TRAUMA OF THE UPPER URINARY TRACT

Timothy Terry

Typical victims of urinary tract trauma

- Young men while performing a sporting activity (55% of cases)
- People in road traffic accidents (25% of cases)
- Victims of domestic or industrial accidents (15% of cases)
- Victims of assault (5% of cases)

In the United Kingdom over 90% of renal injuries are a result of blunt abdominal trauma. Important associated injuries occur in about 40% of patients with blunt renal trauma. A high index of suspicion of a renal lesion is required in the patient with multiple injuries as the signs and symptoms of the renal trauma may be obscured by those of the concomitant injuries.

In children the kidney is the organ most commonly injured by blunt abdominal trauma. This may be explained by the relative lack of perinephric fat in children and the incidence (of up to 20%) of pre-existing renal abnormalities (primary pelviureteric junction obstruction is the commonest).

Mechanism of direct blunt renal trauma. An external force (F_1) may crush the kidney (K) between the 12th rib and the vertebral column, or a force (F_2) may crush the kidney against the paravertebral muscles (quadratus lumborum (QL) or psoas major (in position P but deleted from diagram)).

The mechanism of renal injury due to blunt abdominal trauma may be direct or indirect. With a direct injury the kidney is either crushed between the anterior end of the 12th rib and the lumbar spine—such as in sporting injuries—or between an external force applied to the abdomen anteriorly just below the rib cage and the paravertebral muscles—such as in run over accidents and injuries caused by seat belts and steering columns. Indirect injury occurs when a deceleration force is applied to the renal pedicle (as a result of falling from a height and landing on the buttocks). Such injuries can tear the major renal vessels or rupture the ureter at the pelviureteric junction.

Penetrating renal trauma occurs in about 7% of patients with abdominal stab wounds. As with blunt renal trauma associated injuries are often present (in up to 80% of cases); these affect the liver, lungs, spleen, small bowel, stomach, pancreas, duodenum, and diaphragm in descending order of frequency. Renal stab wounds are potentially serious, with the possibilities of severed major renal vessels and lacerations to the collecting system or upper ureter. Gunshot wounds that involve the kidney may be caused by a low or high velocity missile. Low velocity missiles cause injury by directly penetrating the tissue whereas high velocity missiles produce direct tissue injury plus damage to adjacent tissue because of the shock wave effect see chapter on blast injuries.

Classification of renal trauma

Classification of renal injuries

Minor (85%)

- Contusions
- Superficial lacerations (capsule and pelvicaliceal system intact)

Major (10%)

- Deep lacerations (capsular tears or pelvicaliceal involvement, or both)

Critical (5%)

- Renal fragmentation
- Pedicle injuries (renal artery thrombosis, vessel avulsion, and pelviureteric rupture)

Renal injuries can be classified as minor, major, or critical, based on the clinical and radiological assessments of the patient. Minor injuries (contusions and superficial lacerations) consist of parenchymal damage without capsular tears or involvement of the pelvicaliceal system. Major injuries (deep lacerations) consist of parenchymal damage with capsular tears or extension into the collecting system, or both. Critical injuries include kidney fragmentation and injuries to the pedicle (such as renal artery thrombosis, avulsion of renal vessels, and rupture of the pelviureteric junction).

Clinical presentation

Clinical signs of renal trauma

- Regional skin lesions (abrasions, bruising, and entry and exit wounds)
- Loin tenderness
- Loss of loin contour
- Loin mass
- Gross haematuria (up to 90% of cases)

Severe abdominal and flank ecchymosis with potential urological injury (caused by a seat belt).

Most patients (80-90%) with direct renal trauma give a history of a blow to the flank and complain of loin pain, which is followed after a variable period by gross haematuria. The haematuria may be subsequently accompanied by ureteric colic caused by the passage of blood clots. Clinical examination may show skin abrasions or bruising overlying the upper abdomen, loin, or lower thoracic area. Rigidity of the anterior abdominal wall and local loin tenderness over the affected kidney are invariably elicited. A flattening of loin contour together with a palpable loin mass indicate the presence of a perinephric haematoma with or without urinary extravasation of contrast dye. In such cases a paralytic ileus may be present. Varying degrees of hypovolaemic shock may be present, but this is usually secondary to associated injuries.

About 70% of potentially lethal injuries to the renal pedicle (indirect trauma) do not cause gross haematuria. Patients with such injuries are usually in severe shock, having been brought to hospital after a fall from a height. The same mechanism, in a milder form, usually produces intimal tearings of the renal vessels, which can lead to thrombosis.

The victim of a penetrating renal injury caused by a low velocity missile or stab wound will have an obvious entrance wound. The depth and direction of the wound track and the site of the exit wound, when present, suggest the likelihood of renal involvement.

Radiological investigations

Findings on intravenous urography

Control film

- Fractures (of lower ribs and transverse processes of lumbar vertebrae)
- Loss of psoas shadow
- Loss of renal outline
- Loin mass (displacement of bowel or diaphragm)

Postcontrast film series

- Distortion of caliceal pattern
- Contrast extravasation
- Non-visualisation of part or whole of caliceal system

Excretory urogram with extravasation of dye.

The standard investigation in patients suspected of having a serious renal injury is intravenous urography. This includes all patients with gross haematuria and those with microscopic haematuria and a systolic blood pressure <90 mm Hg. Haemodynamically stable patients with microscopic haematuria have minor renal injuries and do not require urography.

The preliminary control film shows abnormalities in about 15% of patients with blunt renal trauma. These abnormalities include pneumothorax or haemothorax; concomitant fractures of ribs and the transverse processes of lumbar vertebrae; scoliosis with concavity towards the side of injury; loss of psoas shadow or renal outline due to perirenal haematoma; a soft tissue loin mass displacing bowel shadows or raising the ipsilateral hemidiaphragm; and free intraperitoneal gas. In 85% of patients with blunt renal trauma the postcontrast series of radiographs shows no abnormalities. The appearances in the remainder are those of distortion of caliceal pattern, extravasation of contrast dye into the perinephric tissues, or failure to visualise any part or the whole of the caliceal system. These findings suggest the presence of a major or critical renal injury, and the appearance in the intravenous urogram of a normal contralateral kidney is reassuring.

If patients with blunt trauma are clinically stable further information on the precise state of the damaged kidney (the presence of parenchymal disruption, intrarenal or subcapsular haematomas, and perirenal collections) may be gained by renal ultrasonography. This technique is particularly valuable for imaging injuries to the kidneys that are not visualised in the urogram and for following the natural course of perirenal collections. Computed tomography with enhancement with an intravenous radiocontrast agent, although a popular technique for investigating blunt abdominal trauma, is unlikely to give any additional information in patients with renal trauma over that provided by intravenous urography with nephrotomography and complemented with ultrasonography. Selective renal arteriography is indicated in patients with vascular pedicle injuries whose condition is stable and in patients with macroscopic haematuria persisting longer than one week. In the rare cases in which the mode of the accident and the findings on urography suggest the possibility of disruption of the pelviureteric junction a retrograde ureterogram is necessary.

Management of renal trauma

- Treat hypovolaemic shock
- Stage renal injury radiologically
- Treat patients with stable minor and major renal injuries (up to 95% of cases) expectantly
- Operate on patients with critical and unstable major renal injuries

(Left) Retroperitoneal incision sited over the aorta medial to the inferior mesenteric vein to isolate the renal vessels before opening Gerota's fascia. (Right) The left renal vein crosses anterior to the aorta. With this vein retracted superiorly the left and right renal arteries may be located arising from the aorta.

Expectant management of renal injuries

- Make serial clinical observations (pulse, blood pressure, temperature, urine aliquots, abdominal palpation)
- Institute strict bed rest
- Give appropriate analgesia
- Give prophylactic antibiotics
- Perform serial renal ultrasonography

Late complications in renal trauma

- Hypertension
- Arteriovenous fistula
- Hyponephrosis
- Formation of pseudocysts or calculi
- Chronic pyelonephritis
- Loss of renal function

The principle underlying the management of patients with renal trauma is conservation of the maximum number of functioning nephrons with minimal morbidity and mortality. The immediate management of any individual patient is determined, however, more by the patient's general clinical state and the presence of important associated injuries than by the mode and type of renal injury. Less than 5% of all renal injuries are by themselves life threatening, and hypovolaemic shock in a patient with renal trauma is nearly always secondary to the presence of concomitant injuries. The initial general clinical assessment of the patient is thus all important in deciding a plan of supportive and definitive treatment.

In patients with blunt renal trauma urgent surgical exploration for critical injuries (renal fragmentation and pedicle injuries) is mandatory. A generous midline abdominal incision allows complete assessment of the abdomen for concomitant injuries while providing access to the entire length of both ureters, the kidneys, and the vascular pedicles. If conservative renal surgery is being contemplated the ipsilateral renal vessels must be isolated and controlled before Gerota's fascia is incised. Partial nephrectomy may be possible in some patients with fragmented kidneys, but usually total nephrectomy is necessary. Lacerations to the major renal vein may be debrided and sutured. If renal artery thrombosis has been diagnosed within 10 hours of injury thrombectomy, excision of the damaged arterial segment, and direct end to end reanastomosis may be considered. Disruption of the pelviureteric junction is treated by spatulation of the ends and reanastomosis over a ureteric stent.

Minor renal injuries (contusions and superficial lacerations) and major injuries (deep lacerations), which together comprise about 95% of cases of closed renal trauma, are initially managed expectantly. Strict bed rest, appropriate analgesia, and prophylactic antibiotics (cephradine or trimethoprim) are instituted together with frequent serial clinical observations of vital signs and assessment of any loin swelling. Once the vital signs are stable ambulation is allowed only after gross haematuria has cleared (serial aliquots of urine are kept for comparison) and the perirenal swelling, if present, has clinically resolved.

Whether to perform early surgery in patients with major renal injuries is a controversial issue, but it is clearly indicated in those rare cases in which primary haemorrhage or secondary haemorrhage at 10-14 days, usually due to infection, endangers life. The late complications (after six weeks) of major renal injuries that may require surgery include hypertension, arteriovenous fistula, hydronephrosis, formation of pseudocysts or calculi, chronic pyelonephritis, and loss of renal function. Regular follow up is necessary in patients with major renal trauma during the first year after injury if these late complications, of which hypertension is the most common, are not to be missed.

Most penetrating renal stab wounds and all gunshot wounds involving the upper urinary tract require immediate surgical exploration to exclude or treat associated injuries, to assess and repair renal or ureteric damage, and to allow wound debridement.

Finally, an unsuspected penetrating or blunt renal injury may manifest itself at emergency laparotomy performed to control massive intra-abdominal bleeding in a patient with trauma. The clinically silent renal injury manifests itself as a retroperitoneal haematoma. In such cases on table intravenous urography is essential to establish the presence of a normal functioning contralateral kidney and to determine the type of injury to the damaged kidney. The retroperitoneal haematoma should be explored only if a critical injury is identified in the urogram or if the haematoma is large and is seen to expand during laparotomy. In either case the renal vessels must be controlled before opening Gerota's fascia, otherwise the possible use of conservative renal surgery may be jeopardised.

The illustration depicting ecchymosis and the urethrogram were supplied by the department of medical illustration, St Bartholomew's Hospital.

The line drawings were prepared by the department of education and medical illustration services, St Bartholomew's Hospital.

Mr Timothy Terry, FRCS, is consultant urologist, Leicester University Hospitals.

The ABC of Major Trauma has been edited by Mr David Skinner, FRCS; Mr Peter Driscoll, FRCS; and Mr Richard Earlam, FRCS.

ANY QUESTIONS

What is erythema migrans (geographical tongue) and how should a woman in her 70s with the disease be treated?

This common condition attracts attention either when the tongue becomes more sensitive (particularly to acidic fruits or spicy foods) or when the small red patches which characterise the condition have spread out to form red migrating, irregular shaped areas of alarmingly increasing size. The aetiology is unknown and there is no specific treatment. There is, however, a wide ranging differential diagnosis which can aggravate the anxieties of a well read patient. The following list is not exhaustive but is meant to be helpful. A painful "burning" tongue of normal appearance occurs in middle aged and elderly women; such glossodynia may be due to cancerphobia, which requires a positive diagnosis and early detection if it is to respond effectively to counselling. A smooth red tongue may be associated with deficiencies of iron, vitamin B-12, and folic acid all of which readily respond to specific treatment. The small painful aphthous ulcers which are also common to the tongue are multiple and recurrent and easily distinguished from the milky white and red bottomed lesions caused by candidiasis. If the lesions affect the lips herpes should be considered and if the patient is acutely ill with an obviously ulcerated mouth which is opened with difficulty the doctor should not overlook the life threatening Stevens-Johnson syndrome. Lichen planus, drug induced agranulocytosis, and acute leukaemia may all affect the tongue but are accompanied by systemic features which assist the diagnosis. The term used to describe geographical tongue (erythema migrans) is close to that of erythema chronicum migrans (Lyme disease) with which it should not be confused.

—BRIAN LIVESLEY, professor in the care of the elderly, London

At what stage is an operation advisable for carpal tunnel syndrome?

As it passes through the carpal tunnel the median nerve is the most commonly compressed peripheral nerve. Such compression gives rise to symptoms and signs associated with carpal tunnel syndrome. The degree of nerve compression and therefore the symptoms vary from mild and intermittent to severe and continual. The indications for operative treatment are based on an ability to stage the degree of compression by accurate history taking and physical examination.

A patient with mild median nerve compression may present with intermittent symptoms of numbness or tingling in the hand or digits in the median nerve distribution. The most commonly affected finger is the middle, with the whole of the hand next.¹ The patient is often awoken at night and symptoms are exacerbated by activities, relieved by rest and elevation. It is not uncommon for symptoms of pain and discomfort to radiate into the forearm. Examination shows a positive Phalen's test (flexion of the wrist with symptoms evident within one minute) and possibly hypersensitive vibratory perception in the thumb and index finger when compared with the little finger. Two point discrimination is normal and there is no muscle wasting.

A moderate degree of compression is characterised by a positive Phalen's test and diminished vibratory perception with alteration in light touch sensibility. Otherwise, the history and findings on examination are similar to those of mild compression. Severe median nerve compression is associated with continual and often painful sensory symptoms. Wasting of the thenar muscles may be apparent, with associated weakness of the short thumb abductor. Two point discrimination will be abnormal indicating changes within the sensory fibres.

Surgical treatment is based on the above staging:

(1) For mild compression a regimen of splinting is indicated in the first instance with regular assessments carried out at three monthly intervals. If symptoms are improved after the first three months a trial of night splinting alone is continued for a further three months. Should there be a deterioration decompression of the carpal tunnel is indicated. Surgery may be performed under local, regional, or general anaesthetic depending on the patient's fitness and compliance. If surgery is contraindicated steroid injections into the carpal tunnel may give welcome, albeit temporary, relief.²

(2) Patients with moderate compression syndrome have often been treated conservatively before referral, and as a result surgical decompression of the carpal tunnel is indicated. If a trial of night and day splinting has not been carried out this is worth trying for three months in the first instance.

(3) Severe carpal tunnel compression is best managed by surgical decompression without trial splinting.

Electrodiagnostic studies are certainly helpful, but cannot and should not replace accurate history taking and careful physical examination as these studies do not always give an accurate idea of the severity of the problem.³—R W NORRIS, consultant plastic surgeon, East Grinstead

1 Mackinnon SE, Dellon AL. *Surgery of the peripheral nerve*. New York: Thieme Medical Publishers, 1988.

2 Mackinnon SE, Hudson AR, Gentili F, et al. Peripheral nerve injection studies with steroid agents. *Plast Reconstr Surg* 1982;69:482-90.

3 Grundberg AB. Carpal tunnel decompression in spite of normal electromyography. *J Hand Surg* 1983;8:348-9.

A claim has been made about the value of boron in the treatment of menopausal symptoms. Is there any justification for this claim?

This claim is made by a company called Life Plan, which markets boron supplements. The claim seems to be based at least partly on some work published in the United States in 1987.¹ The authors studied 12 postmenopausal women consuming a low boron diet and found that a boron supplement of 3 mg a day reduced the urinary excretion of calcium and magnesium and increased serum concentrations of 17 β -oestradiol and testosterone. They suggested that supplementing a low boron diet induced changes consistent with the prevention of calcium loss and bone demineralisation and that boron may be an important nutritional factor determining the incidence of osteoporosis. A more recent United Kingdom study was not able to replicate these findings (H Peace et al, seventh international symposium on trace elements in man and animals, May 1990). The authors found that a boron supplement of 3 mg daily had no effect on sex steroid concentrations or bone mineral excretion in postmenopausal women.

Although boron may have an influence on calcium metabolism under certain circumstances, it seems unlikely that it plays any part in the development or treatment of postmenopausal osteoporosis.—LINDA BEELEY, director, Drug and Therapeutics Unit, Birmingham

1 Nielsen FH, Hunt CD, Mullen LM, Hunt JR. Effect of dietary boron on mineral, estrogen, and testosterone metabolism in postmenopausal women. *Federation of American Societies for Experimental Biology Journal* 1987;1:394-7.