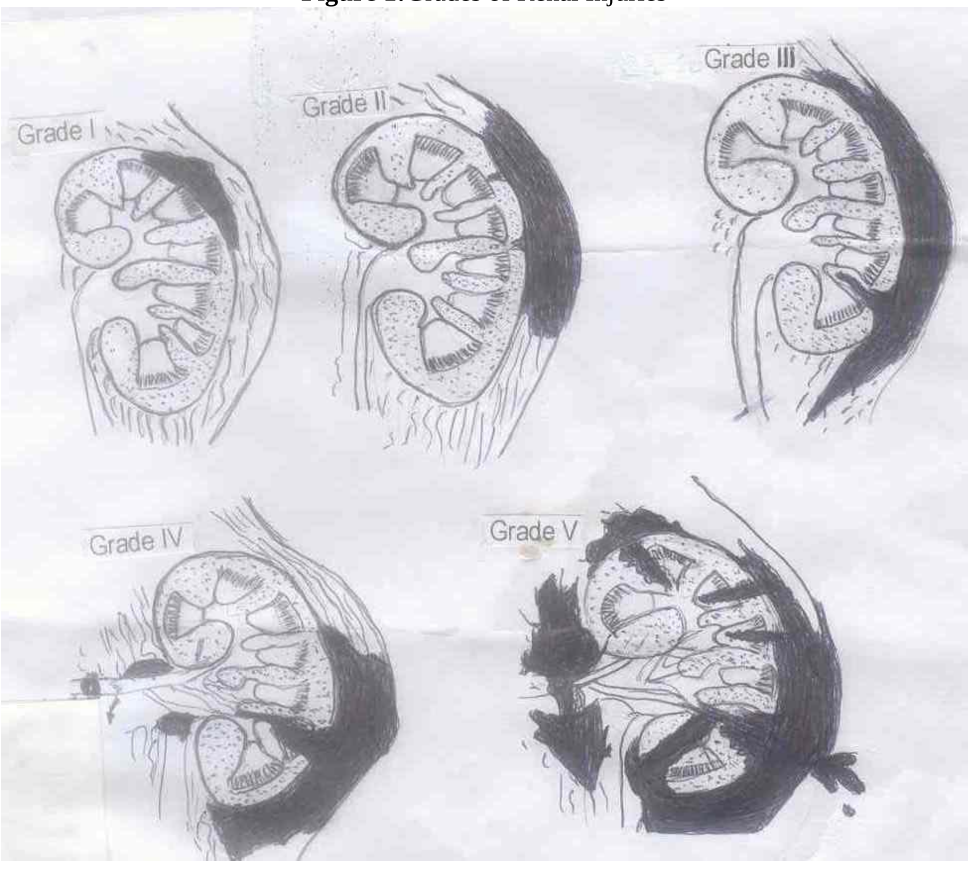
Figure 1: Grades of Renal Injuries



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