For cats with access to the outdoors, road traffic accidents (RTAs) represent a significant hazard – in the UK, they rank as the fourth most common cause of death after old age, cancer and renal failure. Cats involved in RTAs are typically young males (mean age 16 months), which sustain trauma to multiple body systems, including the bony pelvis and adjacent soft tissues. Due to the relatively large surrounding muscle mass, great forces are required to cause pelvic fractures and concurrent non-ortho-paedic injuries are seen in 59–72% of cases. Pelvic fractures are considered a true emergency in humans, due to the high risk of rapid, fatal haemorrhage. In contrast, cats (and dogs) rarely die acutely as a direct result of pelvic fractures, but can suffer significant morbidity and mortality due to associated injuries to adjacent soft tissue structures.

Initial triage and management
Major body systems assessment
When a cat is presented following an RTA, initial assessment should always include a primary survey of the major body systems, to identify and treat any potentially life-threatening injuries.

- **Cardiovascular system** Evaluate heart rate and rhythm, mucus membrane colour, capillary refill time and pulse quality. Packed cell volume/total solids should be checked at presentation and 24 h later. Although fatal haemorrhage is rare following pelvic fractures, bleeding may be severe or prolonged enough to produce significant anaemia, necessitating a blood transfusion, or other support (e.g., Oxyglobin; Biopure Corporation), prior to general anaesthesia for surgery.

- **Respiratory system** Observe respiratory rate and character, then carefully and systematically auscultate the thorax. Lack of normal lung sounds may indicate the presence of abnormal fluid (haemothorax) or viscera (ruptured diaphragm). Gentle palpation may detect rib fractures.

Wound management during triage
Large wounds, grazes or open fractures should be covered with sterile dressings/support bandages during triage, and then fully assessed and treated when the cat is stable.
Neurological evaluation of the cat with pelvic trauma

Abdominal assessment The abdomen should be carefully palpated to evaluate bladder integrity and continuity of the body wall (ie, any ruptures or prepubic tendon injuries), and to assess pain. The abdomen may feel ‘empty’ if abdominal contents have displaced into the thorax through a ruptured diaphragm.

Neurological system An in-depth neurological examination is not necessary during triage: the key aspects to assess are mentation, gait and pain perception. In cats with pelvic trauma, careful assessment must be made of hindlimb deep pain, and anal and perineal reflexes (see box above). Lumbosacral plexus damage and sciatic nerve entrapment are both seen with pelvic trauma. Peripheral nerve injury is common (reported incidence of 13.9%), but usually resolves (Fig 1).

Pudendal nerve reflexes
- Anal sphincter reflex can be tested using a thermometer – on withdrawal, the anal sphincter should close normally.
- The bulbocavernosus reflex is demonstrated by a sharp contraction of the anal sphincter in response to a squeeze of the bulb of the penis or the clitoris.
- The perineal reflex is present if there is contraction of the anal sphincter in response to stimulation of the perineal region.
- Urethral sphincter tone is assessed by manual bladder expression (this tests external urethral sphincter tone).

Motor and sensory function of the tail
Coccygeal nerve function is assessed by pinching the tail at different levels using haemostats and observing for tail movement and cerebral acknowledgement of pain (eg, vocalising or turning round).

Analgesia
Following initial assessment, appropriate analgesia must be provided. Non-steroidal anti-inflammatory drugs (NSAIDs) should be avoided initially, as many cats with pelvic trauma will be hypovolaemic, and risks may be compounded by renal insufficiency in older cats. Rather, opioids are the drugs of choice.

- A full agonist is recommended as the first-line treatment (morphine or methadone; 0.1–0.4 mg/kg IM/slow IV/SC q4h).
- There is some evidence that the partial agonist buprenorphine (0.01–0.03 mg/kg IM/IV/SC/sublingual q6h) may be an acceptable alternative to morphine in cats.
- Fentanyl patches (25 µg/cat) are useful for longer term analgesia, but therapeutic levels of analgesia are not reached for up to 24 h, so they must be combined with other analgesia initially.
- Pethidine (2–5 mg/kg) is not generally useful due to its short duration of analgesia (up to 1–2 h); it should only be administered IM, and animals become resentful of repeated administration.
- Butorphanol is not appropriate as it provides only a short duration (up to 45 mins) of weak analgesia, and its sedative effects make it difficult to assess pain.

Prerequisite to opioid use
It is important that deep pain is assessed prior to administration of opioids, which can mask normal responses.

Withdrawal of a limb in response to a toe pinch does not confirm the presence of deep pain.

MULTIMEDIA
A video recording showing assessment of reflexes associated with urinary function is included in the online version of this article at: 10.1016/j.jfms.2011.03.011
The ‘tail pull’ cat – sacrococcygeal nerve injury

During an RTA, the tail may become trapped underneath a car wheel; the resultant traction can cause subluxation/luxation or fracture at the tail base and stretching of the sacrococcygeal nerve roots/cauda equina, colloquially known as a ‘tail pull injury’ (Fig 2). Depending on the extent of damage to the nerves, affected cats may present with a flaccid tail, bladder paralysis and/or urinary incontinence.

Cats with tail pull injuries are difficult cases to manage: the severity of nerve damage cannot be ‘measured’ and, therefore, the likelihood and extent of recovery is difficult to predict. While cats with neuropraxia (nerve bruising) should have a good prognosis for full recovery, those with completely severed nerves (neurotmesis) clearly will not.

Diagnosis

Depending on the type of neurological injury, a cat may either have a large bladder that is difficult to express (‘upper motor neuron bladder’), or a soft bladder that is easy to express (‘lower motor neuron bladder’). Urinary incontinence can be seen in both scenarios.

There is a high degree of correlation between urinary and faecal continence, because of the common dependence on pudendal and pelvic nerve function. Therefore, if anal tone is decreased, it is likely that urinary incontinence will also be present.

Careful neurological assessment is critical.

Prognostic indicators

The presence of an intact anal reflex is a positive prognostic sign for return of urinary function. In addition, intact pain sensation (within 5 cm of the tail base, assessed within 48 h of the trauma) is strongly predictive of early return of bladder control. However, absence of tail base pain sensation does not preclude eventual recovery, as 60% of cats without sensation at the tail base will also recover.

Good owner communication is essential, given that it is not possible to predict whether a cat will recover or will remain incontinent, and the bladder has to be managed in the meantime. Cases may be complicated by concurrent pelvic fractures, which cannot be left untreated for 4–6 weeks to ‘wait and see’ if the cat becomes continent.

The prognosis based on a case series of 51 cats with sacrococcygeal injuries was good for return of normal urinary function in cats that had intact anal reflex and perineal sensation at the time of initial presentation. If normal urination returned, it did so between 2–30 days (mean 13 days). Every cat that could not urinate normally within 1 month remained incontinent during the 2–36 month follow-up period. Tail function may take several months or longer to improve. In the same study, tail function returned to its fullest extent between 7–150 days (mean 31 days). For this reason the authors do not recommend early tail amputation.

Of 51 cats with sacrococcygeal injuries, every cat that could not urinate normally within 1 month remained incontinent during the 2–36 month follow-up period.
Placing and managing a cystostomy tube

Placement

✜ With the cat in dorsal recumbency, clip and surgically scrub the abdomen from the xiphoid to caudal to the pubis, ensuring the clip extends laterally to mid-flank on both sides. Make a caudal midline abdominal incision from the umbilicus to the pubis.

✜ Gently move the bladder against the left abdominal wall to see where it will comfortably sit.

✜ In that location, push against the inner abdominal wall with a Kelly (curved) haemostat and then make a small incision from the external abdomen, cutting down onto the tips of the haemostat using the scalpel blade. Gently push the haemostat tips through the incision (from inside the abdomen to outside) (image a).

✜ Using either a mushroom-tipped tube (Bard Urological Division, CR Bard, GA, USA) or, preferably, a silicone-based Foley catheter (8–14 Fr silicone), grasp the Foley/mushroom end of the tubing with the forceps and pull it into the abdomen from outside (image b).

✜ Pack off the bladder from the rest of the abdomen using moistened laparotomy swabs. Count all swabs used.

✜ Place a stay suture (2 metric monofilament) in the cranial pole of the bladder to facilitate atraumatic manipulation (image c).

✜ Place a purse-string suture in the ventral or ventrolateral aspect of the bladder, towards the apex (using a 2 metric slowly absorbable monofilament suture [eg, polydioxanone, PDSII; Ethicon]). Although many authors recommend only including the submucosa with the sutures, this is often practically difficult and full-thickness bites of bladder wall are acceptable. Make a stab incision in the middle of the purse-string suture, preferably with a number 11 scalpel blade, and insert the catheter tip into the bladder. If using a Foley catheter, the bulb should be inflated with an appropriate volume of saline solution (image d). The purse-string suture is then tightened (image e).

✜ To reduce the risk of leakage of urine into the abdomen, place four simple interrupted sutures between the bladder wall (non-lumen or lumen penetrating) and the abdominal wall to create a ‘box pexy’ around the tube (image f). A slowly absorbable suture material (eg, PDS) should be used for this and omentum can additionally be wrapped around it.

✜ The abdomen should be lavaged with warm sterile saline, prior to routine three-layer closure of rectus fascia, subcutaneous fat and skin.

✜ The tube should be secured with a ‘Chinese finger trap’ or ‘Roman Sandal’ suture pattern using 3 metric nylon or similar non-absorbable suture material, anchored to the skin (image g). The tube should be connected to a closed urinary bag collection system or incorporate a bung or three-way tap for intermittent emptying. A small self-adhesive sterile dressing should be applied to the tube where it enters the skin. It is also helpful to place a small body stockinette (Surgifix size 4 or 5; Smith & Nephew) to prevent the tube getting caught and becoming dislodged.

Maintenance

The tube should be drained three or four times a day and must remain in place for at least 7–10 days to allow the pexy to seal. Unless an infection develops at the stoma, routine cleaning of the area is not recommended. If early inadvertent removal occurs, the cat must be checked for the presence of uroabdomen with radiographs/ultrasound ± abdominocentesis.

Removal

If a Foley catheter was used, it is deflated, the Chinese finger trap suture is cut, a hand is placed against the body wall, and then traction is applied to the tube – you often have to pull very hard!(Although rare, it is possible for the tip of a mushroom-tipped catheter to break off – should this occur a cystostomy would need to be performed in order to remove it. For this reason, we generally prefer to use a silicone Foley catheter.) The stoma will heal by second intention and does not require surgical closure. This procedure, therefore, can be undertaken in the conscious or sedated animal.

Risk of infection

The development of a UTI is not uncommon, and it is difficult to eliminate infection when a tube is in place. Development of ascending infections can be minimised by good practice: wearing examination gloves when draining the tube, and cleaning the end of the tube where the syringe is connected with alcohol. Prophylactic antibiotic use is not recommended, as this will only select for resistance; when indicated, antibiotics must be used judiciously.
Options for bladder management
Appropriate management of the cat's bladder is of primary importance to ensure that it does not overdistend and overstretch the tight junctions, leading to irreversible damage. Irrespective of the management approach, animals with neurological bladder dysfunction will often have a concurrent urinary tract infection (UTI) and, therefore, urinalysis and urine culture should routinely be performed. Routine antibiotic ‘cover’ is not recommended, however, as it predisposes to resistant infections.

Daily manual expression
Manual expression may be appropriate in the short term if the bladder is easily expressed, but may eventually become painful and distressing to the cat. It is not possible to completely empty the bladder manually, and so residual urine volume should be checked periodically by ultrasound or catheterisation, as large residual volumes will predispose to UTIs. If continence is not regained within a few days, an indwelling catheter can provide further time for improvement or a tube cystostomy can allow longer term management.

Indwelling catheterisation
Indwelling catheterisation simplifies management and prevents urine scalding in the short term. Intermittent catheterisation (every 6–8 h) is associated with a lower risk of UTI than an indwelling catheter; however, it may be more traumatic and can trigger urethral spasm. In the authors’ opinion, if continence is not regained within 5 days, then a cystostomy tube should be placed.

Tube cystostomy
Tube cystostomy is a recognised technique for urinary diversion that allows stress-free management of cats with tail pull injuries. It is a relatively straightforward surgery to perform (see page 350), and may also be performed as an emergency procedure (eg, where urethral obstruction cannot be managed by catheterisation), or electively (eg, where detrusor muscle activity has been affected).10–12 Complications such as catheter dislodgement and subsequent uroperitoneum can occur;13 however, with good surgical technique this is extremely unlikely. In the authors’ experience, most cats tolerate cystostomy tubes surprisingly well for several months, and most owners are happy to manage these cats at home. However, if normal urination has not returned within a month or two, then it will not, and the ethics of life-long cystostomy tube use may be questionable. In addition, the longer the cystostomy tube is present, the greater the risk of UTI and potential ascending infection leading to pyelonephritis and renal damage.

If continence is not regained within 5 days, a cystostomy tube should be placed.

Medical treatment
Depending on the type of neurological dysfunction, medical management (Table 1) can be used to facilitate manual bladder expression, or as a means to encourage normal urinary function while a catheter or cystostomy tube is in place.

<table>
<thead>
<tr>
<th>Rationale</th>
<th>Drug</th>
<th>Dose</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>For urethral spasm</td>
<td>Prazosin</td>
<td>0.25–1 mg PO q12h or q8h</td>
<td>1st choice treatment Avoid in hypotensive patients</td>
</tr>
<tr>
<td></td>
<td>Phenoxybenzamine</td>
<td>1 mg/kg PO q8h</td>
<td>2nd choice treatment Avoid in hypotensive patients</td>
</tr>
<tr>
<td>To encourage bladder emptying</td>
<td>Bethanechol</td>
<td>1–2 mg/kg PO q12h or q8h</td>
<td>This drug is best used as a last resort and should not be used if the cat's bladder cannot be expressed manually (ie, with markedly increased urethral sphincter tone), or the bladder may rupture. It can also cause diarrhoea, so treatment should be started with a low dose</td>
</tr>
<tr>
<td>NB These drugs can take several days to work and are often required in combination</td>
<td></td>
<td></td>
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Urinary tract trauma

Diagnosis
Damage to the urinary tract is common with pelvic trauma, but is easily missed as clinical signs can be vague and non-specific, and may take some time to become apparent. Early signs include haematuria, dysuria, abdominal pain and/or distension, lack of a palpable bladder, free abdominal fluid, and abdominal and perineal bruising. Any animal with rising urea and creatinine levels should be investigated further, as this may indicate post-renal azotaemia developing as a result of leakage of urine from a tear or rupture in the bladder or urethra.

Urinary tract integrity
The ability of a cat to urinate or the presence of a palpable bladder does not indicate an intact urinary tract – a cat with a bladder tear can still pass streams of urine.
Either plain radiography or ultrasound examination can be used for initial evaluation and assessment of the bladder or the presence of free abdominal fluid.

**Radiography**

A plain lateral abdominal radiograph should be assessed for:
- increased opacity/loss of detail within the abdomen or retroperitoneal space, indicative of fluid (blood, urine, bile or exudates);
- free abdominal gas, which could indicate rupture of a hollow viscus or a full-thickness body wall rupture.

The retroperitoneal space runs linearly from the diaphragm to the pelvis, ventral to the vertebrae and dorsal to the intestines, and usually contains the kidneys and ureters. The kidneys are generally easily visualised because of the presence of large amounts of perirenal adipose tissue. However, the ureters are too small to be visualised. Urine extravasation or haemorrhage relating to the kidneys or ureters may be identified by a generalised opacification of this area with obscuring of the kidney(s). Although substantial renal or ureteral damage is rare, if suspected, intravenous excretory urography should be performed (Fig 3).

**Ultrasound examination**

On abdominal ultrasonography any abnormal accumulations of fluid within the abdomen will appear as hypoechoic regions (black pockets). If only a small volume of fluid is present, it will most likely be found around the bladder neck and liver lobes.

**What to do when urinary tract rupture is suspected**

Abdominocentesis should be carried out: it is a safe and well-tolerated procedure, even when performed blind, but is often more successful if performed under ultrasound guidance.

Abdominocentesis can be undertaken with the cat standing or in lateral recumbency. If ultrasound is available, needle placement is determined by observing fluid next to the abdominal wall. If abdominocentesis is to be performed blind, initially sample the right cranial quadrant of the ventral abdomen by advancing a 21 G needle slowly through the abdominal wall, without a syringe attached. Fluid may drip out of the hub and can be collected for analysis. If no fluid is retrieved, a 2.5 ml syringe can be attached and a small amount of suction applied. If this too fails to produce fluid, continue to four-quadrant abdominocentesis, following the same procedure in the right caudal, left cranial and left caudal zones. Depending on the type, severity and duration of injury, the volume of fluid retrieved may vary from a few drops to many millilitres.

Abdominocentesis is a safe and well-tolerated procedure, even when performed blind, but is often more successful if performed under ultrasound guidance.

The origin of the fluid is determined by its cytological and biochemical characteristics. The fluid can be tested in a biochemistry machine: if the creatinine level is higher than normal plasma levels, the fluid is urine. If bacteria are seen on cytology, rapid surgical intervention is required. If no bacteria are seen, uroperitoneum can be managed in the acute stages of stabilisation by abdominocentesis, and placement of a urethral catheter.

**Further evaluation of the urinary tract**

If free urine is identified within the abdomen, the bladder cannot be identified after 12 h of hospitalisation, or there is ongoing suspicion of undisclosed urinary tract trauma (rising azotaemia with no clear cause, necrosis of hindlimb soft tissues, or no urination after 12–24 h) then contrast studies should be performed.
The most common type of urinary tract trauma involves the bladder or urethra, and this can be investigated by performing a positive-contrast retrograde urethrocystogram (see box above). Contrast seen outside of the bladder or urethra is diagnostic of rupture. If rupture is strongly suspected, but no contrast is seen outside the bladder on the initial radiographs, the cat should be left in the appropriate position and a further small volume (2–5 ml, dependent on the cat’s weight) of positive contrast should be instilled into the bladder, and the radiographs repeated.

If the radiographs or ultrasound examination indicate fluid within the retroperitoneal space, an intravenous urogram is performed (see box below) to investigate possible damage to the kidneys or ureters, although this is quite rare.

**Management of bladder rupture**

Bladder rupture is the most common organ damage associated with pelvic fractures. It can occur due to a full bladder being compressed and bursting on impact following blunt trauma, from penetrating fracture fragments, or due to bruising resulting in localised areas of necrosis. In a recent unpublished survey of 110 cats with pelvic fractures, 12 cats (10.9%) suffered lower urinary tract trauma, eight involving the urethra and four involving the bladder. The cats with concurrent urinary tract injuries were reported to have a worse outcome than those with pelvic fracture(s) alone.

Bladder contusion is suspected when mild haematuria is present in an otherwise well cat with normal urinary function, and such cases
Pelvic fractures account for 20–22% of all feline fractures. Bladder rupture is the most common organ damage associated with pelvic fractures.

should be managed conservatively. Small tears in the bladder wall may go undetected and can be expected to heal spontaneously.

Larger tears require surgical debridement of tissue (where indicated) and repair. However, if the cat is not sufficiently stable for anaesthesia, short-term management by regular abdominocentesis or passing of a urinary catheter can be used for 24 h while the cat is stabilised.

Management of urethral trauma
Urethral trauma can result in bruising, rupture or varying degrees of obstruction, and tends to occur almost exclusively in male animals due to their longer, narrower urethra. If the urethra is ruptured, urine will leak and slowly accumulate within the abdomen, pelvic canal or subcutaneous tissues, resulting in azotaemia and uraemia. Accumulation of urine within the subcutaneous tissues of the caudal abdomen and hindquarters results in tissue necrosis, which will usually take at least 24–48 h to become apparent. Urinary diversion is therefore a priority to reduce urine leakage, either via placement of an indwelling urinary catheter, or via surgical placement of a cystostomy tube.

Partial ruptures of the urethra may heal once urinary diversion has been achieved, and larger defects can also heal if an intact strip of urethral mucosa remains. A transurethral catheter should be maintained for 3 weeks, while healing occurs; however, strictures can be a frequent complication, potentially due to the presence of the catheter itself. Currently there is no clear evidence as to whether urethral catheters or cystotomy tubes are less likely to result in stricture formation.

Definitive urethral surgery should be performed, as necessary, but is beyond the scope of this review (see Fossum for further reading). Referral should be considered.

Management of renal or ureteral damage
Renal or ureteral damage may require anastomosis, stenting or re-implantation. Such surgery is complex and delicate, requiring specialist equipment and training. If referral is not an option, and ureteral/renal damage is unilateral, ureteronephrectomy is a viable alternative. (See Fossum for further reading.)

Pelvic fractures
Pelvic fractures account for 20–22% of all feline fractures. In 103 cats with pelvic fractures, 90% involved the pelvic floor, 60% had sacroiliac luxation and 48.5% had iliac body fractures. It is common for combinations of these fractures to be seen (Fig 4).

Specific orthopaedic examination
Following stabilisation and appropriate analgesia, a full orthopaedic examination should be performed. Observe whether the cat is able to stand unsupported or ambulate. Gently palpate the dorsal aspects of the pelvis for symmetry between the two ilial wings, or palpable crepitus, and exert gentle pressure over the ilial wings cranially to determine if there is sacroiliac discomfort. Manipulate individual joints, checking for instability or

Bladder surgery
A caudal ventral midline exploratory laparotomy should be performed. The bladder should be packed off from the rest of the abdomen with sterile moistened laparotomy swabs (count them!). A temporary stay suture (2 metric monofilament, full thickness), should be placed in the ventral cranial pole of the bladder to facilitate bladder manipulation without overtly or repeatedly traumatising the bladder wall.

The ventral, dorsal and lateral aspects of the bladder should be carefully examined. Damage to the bladder will usually be evident as haemorrhage and bruising. Any heavily traumatised/necrotic areas should be trimmed using delicate scissors so that sutures are placed into viable tissue. The trigone is the critical area: as long as the trigone remains intact, 75% of the bladder can be removed and the bladder will still heal and eventually regain normal size and function. Viable edges can be sutured using a single-layer appositional closure (ie, simple continuous or simple interrupted) with the knots placed extraluminally; sutures should preferably not penetrate the lumen. Alternatively, a two-layer appositional or single/two-layer inverting pattern can be used.

Monofilament absorbable suture material is preferred (eg, monocryl or PDS), 1.5 or 2 metric in size. Sutures should be quite tight to facilitate a seal and should be spaced 3–5 mm apart and from the edge. The integrity of the repair should be tested by injecting sterile saline into the bladder, and this will also help to identify any other damage that might have been missed. Should there be concern, the repair can be oversewn using a Lembert or Cushing inverting pattern, or a serosal patch (usually jejunum) can be placed.

Although the bladder itself is weak, it heals quickly, regaining near 100% of presurgical strength by 14–21 days post-surgery.
other orthopaedic trauma; an acetabular fracture, for example, may be indicated by pain on hip manipulation.

If possible, a careful rectal examination should be performed when the cat is sedated or anaesthetised, to assess the degree of displacement of any pelvic fractures and the resultant pelvic canal width. The anal sphincter reflex should have already been assessed as part of the initial evaluation of the patient, but should be re-evaluated at this stage.

**Decision making**

The traditional belief has been that pelvic fractures in cats can usually be managed conservatively. However, there is no evidence to support this, as few studies exist that consider how the cat’s quality of life is affected in the long term. As a profession, we should be aiming to give all our patients as good a quality of life as possible, and not simply basing our decisions on whether they can ‘manage’.

In human orthopaedics, the question of whether plain radiographs are adequate for fracture assessment, or whether advanced imaging such as computed tomography (CT) is necessary, is the subject of much debate. A recent veterinary study found that, in practical terms, plain radiography is often sufficient, as although 60% of fractures were misclassified (on configuration), this did not significantly affect the surgical plan. In that study, ilial fractures were consistently detectable on radiographs but the degree of comminution and spatial orientation was more obvious on CT. Acetabular fractures were more readily evaluated on CT, however, and this imaging modality was helpful for determining whether or not they were reconstructable.

**Orthopaedic versus neurological problem**

It can be difficult to differentiate between orthopaedic disease and neurological damage, particularly if the cat is in pain, and so repeated examination may be necessary.

**Diagnostic imaging**

Orthogonal lateral and ventrodorsal radiographs (Fig 5) are essential for proper assessment of fractures, and this is particularly true of pelvic fractures, where additional oblique views may be required. Radiographs should be taken under sedation or general anaesthesia to facilitate proper patient positioning, as poorly positioned radiographs can be very misleading. In human orthopaedics, the question of whether plain radiographs are adequate for fracture assessment, or whether advanced imaging such as computed tomography (CT) is necessary, is the subject of much debate. A recent veterinary study found that, in practical terms, plain radiography is often sufficient, as although 60% of fractures were misclassified (on configuration), this did not significantly affect the surgical plan. In that study, ilial fractures were consistently detectable on radiographs but the degree of comminution and spatial orientation was more obvious on CT. Acetabular fractures were more readily evaluated on CT, however, and this imaging modality was helpful for determining whether or not they were reconstructable.
General guidelines for surgical versus conservative management of pelvic fractures are given in the box above.

**Surgical management of specific fractures**

**Ilial fractures**

Ilial fractures are common, usually easy to diagnose and can be technically straightforward to repair. The ilium is part of the weightbearing axis, and so surgical stabilisation is beneficial in most cases. The most common configuration of ilial fracture is a long oblique fracture; however, transverse (Fig 6), comminuted and ilial fractures with concurrent acetabular, ischial and pubic injuries are seen. Medial displacement of fragments (Fig 6) can decrease the width of the pelvic canal leading to increased risk of constipation and subsequent obstruction (Fig 7). In such cases, cats may have to undergo pelvic osteotomy and/or subtotal colectomy at a later stage. These procedures are much more invasive, and associated with significant potential morbidity: it is, therefore, preferable to repair the ilial fracture on original presentation.

Ilial fractures are most commonly repaired using a lateral plate and screws (Fig 8). However, other fixation methods have been reported including use of Kirschner wires, lag screws (for long oblique fractures) and interfragmentary wiring.

Although a lateral bone plate is a successful and relatively straightforward method of treating ilial fractures, the only study evaluating long-term outcome in cats revealed a 62% screw loosening complication rate, and all cats suffered varying degrees of pelvic canal narrowing in the follow-up period. An alternative option is to place a plate on the dorsal aspect of the ilium and, in one study, this was associated with a significant reduction in screw loosening and pelvic canal narrowing, but was more technically challenging (Fig 9).
Sacroiliac fractures/luxations are common in cats that suffer blunt trauma to the hindquarters, and account for 27% of pelvic orthopaedic injuries. Due to the rigid box-like structure of the pelvis, they are always accompanied by other fractures, or are bilateral where the pelvis has been shunted cranially. Management may be surgical or conservative, depending on whether the luxation is unilateral or bilateral, and the degree of discomfort, displacement and instability.

Due to the rigid box-like structure of the pelvis, displaced sacroiliac fractures are always accompanied by other fractures, or are bilateral.
Acetabular fractures

Acetabular fractures account for 17.5% of feline pelvic fractures, but can be easily missed, as affected cats can show remarkably mild clinical signs. Oblique lateral pelvic radiographs may be required to identify and characterise the fractures, due to superimposition of the femur on standard views. Do not mistake the normal growth plate within the acetabulum for a fracture line in cats that are under 5–6 months of age and/or neutered.

Acetabular fractures are articular and, therefore, require perfect anatomical reduction and rigid internal fixation, ideally with interfragmentary compression (Fig 11). However, in cases of highly comminuted fractures, reconstruction may be impossible, and a femoral head and neck excision is a viable alternative, and relatively straightforward to perform (Fig 12).

Early studies on acetabular fractures in small animals suggested that the cranial and central thirds of the acetabulum were the load-bearing areas, and that the caudal third of the acetabulum was non-load-bearing. However, this is contradicted by a more recent experimental evaluation of the feline acetabulum during various phases of weightbearing, which demonstrated that weightbearing was focused over the central and caudal thirds of the acetabulum. The decision to manage acetabular fractures conservatively should not, therefore, be based on their location, but rather on the key factors of degree of displacement, comminution, concurrent injuries and pain. Long-term evaluation of cats with acetabular fractures managed

The most common method of surgical fixation is placement of a screw in a lag fashion from the ilial wing into the sacrum, with or without a transiliial pin (Fig 10).
Long-term evaluation of cats with acetabular fractures managed conservatively has shown that many develop a painful hip and muscle atrophy. Therefore, surgery is usually recommended.

**Acetabular fracture: surgical tips**

- A dorsal approach to the hip, including a trochanteric osteotomy or gluteal tenotomy, provides good exposure of the acetabulum.
- The sciatic nerve should be identified and protected.
- Incising the joint capsule allows visualisation of the intra-articular surface for fracture reduction.
- A mini-approach to the ischial tuberosity and placement of bone-holding forceps facilitates manipulation of the caudal fragments.
- Fracture reduction can be maintained using pointed reduction forceps or a temporary Kirschner wire.
- The preferred location for implants is the dorsal aspect of the acetabulum. However, contouring a plate to this region is difficult. Use a reconstruction plate or acetabular plate (prior contouring of the plate will save a significant amount of time).
- Ensure that screws do not penetrate the articular cartilage of the concave surface of the acetabulum – this may be visualised, or detected by gently running a small probe across the cartilage.
- If the fracture line is transverse through the middle of the acetabulum, placing one screw on either side of the fracture line, with orthopaedic wire between the screws in a figure-of-eight pattern and tightened, can work well. Bone cement is then placed over and around the wire (it is essential to protect the sciatic nerve from the exothermic reaction at this stage, using copious lavage).
- Repair of acetabular fractures requires a high level of skill and experience, and referral to an orthopaedic specialist should always be considered.

**Postoperative management**

**Analgesia**

All cats should receive postoperative opioids, preferably a full agonist for 24 h followed by a partial agonist for a further 24–72 h, depending on the level of discomfort. Where appropriate, many benefit from multimodal analgesia, and treatment with NSAIDs (e.g., meloxicam).
All cats with pelvic fractures, whether managed conservatively or surgically, should have strict cage rest for up to 6 weeks.

Rest

All cats with pelvic fractures, whether managed conservatively or surgically, should have strict cage rest for up to 6 weeks. Physiotherapy may be helpful once sutures/staples are removed after 10–14 days. When there is radiographic evidence of healing, a graduated increase in indoor exercise is allowed for 2–4 weeks before allowing full outside access again.

Defecation

Cats with pelvic trauma can become constipated and faecal softeners (eg, lactulose) or the use of enemas can be important for comfort.

Follow-up examination

All cats that have undergone surgery should be re-radiographed at 3–4 weeks (if skeletally immature) or 6 weeks (if skeletally mature), to assess fracture healing.

Implants

Implants are typically not removed unless there is a problem associated with them (eg, loosening, infection, implant failure). Such problems are unusual.

References


