Fixation of a proximal femoral physeal fracture in a dog using a ventral approach and two Kirschner wires

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Summary
A Salter-Harris type I proximal femoral physeal fracture was diagnosed in a six-month-old Norfolk Terrier. The fracture was reduced using a ventromedial approach to the hip joint and fixation with two small Kirschner wires applied from the joint surface and countersunk below the cartilage. The ventromedial approach minimizes soft-tissue and vascular damage and affords direct visualization of the fracture, facilitating reduction and fixation. The two-year postoperative outcome was considered satisfactory in this case.

Keywords
Femoral physeal fracture, ventral approach

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Introduction

The proximal femoral physis is a common site of Salter-Harris fractures in young dogs (4, 8, 9, 12–14). The majority of these are categorized as Salter-Harris type I or type II fractures, and a good prognosis requires surgical intervention (4, 14).

Blood supply to the proximal femoral epiphysis is a critical issue in a young dog. It is provided mainly from branches of the lateral and medial circumflex arteries; the caudal gluteal artery contributes to a lesser extent. These branches form a vascular ring at the capsular attachment around the femoral neck. Ascending cervical vessels that originated there run proximally, surrounding the physis, and end in a vascular network irrigating the proximal epiphysis (4, 5, 9, 12, 14).

Reduction and stabilization of proximal femoral physeal fractures (PFPFs) are most commonly performed using a dorsal or craniolateral approach to access the hip joint (2–4, 9, 10, 12, 14). Fracture fixation is generally accomplished with multiple small pins and/or lag screws from the articular surface of the joint (6, 9, 13, 14) or from the lateral femoral surface (2, 3, 4, 6, 11–14). Fixation of PFPFs with an articular lag screw by means of a dorsal or craniolateral approach can lead to complications, including degenerative joint disease (DJD) (9, 12–14). In addition, the teres ligament may need to be transected, which increases joint instability. Fixation of PFPFs from the lateral femoral surface is complicated by the difficulty in estimating the optimal length and position of implants; pins or screws that are too short and do not provide adequate fixation, and those that are too long result in injury to the hip joint (2, 3, 6–8, 14).

A ventromedial approach to the hip joint (7, 10) and fixation of avulsion fractures of the femoral head with a lag screw and a Kirschner wire (K-wire), introduced from the articular surface of the femoral head, has been described (7). The use of two small smooth K-wires, inserted parallel or in a converging-diverging fashion provides adequate stability in the fixation of PFPFs in small dogs and cats (2, 11, 12, 14).

The report presented herein describes the fixation of a Salter-Harris type I fracture in a six-month-old Norfolk Terrier by means of a ventromedial approach and two Kirschner pins applied from the articular surface. Postoperative outcome was evaluated after a two-year period.

Case report

A six-month-old intact male Norfolk Terrier, weighing five kilograms, was admitted to the Clinic for Small Animal Surgery three hours after a road traffic accident.

On physical examination, the dog was alert but unable to stand without assistance. A haematoma was present over the lateral side of the left hemipelvis, and signs of pain were evident on manipulation of the left hip joint. Survey thoracic and abdominal radiographs did not reveal any abnormalities. Radiographs of the pelvis revealed a simple oblique fracture of the left iliac wing, fractures of both acetabular branches of the pubic bone, a fracture of the right ischium, and a Salter-Harris type I fracture of the left proximal femoral physis (Fig. 1A, B). This fracture was slightly displaced, with the epiphysis remaining within the acetabulum.

Surgical fracture fixation was planned for the next day. Preoperative analgesia

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Fig. 1A, B
Ventrodorsal and laterolateral preoperative radiographs of the six-month-old Norfolk Terrier: A Salter-Harris I fracture is present in the left proximal femoral physis. A fracture of the left iliac wing, fractures of both pubic bones, and a fracture of the right ischium are also present.

was provided with buprenorphine (0.02 mg/kg i.v. q 6h), which was continued for two days after surgery. After anaesthetic induction, an epidural injection of morphine (0.1 mg/kg) and bupivacaine (0.05 mg/kg) was performed. Perioperative antibiotic therapy was provided with cefazolin (22 mg/kg i.v.).

The left hindlimb and left hemipelvis were clipped and aseptically prepared for surgery and the dog was positioned in lateral recumbency, with the left side uppermost. A lateral approach to the ilium was performed (13), and the ilial fracture was reduced. A six-hole, 2.0 mm dynamic compression plate (DCP) was applied on the lateral side of the ilium, and fixated using three screws on each side of the fracture.

The dog was then repositioned in dorsal recumbency, and a hanging-leg orthopaedic preparation of the left hindlimb was performed. A ventromedial approach to the hip joint, including a subtotal pectinectomy, was performed (1, 7, 10). After blunt dissection between the iliopsoas muscle and adductor longus muscle, the iliopsoas muscle was retracted distally and the deep femoral vessels were carefully retracted towards the midline. An incision in the joint capsule was then performed parallel to the femoral neck, and the joint was lavaged with sterile lactated Ringer's solution. The fracture was visually reduced by distal distraction of the femur site. In order to minimize disruption to the blood supply and deformation of the soft bone fragments, care was taken to avoid excessive manipulation of the cartilage and fracture.

Following fracture reduction, a 1.0 mm smooth K-wire was inserted with a power drill in the fovea capitis femoris. The wire was directed towards the third trochanter through the femoral neck, avoiding the trochanteric fossa (Fig. 2). A second 1.0 mm smooth K-wire was then inserted cranial to the first pin, and directed caudally to cross the first wire (Fig. 2). Both K-wires were retracted, cut short, and countersunk below the level of the articular cartilage with the help of a tamper. The hip joint was then

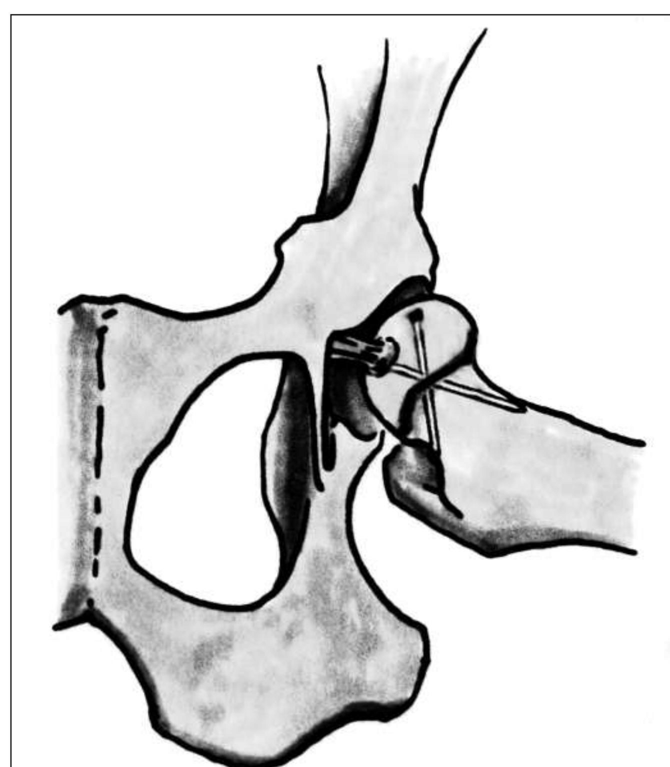

Fig. 2
Repair of the proximal femoral physeal fracture with two Kirschner wires applied from the articular surface of the femoral head. One wire is seated in the fovea capitis femoris and the second is seated cranial to the first and countersunk. The round ligament is not transected and the stability of the joint is maintained.

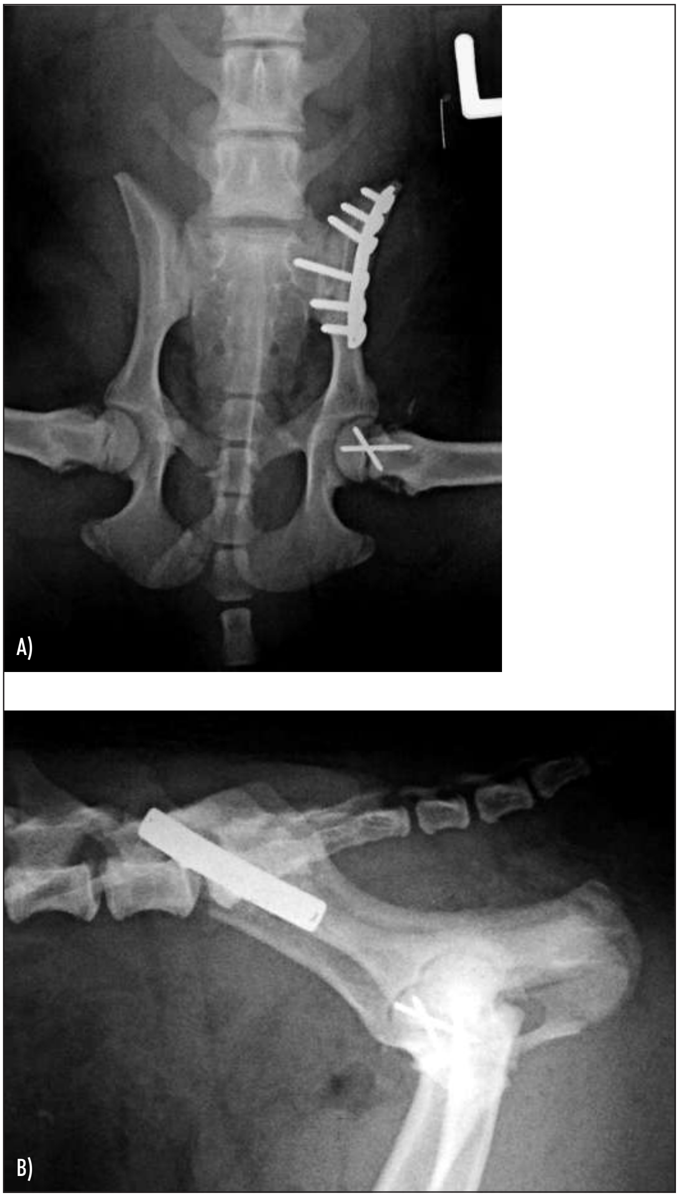

Fig. 3A, B
Frog-legged and latero-lateral postoperative radiographs. Anatomical reduction of the Salter-Harris type I physeal fracture and fixation with two Kirschner wires. A 6-hole 2.0-mm DCP was applied to stabilize the fracture of the ilium.

flushed with sterile lactated Ringer's solution, and the joint capsule was sutured with 1.5 metric polydioxanone (PDS®, Ethicon, Johnson & Johnson, Brussels, Belgium) in an interrupted cruciate pattern. The fascia and subcutis were closed in a simple interrupted pattern with 2.0 metric and 1.5 metric polydioxanone, respectively. The skin was closed in a simple interrupted pattern with 1.5-metric polyamide pseudomonofilament (Supramid®, Aesculap AG & Co. KG, Tuttlingen, Germany).

Postoperative radiographs were taken to assess reduction and fixation of both fractures (Fig. 3A, B). An Ehmer sling was applied after the surgery and left in place for one week. Afterwards, the dog was restricted to leash walks for a further three weeks. Follow-up examinations and radiographs were performed at four and nine weeks, and at 26 months after the surgery.

At the first follow-up examination, the gait of the dog was considered to be normal. The range of motion of the left hip joint was normal, mild muscular hypotrophy was evident, and neither pain nor crepitation was detectable on manipulation. Radiographs revealed healing of the ilial and proximal femoral physeal fractures (Fig. 4). The growth plate was closed and evidence of bone resorption in the femoral neck was detected. The growth plate on the contralateral limb was still visible on radiographs. At the second follow-up examination, the dog was walking free of lameness. Radiographs revealed a slight reduction of radiopacity of the left femoral neck compared to the right side. At this time, the right proximal femoral physis was also closed. Signs of DJD of the left hip joint were not detected.

Physical examination performed 26 months after surgery revealed normal muscular development, normal range of motion of the left hip joint, and neither pain nor crepitation on manipulation of the left limb. Radiographs revealed stable implants, moderate atrophy of the left femoral neck, normal length of the left femoral neck, and normal radiodensity of the left femoral cortices and bone (Fig. 5). Moderate signs of DJD and bone remodelling were detected in both hip joints, and appeared more severe on the right side (Fig. 5).

Discussion

Fractures of the proximal femoral physis account for approximately 15% of all physeal fractures in dogs (4, 8, 9, 12–14).). It has been shown that good reduction of the fracture was necessary to achieve good results and to minimize degenerative changes (4).

Fracture reduction is hampered by a craniolateral approach because visualisation of the PFPF in physiological position is difficult. This approach therefore carries a risk of incorrect fracture reduction, placement of implants in the joint or poor bone purchase of the implants (3, 6–8, 14). The dorsal approach to the hip joint allows better visualization of the fracture (10, 12), which facilitates reduction and fixation. However, a trochanteric osteotomy or a tenotomy of the gluteal muscles must be performed with this approach. A trochanteric osteotomy increases surgical time, implies a second osteosynthesis, and can lead to closure of the growth plate of the greater trochanter (12). A tenotomy of the gluteal muscles can be performed in small dogs and cats, but must subsequently be fixed with a tendon suture pattern.

In order to facilitate reduction and fixation in PFPFs, a technique using screws seated from the articular surface has been described (6). Using a craniolateral or dorsal approach, transection of the round ligament is necessary for placement of articular screws or pins. Although a blood supply is not provided by the round ligament in dogs, in contrast to cats (2), transecting this ligament results in joint instability that may lead to DJD (9, 12, 14).

The fixation of a PFPF with articular lag screws allows anatomical reduction of the fracture, but results in premature physeal closure (13). The fixation of a PFPF with K-wires does not hamper physeal growth if the growth plate remains open after injury. In the present case report, premature closure of the growth plate occurred, which is thought to be related to the initial trauma and age of the patient, and not to the method of fixation (12, 14).

The blood supply to the proximal femoral epiphysis is critical in young dogs and is provided by the lateral and medial circumflex femoral arteries and, to a lesser extent, by the caudal gluteal artery (4, 5, 9, 12, 14). In most cases some joint capsule remains attached to the femoral neck after trauma. In order to luxate the hip joint for the placement of lag screws, these capsular attachments may need to be transected. It reduces the blood supply to the femoral head and may enhance the risk of avascular necrosis (9, 11).

Manipulation, causing disruption to the blood supply, should be minimized during reduction of PFPFs. The ventromedial approach to the hip joint causes minimal soft tissue damage, and may minimize damage to the blood supply. The fracture is directly visualized, making reduction and fixation easier and facilitating countersinking of implants below the joint surface. In addition, the position of the implants in the femoral epiphysis can be directly assessed intra-operatively. A minimal number and size of implants can, therefore, be placed to ensure adequate fixation. In the case described in this report, one K-wire was seated in the fovea capitis femoris, thereby reducing the risk of damage to the articular cartilage. In order to avoid damage to the articular surface of the acetabulum, the second K-wire was countersunk. The risk of implant movement and damage to the acetablular cartilage surface was minimized by seating the first pin in the fovea because this allows deep countersinking of the pin. Both K-wires could also have been inserted in an antegrade fashion from the medial side of the femoral neck until it was seen protruding through the femoral head, at which point, they must be retracted below the articular cartilage and bent to avoid migration and protrusion above the articular surface.

Fig. 4 Follow-up radiograph one month after surgery, documenting healed ilial and physeal fractures, stable implants, closure of the grow plate, and moderate narrowing of the femoral neck. No shortening of the operated femoral neck is detected.

Fig. 5 Ventrodorsal view of the pelvis with extended limbs 26 months following surgery, revealing stable implants, narrowing of the left femoral neck, and signs of degenerative joint disease in both hip joints.

This technique may also prove suitable for the treatment of adult dogs with avulsions of the capitis femoris ligament. In cases with severe damage of the physis, which precludes reduction of the fracture, alternative methods, such as excisional arthroplasty or total hip replacement are considered more appropriate (12, 14).

Moderate DJD was observed in both hip joints at 26 months following surgery in this case. The surgical technique was therefore unlikely to have been solely responsible for these changes. Despite earlier closure of the physis, shortening of the femoral neck, compared to the contralateral side, was not detected, suggesting that growth of the femoral neck was likely completed at the moment of trauma.

In conclusion, the use of Kirschner wires placed by a ventromedial approach to the hip is a promising alternative for PFPF repair in the dog. Further studies are necessary to assess the usefulness and outcome of PFPF repair with this technique compared to previously described methods.

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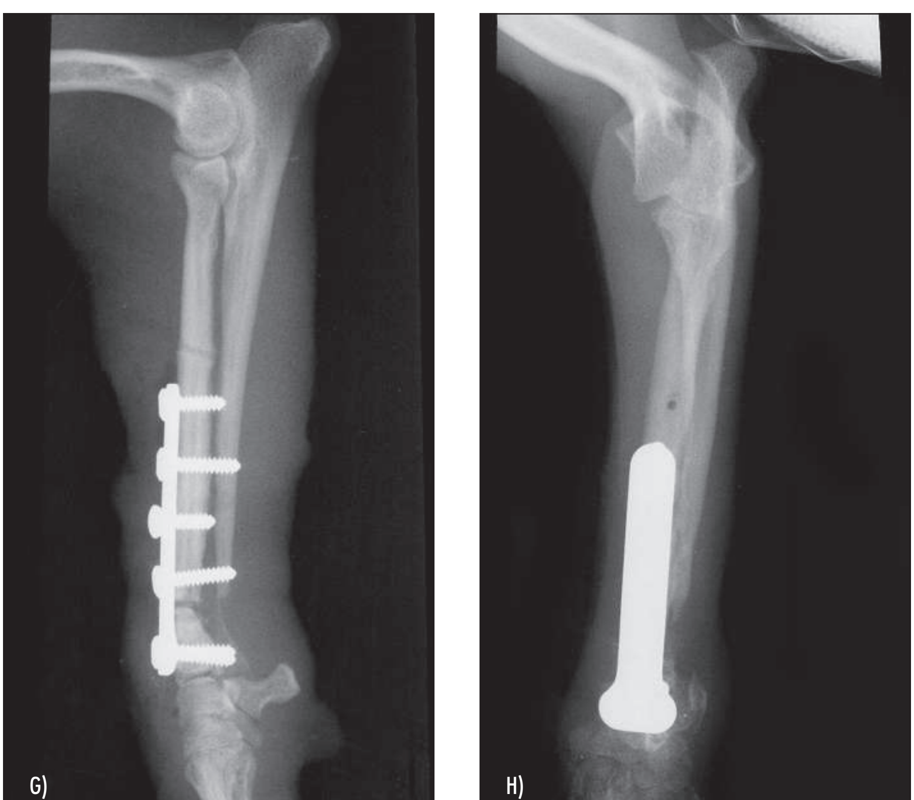
Errata

In the article by Hamilton, Langley Hobbs "Use of the AO veterinary mini "t"-plate for stabilisation of distal radius and ulna fractures in toy breed dogs", which appeared in issue 1/2005 (Vet Comp Orthop Traumatol 2005; 18: 18–25), the incorrect figures for Figs. 2G, 2H and 3B were published. The correct figures are stated below and also online (www.vcot-online.com). The Publisher apologises for this error.



Figs. 2G, H Immediate post-operative lateral and craniocaudal radiographs of case 13 following application of the AO veterinary mini 'T'-plate. Osteotomies of the fracture ends have been performed to improve bone surface apposition.

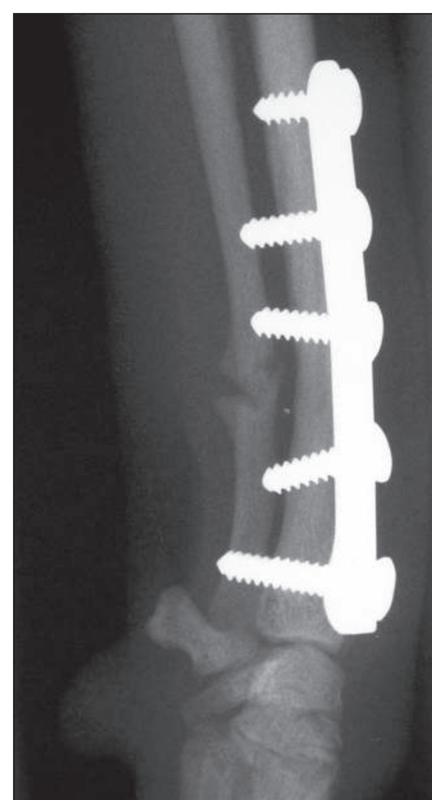


Fig. 3B Immediate and six week post-operative radiographs of case 3. The fracture line is barely visible on the six-week radiograph. The dog was sound at this time and was gradually returned to normal exercise over the next six weeks.