PELVIC FRACTURES: MANAGEMENT, TREATMENT AND COMPLICATIONS

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JON MILLS and ANDY WHITTINGHAM look at the surgical options available when confronted with this type of fracture, focusing on conservative management and internal fixation

PELVIS fractures are very common in small animal practice and they can be a challenge to manage. Conservative treatment can often work well, but early patient mobilisation and comfort are often much improved by timely surgical intervention.

Surgical treatment is desirable if:

• the weight-bearing axis is compromised, especially if this is bilateral;

• acetabular fracture(s) are present involving the weightbearing part of the acetabulum. Injuries involving the cranial and the dorsal parts of the acetabulum are more significant than those involving the caudal and ventral parts;

• pelvic dimensions are significantly compromised, with risks of future obstipation or dystocia; or

• pain management and convalescent nursing care are otherwise problematic.

Most pelvis fractures occur after high-energy trauma sustained during road traffic accidents and accompanying injuries are common.

The patient may have other problems that can greatly affect the treatment plan and the prognosis, including:

• shock and/or hypovolaemia;

• thoracic injuries, including ruptured diaphragm and pneumothorax;

• CNS trauma, with implications for prognosis, anaesthesia and opiate use;

• spinal injuries;

• sacrococcygeal fracture/ luxations;

• urinary dysfunction; and

• cranial/maxillary/mandibular injuries affecting the normal ingestion of food through altered mentation, olfaction or mechanical ability to ingest normally.

Diaphragmatic rupture is not uncommon after a road traffic accident. This can be clinically silent at presentation. Similarly, signs of peritonitis following biliary trauma can be delayed and insidious.

Sacrococcygeal fracture/ luxations – "tail pull" injuries – may seriously compromise pelvic nerve function, but these fracture/luxations may not be obvious in one radiographic plane and orthogonal pelvic radiographs are required.

Urinary dysfunction may still be present in the absence of radiographic evidence of vertebral displacement. Return of urinary function may not occur at all after spinal/sacrococcygeal injuries. If function does return, it may take weeks – long after the opportunity for internal fixation of fractures has passed. It may be desirable to fix pelvic fractures before urinary function has returned for reasons of patient comfort, mobility and before the fractures become too problematic to reduce.

In this case, the owner must be counselled that, in the event that urinary function does not return, they may end up considering euthanasia a few weeks down the line. The caudal rectal/ pudendal nerve supply to the anus and the pelvic nerve supply to the bladder/urethra both involve the S1 to S3 nerve roots. The continued absence of an intact anal reflex and the absence of tail sensation within a couple of weeks of the injury are poor prognostic indicators for the ultimate return of urinary function.

Nerve damage during pelvic trauma and limb disuse in the convalescent phase can both lead to dramatic hamstring muscular atrophy in the weeks following pelvic trauma. Owners should be counselled to expect this atrophy, as it can be a shock for them, even if the eventual outcome is good.

The lumbosacral nerve trunk, running medial to the iliac wing, can be impinged if the caudal part of the ilium displaces craniomedially (Figure 1). Fractures of the ischium often rotate distally under the pull of the hamstring muscles that originate from the ischial fragment. There may be sciatic nerve impingement by sharp craniodorsal features of the caudal fragment (Figure 2). Sacral nerve roots can be impinged by sacral fracture/luxations, which often pass through one or more of the sacral foramina.

Preoperative assessment should include as full a neurological examination as possible. This should include assessment of the anal reflex and tone, and assessment of tail sensation and movement. The sensation of the hind feet must be assessed. Digit two has femoral innervation and digit five has innervation derived from the sciatic nerve. Check for the presence of voluntary movement of the hindlimbs. In a recumbent, frightened, painful, potentially aggressive animal, subtle neurological deficits are easily overlooked.

The pelvis is a ring-shaped, rigid structure. A break in this ring structure implies interruption in at least two places – in the same way that a mug handle never breaks in just one place.

Pelvic fractures commonly involve combinations of:

• iliac wing;

• sacroiliac joint with or without sacral fragments;

• acetabulum; and

• ischium/pubis/pelvic symphysis.

Common management of various pelvic fractures:

• sacroiliac separations are typically treated conservatively or fixed with screws;

• iliac wing fractures are typically plated;

• acetabular fractures are typically plated, or occasionally managed conservatively – with or without delayed femoral head and neck excision;

• ischial fractures are typically treated conservatively or plated; and

• pubis fractures are almost always treated conservatively.

Conservative management

Conservative management of pelvic fractures involves analgesia, urinary management, cage rest, assisted lifting and physiotherapy. Conservative management is often appropriate when pelvic dimensions aren't seriously compromised, or when general anaesthesia is a problem for medical or financial reasons.

The pubis and the pelvic symphysis are commonly fractured in association with other pelvic injuries. They are typically not repaired, as they are not part of the weight-bearing axis, but simply provide for muscular attachments. Even if the whole floor of the pelvis is displaced, this can usually be managed conservatively. Occasionally, pubis and symphyseal fragments can cause serious lacerations to the urethra, necessitating reduction and fixation with wire sutures. Sometimes, a pubic fragment might be repaired as part of an abdominal rupture repair. Care needs to be taken to spare the obturator nerve that passes through the obturator foramen craniolaterally.

Sacroiliac luxations are often managed conservatively. If there is marked displacement, fixation may be considered. Sacral fracture/luxations often involve nerve impingement and require internal fixation with screws, transilial pins/bolts or locking plates.

Sacrococcygeal luxations are managed conservatively, as they are not amenable to surgical stabilisation. Tail amputation may be necessary to prevent a paralysed tail from getting caught on objects in the environment in the future, but this is best delayed for a few weeks until inflammation has settled down. Cage confinement until such time as tail function returns or the tail is amputated is wise to prevent further "tail-pull" injuries.

Concurrent bilateral sacroiliac luxations, ventrally displaced symphyseal fracture and sacrococcygeal luxation can all be managed conservatively ([Figure 3]).

Fractures of the caudal third of the acetabulum and of the medioventral part of the acetabulum can often be managed conservatively, whereas dorsal and cranial acetabular fractures require internal fixation with plates for best functional outcome.

Conservative management can be appropriate for ischial fractures, but internal fixation with plates may be indicated if there is pain from sciatic nerve impingment or if there is significant involvement of the acetabulum ([Figure 2]). Ischial tuberosity growth plate fractures are managed conservatively ([Figure 4]).

Conservative management is not usually recommended for fractures of the ilium and the craniodorsal acetabulum if surgery is an option. Plating relieves any nerve impingement and anatomical reduction allows rapid mobilisation and the best hope for return of good function.

Internal fixation

Sacroiliac luxations are typically treated conservatively or they are reduced and lag-screwed.

Where significant compromise of pelvic dimensions results from sacroiliac luxation(s) with concurrent pelvic floor fractures, the pelvic shape can often be very satisfyingly restored with nothing more than one or two well-placed sacroiliac screws.

The approach to sacroiliac luxations is easy. Division of the muscle dorsal and medial to the iliac crest exposes the luxation gap between the sacrum and the iliac wing. However, the target area for screws in the lateral sacrum is small. The lateral face of the sacrum is not in the sagittal plane. Yet this is the surgical reference plane. If the drill is positioned perpendicular to the lateral sacral face, there is a high chance of inadvertently drilling into the L7-S1 intervertebral space. So the drill needs to be aimed off caudally by 10 degrees or so.

Care also needs to be taken to judge the drilling position between the dorsal and ventral borders of the sacrum to avoid drilling too far dorsally into the neural canal, and to avoid drilling too far ventrally into poor bone stock. To avoid inadvertently drilling too deep, use a sharp drill bit that can be controlled without the addition of much pressure. Consider seating the drill bit deeply in the chuck to limit the length of drill bit that is exposed beyond the chuck. Consider cutting a length of sterile drip tube to create a made-to-measure drill sleeve that allows the depth to be more accurately assessed during drilling.

Also, consider drilling with a pin rather than with a drill bit, with just a short amount of pin exposed beyond the chuck. Although the trochar tip of the pin generates more heat than a drill bit does, using a pin has two advantages over a drill bit. Firstly, breakage is far less likely. Secondly, in the extremely undesirable event of the pin penetrating the neural canal, a pin is less likely to “grab” delicate soft tissues.

Probe the depth of the drilled hole with a thinner pin – there should be a “bottom” to the hole. Assess the depth of the hole and choose a screw that won’t quite reach the bottom. If a screw did hit the bottom, continued turning of the screw would then strip the threads. When bilateral luxations are fixed, there is the further potential problem of implant conflict if either of the screws crosses the midline (Figure 5

Fracture/luxations of the sacroiliac junction often involve the sacral foramina and accurate reconstruction is challenging. The cancellous bone, especially if comminuted, can appear horribly unfamiliar and confusing. The target area for screws can be just a few square millimetres. The sacral nerve roots are waiting to be trapped between bone fragments or to be impinged by drills and implants. Traditional fixation with screws or transilial pins/ bolts requires accurate reduction and introduces compressive forces at the fracture site.

The availability of affordable locking plates in recent years has greatly facilitated the fixation of many challenging pelvic fractures, including sacral, iliac and acetabular fractures. Screws “lock” into threads engineered into the locking plate, as well as gripping in threads cut into the underlying bone. Locking plates function in the same biomechanical way as external fixators. Locking plates do not require any plate-bone contact, so they do not need to be precisely contoured to the bone surface as a conventional plate does. The locking plate is roughly contoured to allow screws to be angled to purchase the underlying bone. The “string of pearls” (SOP) plate is a commonly used and affordable locking plate. SOP plates are easy to contour with their dedicated plate benders. They can be twisted along their axis, bent up or down and bent in or out.

During contouring, the threads in the SOP plate are protected from deformation by the placement of temporary inserts. Once the first screw is placed in a locking plate, further manipulation of the plate’s position is limited to rotation of a few degrees around the first screw. Once the second screw is placed, there is absolutely no freedom to further adjust the plate position, and hence the directions of subsequent screws are dictated by the orientations of their respective holes as they are now aligned. So, although locking plates don’t require precise contouring to fit the bone surface, it is important to check all plate holes that will receive screws are correctly orientated to the underlying bone before the second screw is placed.

Locking plates can be placed as a bridge between the iliac crests. This is technically easy and anatomically safe. The locking plate is bent into a “U” shape that is slightly narrower than the desired final gap between the iliac crests. The plate is positioned dorsal to L7 between the iliac wings under the epaxial muscles (Figure 6). It is first attached to the stable iliac crest with screws. The iliac crest on the fractured side is then manipulated into position and the plate is screwed into the second iliac crest to complete the fixation. In this way, sacral fractures are robustly buttressed without compression and without the need to place implants near the fracture.

SOP plates are ideal for this placement because they can be contoured with exceptional freedom and yet remain strong implants. A contoured SOP plate is still just as strong as an untouched dynamic compression plates (DCP) of comparable size. SOP plates are engineered so the “nodes” (the sections with the holes) and the “inter-nodes” (the sections between the holes) have similar stiffness. So the stiffness profile along the SOP plate is far more uniform than is the case for other plates where the sections containing holes are much weaker than the neighbouring solid sections. In a plate that is bent through 180° to fit a transilial placement, weak points would otherwise act as stress risers and be potential sites for failure.

Locking plates are ideally suited to neutralising or buttressing iliac fractures when there is limited bone cranial to the acetabulum for the placement of the distal screws. They are also useful for neutralising or buttressing acetabular fractures, a location in which the contouring of a conventional plate can be challenging. In both situations the distal screws can purchase ischial bone caudal to the acetabulum. The sciatic nerve can either sit in the gap between the plate and the ischium, or the plate can be passed deep to the sciatic nerve as the nerve courses distally (Figure 6).

For iliac wing fractures, the most common fixation employs conventional plates placed laterally. Attaching the plate to the caudal fragment first can assist in subsequent reduction of the fracture.

When the ilium is drilled in a lateromedial direction, care must be taken to avoid iatrogenic damage to the lumbosacral trunk. The main drawback of placing conventional plates laterally on the iliac wing is that stripping of screw threads is relatively common because the screws are engaged into thin bone stock. This can occur during placement as screws are tightened, or during load bearing in the postoperative period. Screws that cross the iliac wing and purchase some sacral bone have increased pull out resistance. Screws engaged into locking plates don't strip threads as they are tightened and they can't "toggle" loose during loading in the same way that screws placed through conventional plates can. A locking plate construct is less inclined to fail in a poor bone-stock environment than a conventional plate system.

In the fracture illustrated in Figure 7 there was a fractured iliac wing with severe reduction in pelvic dimensions. There was also contralateral sacroiliac luxation and craniodorsal coxofemoral luxation. Simple, robust conventional plating, using all of the available right iliac bone, re-established pelvic dimensions and restored the weight-bearing axis of the left hemipelvis. One of the proximal iliac screws had some sacral bone purchase, increasing its pull-out resistance. The other injuries were addressed with conservative or delayed surgical management.

Figure 8 shows a segmental fracture comprising a long oblique fracture of the iliac wing and a more caudal fracture of the ischium and the caudal, non-weight bearing part of the acetabulum. The iliac fracture was reduced with the help of a trochanteric osteotomy to increase exposure. Prior to plate placement, dorsal and ventral hemicerclage wires facilitated reduction of the oblique iliac fracture. The locking plate buttressed the iliac fracture, though a DCP could have been used instead. The ischial/ acetabular fracture was managed conservatively.

For the traditional lateral access to the iliac wing, a "rollup" of the gluteal muscles is often enough. When more access is needed, a trochanteric osteotomy allows the gluteal muscles to be reflected dorsally. Pre-drilling the greater trochanter before completing the trochanteric osteotomy with a saw, an osteotome or Gigli wire saw, makes closure much easier. These approaches can be combined with a caudal approach to the coxofemoral joint, allowing good visualisation of the sciatic nerve. Access to bone caudal to the acetabulum can be increased by sectioning the tendons of insertion of the outward rotators of the hip. The tuber ischii is approached caudal to the biceps femoris muscle.

Plates, whether conventional or locking, can be positioned dorsally on the iliac wing (Figure 9). This allows screws to engage into a greater depth of bone with less chance of screw thread stripping than is the case with lateral plate placement. However, the target area that is then presented for screw placement is smaller with dorsal plating and any plate needs to be very accurately aligned with the bone.

Locking plates are especially useful to avoid the challenges of accurately contouring a conventional plate over the acetabulum. A dorsal approach for plating of the pelvis avoids the need for osteotomy of the greater trochanter. Patients are placed in ventral recumbency, and an incision is made over the full length of the pelvis on the damaged side. Some incision is required through muscle coming from spinal attachments. Care is taken not to damage the cranial and the caudal gluteal vessels and the sciatic nerve, which all cross the surgical field. Good visualisation can be achieved for fractures of the acetabulum, ischium and ileum (although long oblique fractures of the ilium may be difficult to visualise well without more extensive dissection).

Acetabular plates are available in a range of sizes to fit the reconstructed dorsal acetabular dimensions (Figure 10). These used to be the mainstay of acetabular fixation, and are still useful in the absence of locking plates. Like any conventional plate, bone fragments are pulled tight to the plate by screws, so choosing a plate that approximates closely to the acetabular rim is very important if the implant is not to distort the curvature of the acetabulum as screws are tightened.

The prognosis for an acetabular fracture, like any articular fracture, has to be at least somewhat guarded. However, very satisfying long-term function can be achieved with accurate reduction (Figure 11).

External fixators are occasionally used on pelvic fractures (Figure 12). Pin placement needs care to avoid the sciatic nerve, so open placement is usually required. External fixation is cheaper than locking plate fixation and implants are much more easily removed. However, the heavy pelvic musculature makes pin tract issues and early pin loosening relatively likely, and the inconvenience of managing the patient with a frame needs to be considered.

Cerclage wire alone rarely offers adequate fixation, but in selected cases it can work well (Figure 13).

A stray cat presented in considerable pain with a displaced acetabular fracture. A simple figure-eight tension band wire was placed dorsal to the acetabulum between two bone tunnels. Reduction of the fracture relieved the pain caused by impingement of the sciatic nerve (Figure 2). This case was fixed pro bono and then rehomed to an amenable vet nurse colleague, so we could be confident the new owner would diligently adhere to the postoperative management plan.

Complications

Conservative management can lead to suboptimal pelvic dimensions and subsequent constipation (or dystocia), sometimes years into the future. Where joints are involved, reduced articular function can require degenerative joint disease management or salvage surgery, such as femoral head and neck excision.

Iatrogenic nerve damage (sacral nerves, lumbosacral trunk, sciatic nerve, obturator nerve) and haemorrhage can occur during drilling and fixation.

Non-union is uncommon in pelvic fractures. The overlying muscles and good blood supply mean healing usually proceeds rapidly. With internal fixation, infection or implant failure can occasionally occur. Screws can pull out, especially from soft juvenile bone and with conventional plates placed laterally on the iliac wing. Close confinement should be considered for the early postoperative period. Failure of the pin and wire fixation of a trochanteric osteotomy can occur. The strength of this fixation is in the size of the wire, not the size of the pin. Occasionally, there is the need for implant removal because of loosening or irritation.