Small animal orthopedic and neurosurgery

2nd Continuing Education Course for Japan Small Animal Surgeons at the Small Animal Surgery Clinic, University of Zurich, Switzerland
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Impressum

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Program overview

14.02  Joint surgery of the frontlimb  
Zurich university

0900  Welcome, goal of the course  
0915  Caudal approach to shoulder joint, OCD  
1015  Elbow: craniolateral approach, fracture treatment  
1115  Elbow: medial intermuscular approach  
1200  Lunch  
1300  Elbow: epicondylotomy, OCD  
1400  Ulnaostectomy  
1445  Break  
1500  Partial carpal arthrodesis  
1600  Craniodorsal approach to hip joint: hip luxation  
1645  Other approaches to hip joint: trochanter osteotomy, intermuscular, caudal  
1730  End of the day, apero

15.02  Joint surgery hindlimb  
Zurich university

0800  Ventral approach hip joint: PIN, femoral head resection  
0915  Patellar luxation  
1015  Break  
1030  Cranial cruciate ligament rupture: Extracapsular repair  
1200  Lunch  
1300  Cranial cruciate ligament rupture: Proximal tibia corrective osteotomy  
1700  End of the day

16.02  Joint surgery of the frontlimb  
Zurich university

0800  Introduction to arthroscopy  
0900  –  Arthroscopy seminar  
1200  Lunch  
1400  Afternoon recreation  

17.02  All day  
Winter resort: Skiing

18.02  AO advanced course  
Bettlach

0730  Departure at the hotel  
0900  Advanced course in fracture treatment: Several exercises on plastic bones with original material  
1800  Arrivial at the hotel

19.02  Joint surgery hindlimb and neurosurgery  
Zurich university

0800  Achilles tendon injury: tendon suture, transarticular external fixator  
0900  Break  
0930  Introduction to neurosurgery  
1100  Ventral slot for cervical discus  
1200  Lunch  
1300  Hemilaminectomy for thoracolumbar discus  
1415  Fracture/luxation spine: spinal stapling  
1545  Break  
1600  Dorsal laminectomy for cauda equina syndrome  
1700  Sacrococcygeal luxation  
1745  End of the day
Caudal approach to the shoulder joint, OCD
Daniel Koch, Dr. med. vet. ECVS

Introduction

The most important indication for a caudal approach to the shoulder joint is an osteochondrotic lesion in the caudocentral area of the humeral head. An OCD is found in both shoulder joints in 27% to 68% of the cases. The dogs develop the disease between the age of 6 to 12 months. OCD is a general developmental skeletal disease. It is presumably caused by genetic predisposition, rapid growth and overnutrition (quantity, Calcium) in large and giant breed dogs. OCD lesion may be found elsewhere on the skeleton (shoulder, elbow, stifle, tarsus). The treatment consists in removal of the fragment, surgical curettage of the lesion and adjusting general management and feeding of the dog. Shoulder OCD has a favourable prognosis.

The caudal approach to the shoulder joint requires no tenotomies. However, the axillary nerve must be spared. A good visualisation of the joint is achieved. With a mosquito, even cranial parts of the joint and the bicipital tendon sheet can be explored. Alternatively, the shoulder joint can be approached with an arthroscope and the OCD lesion can be treated through an instrumental portal.

Technique

1. Incise the skin from midscapula to midhumerus
2. Incise the subcutaneous fat and identify the following muscles: scapular part and acromial part of the deltoid muscle, lateral and long head of the triceps muscle
3. Incise the fascia between deltoid and triceps muscle
4. Retract the deltoid muscle and identify the muscular branch of the axillary nerve and the caudal humeral circumflex vein.
5. Retract the teres minor muscle cranially, the axillary nerve is now seen
6. Use a Penrose drain to protect the axillary nerve and gently move it caudally or craniodistally. Accompanying vessels are also retracted.
7. Incise the joint horizontally, about 5 mm distal to the glenoid rim
8. Explore the shoulder joint by retracting the joint capsule and inward rotation of the leg.
With different flexions angles of the forelimb, the whole joint is visualized.

9. Curette the OCD lesion with a sharp spoon. Sclerotic bone is treated with osteostyxis in order to promote bone healing.

9. Close the joint with single sutures on the joint capsule, the intermuscular fascia, the subcutis and the skin.
**Craniolateral approach to the Elbow joint**

Martin Bass, Dr. med. vet.

The indications for the craniolateral approach are condylar and intercondylar fractures. Perfect anatomical reduction of the fractured articular surfaces with rigid fixation and movement of the elbow is important for the best functional results. This approach gives good visualization to the fracture area and exposure of the joint surfaces. Although it is proximal to the main area of exposure, it is well to note the location of the radial nerve.

**Exercise:**

1. The skin incision extends from the distal third of the humerus to the proximal third of the radius. The incision passes slightly caudal to the lateral condyle. The subcutaneous fascia is incised on the same line.
2. An incision is made through the deep fascia near the cranial border of the triceps muscle and is continued distally over the extensor muscles. Pay attention to the radial nerve, which is cranioproximal to the incision!
3. An incision is started distally in the intermuscular septum between the extensor carpi radialis and the common digital extensor muscles. This incision continues proximally into the periostal origin of the distal half of the extensor carpi radialis muscle.
4. The extensor carpi radialis muscle is elevated from the bone and underlying joint capsule, and the capsule is opened with a L-shaped incision. Care must be taken to protect the cartilage of the condyle.
Medial intermuscular approach to the elbow joint
Martin Bass, Dr. med. vet.

The main indications for a medial approach to the elbow joint are the osteochondritis dissecans (OCD) of the medial humeral condyle and the ununited or fragmented medial coronoid process (FCP), which are part of the elbow dysplasia complex. The simple muscular-separating approach gives adequate exposure for a fragmented medial coronoid process. For a good visualization of an OCD lesion of the medial condyle of the humerus an epicondylotomy is preferred.

Exercise (lateral recumbency, leg freely moveable)

1. The skin incision starts proximal to the elbow joint and extends to proximal third of the ulna. Deep antebrachial fascia is incised on the same line as the skin and retracted to expose the flexor muscle group. Protect the ulnar nerve during the fascial incision and elevation.
2. The division of the flexor carpi radialis and deep digital flexor muscles is done by blunt dissection. The intermuscular incision can alternatively be made between the pronator teres and flexor carpi radialis muscles.
3. Strong retraction between the muscles exposes the joint capsule, which is incised parallel to the muscles. Protect the underlying articular cartilage when making this incision.
4. Exposure of the medial coronoid process may require extension of the joint capsule incision parallel to the trochlear notch of the ulna, but the incision should not cross the medial collateral ligament.
5. Visualization of the medial coronoid process is facilitated by strong pronation and abduction of the antebrachium to open the joint on the medial side.
Medial approach to the elbow joint by epicondylotomy
Martin Bass, Dr. med. vet.

Exercise:
1. The skin incision is centered on the medial humeral epicondyle and follows the humeral shaft proximally and the shaft of the ulna distally. The subcutaneous fat and the deep antebrachial fascia are incised on the same line. Be aware of the neurovascular tissues deep to the fascia.
2. The osteotomy should include all of the origin of both the pronator teres and flexor carpi radialis muscle from the adjacent digital flexor muscles. A suitable glide and tap hole should be drilled now, just distal to the epicondylo.
3. The incisions 1 und 2 are first made by an osteotome to a depth of approximately 5 mm, and then incision 3 is made parallel to the surface of the condyle, taking care not to include articular cartilage.
4. The osteotomized bone with attached muscles and collateral ligaments can be retracted distally after incising the joint capsule.
5. The osteotomized epicondyle is reattached to its origin by a lag screw.
Instrumentation:

- 1 osteotome
- 1 hammer
- 1 drilling machine
- 2 drill bits
- 1 drill guide
- 1 tap
- 1 depth gauge
- 1 screw
- 1 screwdriver
Ulnar ostectomy
Daniel Koch, Dr. med. vet. ECVS

Ulnar ostectomy is indicated in cases of elbow dysplasia where a gap is visible between radial head and the coronoid processus of the ulna (short radius). The ostectomy allows the ulna to regain its physiological position. Overload on the medial coronoid process is reduced. The ulnar ostectomy is also indicated in dogs younger than one year, where overload on the coronoid process is suspected or proven, in order to prevent further damage. We recommend the ostectomy to be performed in the distal part of the ulna. No osteosynthesis or stabilisation is needed. The dynamization effect of the procedure is shown to persist also in dogs older than one year. Care has to be taken not to injure the radius during osteotomy. The developing callus could result in synostosis of the bone. In cases of dogs younger than 6 months of age, a fat graft from the falciforme ligament prevents too rapid bony union.

Technique:

1. Skin incision on the distal and lateral side of the ulna of 4-6 cm length

2. Incision into the fascia antebrachii between the tendon of the lateral digital muscle (cranial) and the lateral ulnar muscle (caudal). Retraction of the tendons reveals the ulna.

3. The tissue around the osteotomy cuts is prepared, retracted and protected with the help of two periosteal elevators or Hohmann retractors.

4. The ulna is cut twice with a Gigli saw, an osteotome or an oscillating saw. The radius is avoided. The ulna and its surrounding periosteum is removed. Try to avoid the interosseous artery.

5. In young dogs: A fat graft from the ligamentum falciforme is placed between the cut ends. Too fast revascularization is prevented.

6. Closure of the fascia with interrupted cruciate pattern, subcutaneous tissue and skin are closed with single interrupted sutures.

7. A bandage protects the wound for 3 to 8 days. Early postoperative physical therapy (prevention of synostosis) is recommended.
Partial carpal arthrodesis
Dr. Marcel Keller, Dr. med. vet.

Hyperextension of the carpus, occurring in midsize and large breed dogs after falls and jumps, is one of the most serious injuries to the carpus. The structures responsible for maintaining the normal 10 to 12 degrees of carpal extension are the palmar ligaments and palmar carpal fibrocartilage. Rupture of these structures leads to different grades of carpal hyperextension. Surprisingly minimal signs of pain and inflammation are associated with hyperextension injuries after a few days. Animals commonly will attempt weight bearing within 5 to 7 days. A plantigrade stance is characteristic but variable in appearance. Some animals may be walking on their carpal pads, but others may show only 20 to 30 degrees of extension.

In order to select the proper treatment, it is important to know at which joint level the injury has occurred. A lateral radiograph is made with the limb stressed to maximal carpal hyperextension. In order to check for rupture of the collateral ligaments also valgus and varus stress radiographs are made. If there is also damage to these ligaments, most of the time it will be the medial, a bone tunnel reconstruction has also to be performed or a pancarpal arthrodesis is indicated.

Partial arthrodesis involves surgical fusion of only the middle level and carpometacarpal joints. The function of the carpus remains essentially normal because there is little motion normally present in these joint levels. The antebrachioarcarpal joint, which is responsible of virtually all flexion of the carpus, remains functional.

The pin fixation method has better results than the dorsal plate technique and will be adressed here.

Figure 1: left carpus, dorsal view

Figure 2: Left carpus plamar view, superficial ligaments
Partial Carpalarthrodesis – Pin fixation method

Material:
- Standard instrumentation
- High speed burr or currette
- Jacob’s chuck
- Kirschner wires (1.0 – 1.6 mm Ø)
- Wire cutter
- Steinmann pin 2 mm Ø or rongeur

1) A combined corticocancellous bone graft from the wing of the ilium is taken

2) A dorsal midline approach to the carpus is made with the incision extending distally to the level of the metacarpophalangeal joints. The intercarpal and carpometacarpal joints are opened.

3) Articular cartilage of the middle carpal, intercarpal and carpometacarpal joint is debrided with a curette or high speed burr. Care is taken to preserve the insertions of the extensor carpi radialis tendon on the proximal ends of metacarpals II and III.

4) Slots are burred in the dorsal cortex of metacarpals II and III in the distal third of the bones. Alternatively a Steinmann pin and rongeurs can be used.

5) Kirschner wires (1.0 – 1.6 mm) are introduced through the slots into the medullary canal in the manner of a Rush pin and driven proximally into the base of the metacarpal bone. The cortical slots must be long enough to allow the pin to bent as it is introduced into the medullary canal.

6) With the carpus held in extreme flexion to reduce the subluxation of the middle carpal or carpometacarpal level, pins are driven proximally into the radiocarpal bone. The pins must not penetrate the proximal articular cartilage of the radiocarpal bone.

7) Corticocancellous bone graft is packed into the prepared joint spaces.

8) The pins are bent, cut and rotated flat against the bone.
9) Deep fascia is closed to ensure that tendons and vessels are securely held in position. Skin closure is routinely.

A caudal splint is applied until radiographic signs of fusion are noted, typically 6 to 8 weeks later. A gradual return to normal exercise is allowed over the next 4 weeks.
Craniodorsal Approach to the Hip Joint, Coxofemoral Luxation
Katja Voss, Dr. med. vet.

Introduction

Surgical approaches to the hip joint include the craniodorsal approach, the caudal approach, the dorsal approach via a trochanteric osteotomy and the ventral approach. The craniodorsal approach allows visualization of the craniodorsal aspect of the hip joint and is indicated for femoral head and neck excision, for cranial acetabular fractures, for femoral head and neck fractures, for installation of total hip prosthesis and for open reduction and internal fixation of coxofemoral luxations.

Coxofemoral luxations are usually the result of external trauma, such as hit by car, which leads to failure of the joint capsule and the round ligament. The femoral head may dislocate in a craniodorsal direction, the most frequent form, or in a caudodorsal or ventral direction. Hip luxations can be accompanied by femoral head or acetabular fractures.

Closed reduction of the hip joint followed by the use of an external support like the Ehmer sling may be unsuccessful due to persisting remnants of the round ligament, the joint capsule or blood clots in the joint or due to coexisting hip dysplasia. These conditions require open reduction and internal fixation. Internal fixation is also advised in animals with concurrent injuries of another leg, which makes the application of an Ehmer sling impossible. Numerous methods have been described for internal fixation after reduction of a coxofemoral luxation. An extraarticular stabilization technique was described by B. Slocum, consisting of a suture sling between the greater trochanter and the cranial aspect of the acetabulum. This sling, like the Ehmer sling, holds the hind leg in internal rotation, thus preventing reluxation in the postoperative period. The final joint stability is due to joint capsule healing and formation of periarticular fibrosis.

Surgical Technique

- Skin incision from the level of the greater trochanter, along the cranial border of the shaft of the femur, to half of the length of the femur (Fig. 1)
- Incision through the superficial leaf of the fascia lata, along the cranial border of the biceps femoris muscle and caudal retraction of the muscle (Fig. 1)
- Incision of the deep leaf of
the fascia lata distally and continuing the incision proximally between the cranial border of the superficial gluteal and tensor fascia latae muscle (Fig. 2)

- Dorsal retraction of the superficial and middle gluteal muscles and partial tenotomy of the tendon of the deep gluteal muscle at its insertion on the greater trochanter (Fig. 3)
- Dorsal retraction of the deep gluteal muscle and preparation of the joint capsule with an periosteal elevator
- T-shaped incision of the joint capsule (if still intact) with a No. 15 blade. The “top of the T” incision is made on the distal end.

- Excision of the remnants of the round ligament and cleaning-up of the joint
- Drilling of two parallel holes with a 1.6 mm Kirschner wire through the greater trochanter (rather proximal) in a caudal to cranial direction
- Drilling of another hole ventral through the ilium, just cranial to the acetabulum, in a proximolateral to distomedial direction
- Placing of the suture sling in a figure-of-8 form through the hole in the ilium and through the two holes in the greater trochanter, without severing the ischial nerve (Fig. 4). Depending on the size of the animal, several suture slings can be placed through the holes in the same manner.
- Suturing the joint capsule with a cruciate suture pattern
- Tying the ends of the suture sling with a gliding knot, while the leg is held in slight abduction and internal rotation
- Repair of the tenotomy of the deep gluteal muscle
- Closure of the fascia, the subcutaneous tissue and the skin using interrupted suture pattern
Special Instrumentation

Multifilament absorbable suture material (Vicryl®), size 0 to 2

References
- Meij et. al., 1992: Results of extra-articular stabilisation following open reduction of coxofemoral luxation in dogs and cats, Journal of Small Animal Practice, 33, 320-326
Approaches to the Pelvis and the Hip Joint
Daniel M. Damur, Dr. med. vet. FVH

Surgical approach is dictated by the degree of exposure required for a specific procedure. Oscillating drilling mode is used to drill any screw holes into the pelvis.

1. Approach to the Sacroiliac Joint
   - The dorsal approach to the iliac crest is used, and medial retraction of the sacrospinalis muscles allows exposure of the sacroiliac joint and evaluation of the reduction. The cranial gluteal artery, vein and nerve are avoided where they pass from medial to lateral over the caudodorsal iliac spine to enter the middle gluteal muscle. Ventral reflection of the middle gluteal muscle ("roll down") permits placement of one screw through the dorsal tuber sacrale into the sacrum.
   - The ventral approach is also advocated with dorsal reflection of the middle gluteal muscle ("roll up") to allow placement of a screw through the iliac wing into the sacrum. Elevation of the iliacus muscle and digital palpation of the sacrum and of the ilial auricular surface helps for the reduction of the sacroiliac joint. Palpation of the promotorium of the sacrum permits optimal placement of the screw in the body of S1. This approach is preferred especially for simultaneous repair of coexisting iliac body fracture.

2. Approach to the Ilium
   - For most iliac shaft fractures, a lateral approach allows optimal visualization. It provides access through muscle separation and subperiosteal elevation rather than transection of muscle. The middle gluteal muscle can be partially or entirely elevated from all but the dorsum of the ilium and reflected dorsally. The deep gluteal muscle is elevated to allow visualization of the fracture reduction or of placement of implants, if necessary.
   - Intergluteal approach is recommended to provide access to the wing of the ilium. The middle gluteal muscle fibers are separated. This technique is mainly used for harvesting corticocancellous bone grafts.
3. Approach to the Acetabulum

- The caudal approach provides exposure of the acetabulum equal to a trochanteric osteotomy, it does not require creation of a femoral osteotomy, and it is more quickly closed than a trochanteric osteotomy. The superficial gluteal muscle is isolated, incised at its insertion, and reflected dorsally. If necessary, the obturator and gemellus muscles are incised at their insertion at the trochanteric fossa, are tagged and retracted caudodorsally. After the fracture is stabilized, the internal obturator and gemellus muscles are sutured to the muscle’s insertion point using a tunnel technique into the fossa intertrochanteric area. Inward rotation of the femur allows visualization of the craniodorsal area of the acetabulum.

- Dorsal approach by trochanteric osteotomy. The superficial gluteal muscle is isolated, incised at its insertion on the third trochanter, and reflected dorsally. The osteotomy is started at the level of the third trochanter and is extended dorsally to the junction of the greater trochanter and the femoral neck, which is identified with the help of two mosquitos. The middle and deep gluteal muscle are reflected dorsally with the greater trochanter requiring separation of the deep gluteal from the dorsal joint capsule. After repair of the fracture, the greater trochanter is reattached to the proximal femur with the tension band technique. “Swiss chalet” or “Chevron” osteotomies require only minimal fixation, i.e. with screws.

- Dorsal approach by splitting the gluteal muscles directly over the fracture. This approach is recommended for minimal or non dislocated fractures of the acetabulum. The gluteal muscles are splitted to allow visualisation of the dorsal aspect of the acetabulum.
4. Approach to the Hip Joint

- The craniolateral approach or the modified craniolateral approach is the most commonly used approach to the hip joint. It allows exposure of the caudal aspect of the iliac body, cranial third of the acetabulum, and cranial and dorsal aspects of the femoral head and neck. Retraction of the biceps muscle caudally, the tensor fascia lata cranially and the superficial gluteal muscle caudally exposes the hip joint. It is bordered dorsally by the middle and deep gluteal muscle, cranially by the rectus femoris muscles and laterally by the vastus lateralis muscle. Retraction of these muscles permits exposure of the cranial joint capsule. Exposure is enhanced by performing a tenotomy of the insertion of the deep gluteal muscle at the greater trochanter.

- The ventral approach offers access to the ventral aspect of the femoral neck and head and the ventral aspect of the acetabular fossa. It is recommended for femoral head and neck excisions and repair of femoral head fractures in dogs and cats. The femoral artery and vein have to be protected. The pectineus muscle is transected near its origin on the prepubic tendon. Retraction of the iliopectineal cranially and the adductor and the obturatorius nerve caudally exposes the acetabulum.

References

**Ventral Approach to the Hip Joint and Pectineomyectomy, Iliopsoasstenotomy, Neurectomy of the Joint Capsule (PIN)**

Katja Voss, Dr. med.vet.; Pierre M. Montavon, Prof. Dr. med. vet.

**Introduction**

The ventral approach to the coxofemoral joint can be used for femoral head and neck excision or for the repair of fractures of the femoral head. Femoral head and neck excision is a commonly performed salvage procedure in cats and small dogs with otherwise untreatable diseases of the hip joint, such as coxarthrosis, Legg Calve Perthes disease or complicated acetabular and femoral head and neck fractures. After femoral head and neck excision contraction of the pectineus muscle often leads to dorsal displacement of the femur in relation to the pelvis. Performing the head and neck excision via a ventral approach allows a prophylactic pectineomyectomy during the same operation.

The ventral approach to the hip joint is also used for the pectineomyectomy, iliopsoasstenotomy and neurectomy of the hip joint capsule (PIN) as a treatment for coxarthrosis in dogs. Dysplasia and instability of the hip joint lead to coxarthrosis. Chronic pain of the hip joint leads to lameness, associated with contracture of local muscle groups. Abduction and extension of the hip joint are restricted and painful. Local palpation of the medial aspect of the joint may reveal pain on pressure over the contracted pectineus muscle.

Pectinotomy and pectinectomy have been used successfully to reduce pain in patients with coxarthrosis. Contracture of the pectineus muscle leads to subluxation of the femoral head and painful stretching of the ventral joint capsule, and reduces the abduction.

The tendinous part of the iliopsoas muscle is in direct contact with the ventral joint capsule. During extension of the hip joint it exerts pressure on the inflamed joint capsule of the coxarthrotic dog.

The ventral part of the joint capsule is involved in generating pain in dysplastic patients. Subluxation of the joint distends mostly the ventral joint capsule and nociceptors are concentrated in this area. The obturatorius nerve is mainly responsible for the innervation of the ventral capsule of the hip joint.

The present surgical technique for the treatment of coxarthrosis adds the iliopsoasstenotomy and neurectomy of the joint capsule to the classical pectineomyectomy. The outcome is an increased hip joint extension (iliopsoasstenotomy) and enhanced pain reduction (neurectomy). Indications for this technique are principally older patients with concomitant orthopedic problems. Also, financial considerations can lead to the choice of this technique.

**Technique**

Ventral approach to the hip joint and PIN:

- Good knowledge of the local anatomy is required in order to preserve important structures in presence such as the femoral vessels and their branches, and the obturatorius and saphenous nerves.
- After skin incision, the pectineus muscle is subtotally resected while performing optimal hemostasis. During the approach, the obturatorius nerve area is retracted toward caudally and the femoral vessels toward cranially. The deep femoral vessels should be preserved during the preparation of the origin of the pectineus muscle. The proximal caudal femoral vessels are retracted in a distal direction during transection of pectineus muscle, in the area of its musculotendinous junction (Fig. 1).

- The deep femoral vessels are prepared and retracted over the ventral joint capsule toward proximal. The iliopsoas muscle is then prepared proximal to its insertion on the lesser trochanter, which is palpable on the caudal part of the proximal femur. The tendinous part lays below the muscle. The tendon has to be retracted with a curved instrument (Mosquito, small Hohman retractor) and transected on its entire width. This releases the pressure on the joint capsule and improves the extension of the hip joint (fig. 2).

- Neurectomy of the ventral joint capsule is carried with a periosteal elevator and/or with electrocauterization avoiding contact with instruments retracting important anatomical structures (Fig. 3). Arthrocentesis can be performed in young animal with synovitis.

- After repeated control of the hemostasis the wound is closed in appositional fashion, avoiding damage to the large vessels. Both sides can simultaneously be treated.
Ventral approach to the hip joint, pectineomyectomy and femoral head and neck excision:

- The approach and resection of the pectineus muscle is performed as described above.
- After retraction of the vessels towards dorsally and retraction of the iliopsoas muscle towards ventrally, the hip joint capsule is incised parallel to the axis of the femur. The capsule is then retracted with two Mosquito forceps.
- The osteotomy starts on the medial side just proximal of the minor trochanter and ends just proximomedial of the greater trochanter. The direction can be estimated by holding the osteotome 45° to the long axis of the diaphysis of the femur (Fig. 4).
- After the osteotomy is performed and the round ligament and joint capsule are incised, the femoral head and neck are removed.
- Digital palpation allows detection of left over sharp bone ends. Any protruding or rough bone ends are removed with a rongeur.
- Closure as described above excision via a ventral approach

**Special instrumentation**

- Osteotome

Fig. 4: Femoral head and neck
Patellar luxation: surgical repair
Daniel Koch, Dr. med. vet. ECVS

Cranialisation

The lateral or medial transposition of the tibial tuberosity as a part of the treatment for patellar luxation can be combined with a cranialisation. This is achieved by oblique osteotomy of the tibial tuberosity (fig. 1) and fixation by tension band. The whole procedure for the treatment of patellar luxations includes also sulcoplasty of the femoral groove and additional soft tissue reconstructions.

The cranialisation of the tibial tuberosity offers the following advantages:

(1) The compressive force transmitted from the patella to the femur is reduced (fig. 2). In osteoarthritis of the patellofemoral joint and in chondromalacia of the patella, cranial displacement of the patella tendon consistently relieves pain.

(2) A cranial cruciate ligament rupture can be prevented. Recent studies of the biomechanics of the stifle reveal that an advancement of the tibial tuberosity reduces the force of the cranial cruciate ligament.

(3) The patellar tendon remains straight. In several other techniques, where the tibial tuberosity is fixed on the medial or lateral side of the tibia, the tendon becomes twisted. The patella and the underlying femoral cartilage are unphysiologically loaded, which causes anterior knee pain.

Figure 1: Lateral (x) and cranial (y) advancement of the tibial tuberosity after oblique osteotomy (O) in case of medial patellar luxation.

Figure 2: Effect of cranio-caudal displacement of the tibial tuberosity on the compressive force of the patella onto the femur: cranialisation reduces the compressive force.
Preoperative planning

The indication for surgical treatment of canine and feline patellar luxation is based on the clinical signs and the degree of patellar luxation. A tibial crest osteotomy and a femoral sulcoplasty is necessary to reestablish normal stifle function. In individuals younger than 5 months, a sub-chondral sulcoplasty, in individuals older than 5 months, a wedge sulcoplasty is performed. Postoperative pain can be relieved, when the retropatellar force is reduced. This is done by a cranialisation of the osteotomized tibial crest. An oblique osteotomy is performed, which allows vast correction of patellar luxation and also cranial advancement of the tibial crest and of the patellar ligament. For medial patellar luxations, the caudal landmarks for the osteotomy are the cranial border of the medial meniscus and the tendon of the extensor digitalis extensor muscle (Fig. 1).

In addition to these bony corrections, soft tissue reconstructions aid in the postoperative period, but should not be used as sole method of therapy.

Technique (medial patellar luxation)

1. Clip the hindleg including the tarsal area and place the animal in dorsal recumbency
2. After the skin incision, arthrotomy is made on both lateral and medial aspect, respecting the parapatellar fibrocartilages. Luxate the patella
3. Inspect the stifle (ligaments, menisci, chondromalacia, deformities, synovitis)
4. Identify the tuber Gerdy laterally and the cranial border of the medial meniscus as landmarks for the osteotomy.
5. Use a hobby saw to make an oblique osteotomy cranial to the landmarks and extend it further distally (Fig. 1., Fig. 3). Reflect the osteotomized tibial crest proximally.

6. Wedge sulcoplasty: Mark the beginning of the wedge sulcoplasty with a scalpel blade. The highest point of the sulcus must remain intact. Carefully plan the thickness of the additional slice to be removed. Use a X-ACTO saw to create the wedge. Be careful not to dam-
age the origin of the posterior cruciate ligament. Remove an additional slice on the side of patellar luxation (Fig. 4).

7. Break the sharp edge at the basis of the wedge and further deepen the cut on the femur with a rongeur. Replace and fit the wedge until it is stable and a satisfactory sulcus is obtained. The supratrochlear entrance of the sulcus may be enlarged with filing if to narrow.

8. Replace the patella and define the amount of lateral tibial crest transposition without twisting the patellar ligament. Fix the tibial tuberosity with a tension band wire using two 0.8 (cats) to 1.6 mm (big dogs) pins and 0.6 mm (cats) to 1.2 mm (big dogs) cerclage wire in figure 8 pattern (Fig. 5).

9. Soft tissue reconstructions (as far as needed, possibilities):
   - Medial muscle release: transsect the M. sartorius and the M. vastus medialis off the patella and fix it further proximal to the rectus femoris
   - Lateral imbrication: fascia lata is closed with an overlapping suture pattern
   - Medial capsule and retinaculum incisions may be left unsutured
   - Derotational suture: place a suture around the lateral fabella and in the patellar ligament to enhance lateral tension in case of medial patellar luxation with excessive inward rotation of the tibia

10. Postoperative care: Put the leg in a bandage for 3 – 7 days and force physical therapy thereafter. Control the repair with x-rays immediately postoperative, after 6 weeks and 3 months.

References

Cranial cruciate ligament rupture: extraarticular reconstruction
Daniel Damur, Dr.med. vet. FVH; Daniel Koch, Dr. med. vet. ECVS

Investigation of stifle biomechanics in recent years has led to a revised understanding of the pathophysiology. Most philosophies for treating ACL ruptures base on the anatomical or functional replacement of the injured tissue. This has led to the two major technical categories of intraarticular and extrarticular reconstructions.

However, almost every ruptured cruciate ligament shows signs of previous degeneration. As a conclusion, there must be a force, which constantly and in an unphysiological manner, damages the ACL, which leads to partial and, later in the course of the disease, to complete ACL rupture. This force, called cranial tibial thrust, was objectivated by Barclay Slocum by introducing muscles as active elements to the established model of passive structures holding the stifle joint stable. The goal of the tibia plateau leveling osteotomy is minimizing the cranial tibial thrust by changing the slope the tibial plateau. This therapy may therefore be called causative, whereas the ACL replacement techniques are rather symptomatic.

Extracapsular suture techniques (Flo, combined with Harrison)

Introduction:
A heavy polyester suture is placed in figure 8 configuration extracapsular around the lateral fabella and through a tunnel in the tibial tuberosity close to the proximocranial end of the tibia. One suture is placed in the same manner around the medial fabella and a separate tunnel in the tibia, which adds stability to the reconstruction. The property of the suture material used leads to a periarticular inflammation and scar tissue formation. In case of suture material failure, the scar tissue should hold the stifle stable. An aponeurotic sling helps to protect the extracapsular repair and prevent meniscal damage in the early postoperative period.

Indications:
An extraarticular repair for ACL rupture is described for any size of dogs under any type of circumstances. We however limit its use to dogs weighing less than 15 kg body weight and unilateral ACL rupture. In heavier dogs and both side affected dogs, weight bearing in the postoperative period may lead to prosthesis loosening.

Step by step:
1. Lateral approach to the stifle joint (Piermattei 1993)
2. Exploration of the stifle joint. The damaged ACL is cut, meniscal lesions are excised. The cranial horn of the medial meniscus should be left intact. A synovectomy is performed.
3. Closure of the joint capsule.
4. Preparation of the fossa extensoria, two holes are drilled into the tibial tuberosity in the proximocranial part of the tibia, close to the insertion of the patellar ligament.

5. A heavy non-resorbable braided suture material (e.g. Polyester) is used for the extracapsular repair. It is placed around the lateral fabella, then crossed in figure 8, passed through the tunnel and taken back to the lateral side underneath the patellar ligament.

6. An similar maneuver is performed at the medial side using the more distal hole and avoiding damage to the suture material already in place.

7. The lateral sutures are tied strong in slightly flexed stifle position and outward rotation of the extremity. The medial suture is also tied.

8. The medial and lateral fasciae are prepared far proximally (Harrison technique). They are imbricated cranial to the tibia with horizontal mattress sutures. The fascia is imbricated also on the lateral side of the stifle.

9. The limb is bandaged for ten days. Physical therapy and analgesics help in the postoperative period.
Proximal tibia corrective osteotomy techniques for the repair of the cranial cruciate deficient stifle
P.M. Montavon, Prof. Dr. med. vet.; Daniel M. Damur, Dr. med. vet. FVH; Slobodan Tepic, Dr. Sci.

The treatment of cranial cruciate deficient stifle has been influenced by the introduction of biomechanical concepts. Conformational malalignment entities have been evidenced. The treatment has been more attentive on compensating the cause of the cranial cruciate rupture rather than replacing the loss of its function. It led to the development of new techniques, not only stabilizing the cranial drawer sign but also constraining the tibiofemoral shear force leading to cranial tibial thrust. The results of those repairs are improved when compared to the traditional ones, providing full function return with no or only little progression of postoperative arthrosis.

Lack of objective data concerning this technique leads to controversy regarding the understanding of its effects, the preoperative planning and the type of technique to be used. The purpose of this discussion is:
1) to rationalize and develop further the preoperative planning
2) to present a modification of Slocum’s technique for the leveling of the tibial plateau
3) to introduce a surgical procedure consisting in a cranialization of the patellar ligament, allowing the quadriceps muscle to stabilize the stifle in presence of increased shear forces.

The surgical corrections pointed out here are feasible on any size of dogs, with readily available instruments and implants. Simultaneous limb realignment is possible. A soft tissue technique during closure of the wound stabilizes the persisting cranial drawer sign of the tibia, to avoid later meniscal damage.

Preoperative planning
Analysis of biomechanics of the hind limbs (figure 1) evidence the direction of the joint force of the stifle joint to be nearly parallel to the patellar ligament force. The joint force can be calculated from the joint reaction (compressive) force and the tibiofemoral shear force (figure 2). It must be perpendicular to the tibial plateau growth plate in young animals. The tibiofemoral shear force and the quadriceps muscle main peak activity have been demonstrated to be maximal in the early stance phase in humans. It is the task of the anterior cruciate ligament to stabilize the tibiofemoral shear force.

The tibiofemoral shear force is neutralized if the tibial plateau is perpendicular to the force of the patellar ligament. Greatest divergence angle between these two forces is present on radiographs of the stifle in extension.

Two possibilities exist in order to counteract the tibiofemoral shear force in cranial cruciate deficient stifles:
1) leveling the tibial plateau with Slocum’s procedure (figure 3) or its modification
2) change the direction of the patellar ligament (figure 4)

The necessary angle for neutralizing the tibiofemoral shear force is measured on the mediolateral radiograph of the extended stifle (figure 8). A line passing through both tibial insertions of the cranial and caudal cruciate ligaments is traced, representing the orientation of the tibial plateau. A second line passing through the patellar insertion of the patellar ligament is
traced perpendicularly to the line representing the tibial plateau. In most cases, the amplitude of this angle approximates 10°-15°.

**Surgical techniques**

Lateral approach to the stifle joint and lateral arthrotomy allows its exploration. Routine cleaning up is performed. Partially ruptured anterior cruciate ligament is left intact, removing only torn parts.

The insertion of the cranial tibialis and peroneus longus muscles is elevated from the lateral fossa extensoria unto the sulcus extensorius. A parapatellar incision of the pes anserinus is extended to the middle of the tibia and elevated off the proximal aspect of the medial tibia. The joint capsule is also opened on the medial aspect of the stifle joint.

**Modified Slocum’s technique:**

The retropatellar fat pad partially excised, respecting the cranial aspect of the menisci as well as the bursa located on the tibial tuberosity, under the patellar ligament.

The lateral muscular structures are retracted caudally and a transverse pilot hole is drilled through the tibia, using oscillating mode. Its origin is located at the distal insertion of the medial collateral ligament of the stifle. It represents the basis of a wedge ostectomy situated between the bursa of the patellar ligament cranially and the cranial aspect of the sulcus extensorius caudally (figure 5). The size of the wedge is analogue to the figured angle of correction. A 10° template is helpful to first set landmarks in order to define the transversal wedge to be removed from the proximal tibia using the oscillating saw. First, the cranial osteotomy line is carried out monocortically and then completed toward laterally while sparring periarticular soft tissue structures.

Overlapping of osteotomy lines has to be avoided to not create stress rising areas, which could generate later fracture of the tibia. Very slightly diverging osteotomy lines towards laterally are used to correct excessive tibial internal rotation. The bony wedge is removed.

A Hohman retractor is placed along the caudal tibial cortex after partial elevation of the popliteus muscle, to protect popliteal structures and vessels. Holes and a small cut with the saw are placed on the caudal aspect of the tibia, in order to weaken it, slightly proximal to the initial pilot hole. It is then possible to fracture the caudal tibial metaphysis towards cranially bringing it into contact with the tibial tuberosity, using bone-holding forceps. Severance of the fibula just below its head may help to respect the functional axes of the tibia during the leveling of the tibial plateau and maintain intimate contact between the two fragments.

Two interfragmentary screws of minimal sizes are placed in position function into a craniocaudal direction in order to stabilize the osteotomy (figure 6). The first, distal screw is aimed perpendicularly to the osteotomy line in a caudolateral direction. The second, proximal screw is parallel to the tibial plateau and to the medial cortex. Tapering the screw heads is avoided to not weaken the tibial tuberosity.

**Aponeurotic sling:**

After copious flushing of the wound the fibrous joint capsule is closed in oppositional cruciate suture pattern. The medial and lateral fasciae of the stifle are prepared further proximally around the femoral condyles and imbricated over the proximal cranial half of the tibia, with the
help of preplaced horizontal mattress suture pattern. The proximal lateral fascia is imbricated
over the patellar ligament with a far-near-far-near pattern (figure 7)

Cranialization of the patellar ligament
The insertion of the patellar ligament is advanced cranially by an open sagital osteotomy of the
tibial tuberosity (figure 4). After performing a medial arthrotomy, the medial meniscus is in-
spected for its integrity. An oscillating saw is used to perform a sagital incomplete osteotomy
preserving the insertion of the patellar ligament. The incomplete osteotomy is secured distally
using a hemicerclage wire (figure 9). The osteotomy is completed by fracturing distally the cra-
nial fragment. A bone expander wedge (tricalciumphosphate) of adequate size is inserted at the
osteotomy site to position the tibial tuberosity cranially. The repair is stabilized using a positive
threaded single pin inserted through the tibial tuberosity, bone expander, and into the proximal
tibial metaphysis.
After copious flushing of the wound the fibrous joint capsule is closed in appositional cruciate
suture pattern.

Closure
Facial incisions, subcutaneous layers and skin are then closed in appositional fashion.
Postoperative radiographs are made and a soft Robert-Jones bandage is applied over the limb
during the first two days. The activity of the dog is restricted with a leash until the first radi-
ological control,
4 - 6 weeks after the surgery.

Results
Three generations of this modified tibial plateau leveling osteotomy technique have been used
for the repair of cruciate deficient stifle on over 500 dogs (8 – 84 kg bodyweight) at the Univer-
sity of Zurich. The technique offers typically good to very good results. The gait was functional
and the operated stifles stable upon palpation 4 to 6 weeks after the surgery. Patients regain
their maximal musculature within 4 to 6 months postoperatively. Partial cruciate rupture did not
evolve and arthrosis appeared minimal at later controls (1 year or more). A clinical study on 100
consecutive surgeries revealed that 87% of operated dogs returned to full function of the oper-
ated limb 4 months after the surgery. Surgical complications could be revised and can be avoi-
ded.
Arthroscopy in the dog
Daniel M. Damur, Dr. med. vet. FVH

With the advent of advanced instrumentation and techniques, the use of arthroscopy in small animal orthopedics is growing in popularity. Although the long term medical efficacy and cost efficiency has yet to be determined, it is clear that arthroscopy provides both superior joint visualization and decreased patient morbidity when compared to open surgery. Perhaps the strongest indication for the use of arthroscopy is in the management of developmental skeletal disorders and osteoarthritis. Arthroscopic treatment of developmental disease such as OCD and canine elbow dysplasia has the potential to eliminate or diminish pain and dysfunction associated with both the primary disease and the secondary osteoarthritis. In addition, while a definitive protocol for the treatment of osteoarthritis remains elusive, it is likely that future management of this disease will involve both medical and arthroscopic techniques.

Advantages:
Although arthroscopy is a minimally invasive technique it allows an extended and a detailed inspection of the joint with the intra-articular structures and their pathologic changes. Arthroscopy can be used to demonstrate very discrete or early lesions without radiographic evidence. Because of the minimal surgical trauma, there is little postoperative care and minimal risk for complications. In case of osteochondrosis, bilateral treatment can be performed during one anesthesia.

Disadvantages:
The greatest initial disadvantage of arthroscopic surgery are the cost of equipment and the initial learning curve. Extensive practice on cadaver specimens is recommended prior to the application of arthroscopy on clinical patients. Practice is necessary to avoid complications including cartilage damage, periarticular swelling, and damage to equipment.

Materials
Arthroscope: 1.9 mm to 2.7 mm, 25 – 30 ° foreoblique
Trocar sheath
Light source- Light cable
Camera
Instruments : Probe, grasping forceps, curette, hand burr, banana-shaped knife, biopsy forceps
Instrument cannula
Joint distension and irrigation: Irrigation fluid (saline, lactated Ringer’s solution), gas

Methods
General anesthesia, Surgical preparation, Positioning
References


Schulz KS. Advancements in Arthroscopic treatment of developmental skeletal disorders. ACVS Proc.

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Standarized image documentation

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Practical course for fracture treatment (AO principles, advanced)

Daniel A. Koch, Pierre M. Montavon
(from the AO instructional videos, edited by A. Johnson, R Vannini, J. Houlton, K. Johnson, E. Asimus, D. Koch)

Comminuted Proximal Femoral Fracture
A comminuted fracture of the proximal femur is shown. Contouring the plate over the proximal end of the trochanter is important to achieve good fixation of this fracture. The contoured plate should fit the bone throughout its length, especially along the trochanter. The plate is secured to the bone with forceps. The first screw is placed through the plate into the trochanter. The next screw is placed through the most distal hole of the plate, in the diaphysis of the femur. Because of the configuration of this fracture, a lag screw is placed through the plate to give interfragmentary compression across one fracture line. The segmental portion is secured with a cortex screw through the plate. A screw is placed within the neck of the femur parallel to its long axis providing additional support to the proximal fracture stabilization. This screw should not penetrate the femoral head. All the plate screws are now in place. The proximal segment is secured because the screws in the proximal segment are triangulated.

Fracture of the Ilium and Acetabulum: The Reconstruction Plate
A fracture of the ilium and acetabulum presents a challenging situation to the orthopedic surgeon. One method of fixation of this fracture is to pre-contour a reconstruction plate that will fix both the acetabular and the ilial fractures with one plate. This plate must be bent and twisted to the contours of the pelvis. Once the plate is in place and the fracture reduced, a screw is placed through the most distal hole of the plate securing the plate to the caudal acetabular fragment. The steps of drilling, measuring the screw and tapping are performed as with any plate and the screw inserted. The next screw secures the cranial fragment of the acetabulum. The ilial shaft is secured in place with a screw placed in the proximal ilium. Additional screws are placed throughout the plate to provide the stabilization of the fracture fragments. A minimum of 2 screws should be placed in each fracture segment and where possible 3 or more screws used to provide stabilization. Any screw holes that lie over a fracture line should not be filled. An alternative method of fixing this type of fracture is to apply a standard dynamic compression plate to the ilium and an acetabular plate to the acetabular fracture.

Comminuted Acetabular Fracture repaired with a 2.7 Reconstruction Plate
This is the fracture to be repaired in this exercise. The landmarks for the incision are the wing of the ilium, the greater trochanter and the tuber ischium. This approach has been used because of the nature of the foam model. Other surgical approaches are possible. The foam is incised on the lateral aspect of the pelvis to expose the greater trochanter. Additional dissection to expose the acetabulum can include a trochanteric osteotomy. The joint capsule is incised to expose the articular surface. The intra articular fractures are reduced anatomically and temporarily fixed with K-wires. A 2.7 reconstruction plate is contoured to an intact acetabulum. The plate is applied to the fracture. The fracture reduction, the articular surface and the fixation are all evaluated.
Avulsion Fracture of the Femoral Head repaired with 2.0 mm lag screws,
This is the fracture to be repaired in this exercise. The landmarks for the incision for a medial approach to the hip are the pubis, and the pectineus muscle. The foam is incised over the medial aspect of the pectineus muscle. For viewing purposes the bones are removed from the foam. The joint capsule is incised to expose the fracture. The fracture is reduced and secured with 2, 2.0 mm lag screws. Countersinking ensures the screw heads will be below the cartilage after the screws are tightened. The fracture reduction is checked and the joint motion is evaluated.

Transverse Fracture of the Patella Tension Band Wire
This is the fracture to repair in this exercise. The landmarks for the incision are the distal femur, the patella and the tibial tuberosity. The foam is incised on the lateral surface of the stifle to expose the fracture. A K-wire is placed through the proximal bone segment from the fracture line to the proximal pole of the patella. Predrilling may be required if the bone is hard. The K-wire is reversed and the blunt end is driven proximally. The K-wire is withdrawn until the point is flush with the fracture surface. The fracture is reduced and the K-wire is driven distally. A tension band wire is placed by passing the wire through the soft tissues adjacent to the patella and behind the K-wire. The excess K-wire is cut. Alternatively, two K-wires may be used if the bone size permits.

Lateral and Medial Malleolar Fractures repaired with a Tension Band Wire and 2.7 mm cortex screw
In this exercise, these are the fractures to be repaired. The landmarks for the incision for the lateral malleolar fracture are, the fibular malleolus and the base of the 5th metatarsal bone. The foam is incised over the lateral aspect of the, fibula and the tarsus. The foam is retracted, to expose the fracture. A hole is drilled with a K-wire through the fibula 1cm proximal to the fracture. A strand of wire is placed through the hole. A K-wire is inserted starting at the malleolus and exiting at the fracture. The fracture is reduced and the wire driven proximally. The figure of eight wire is secured to form a tension band. The landmarks for the incision for the medial malleolar fracture are the distal tibia, medial malleolus and the base of the second metatarsal bone. The foam is incised over the medial aspect of the distal tibia and tarsus and the fracture is exposed. The malleolar fragment is overdrilled from inside out to ensure proper placement of the screw while avoiding the articular surface. The fracture is reduced and secured with a 2.7 mm lag screw. An anti-rotational K-wire can be used with a larger fragment.

Proximal Intertarsal and Tarsometatarsal Arthrodeses using an 8 hole 3.5 DCP
The landmarks for the incision are the calcaneus and the lateral surface of the base of the metatarsal bones. The foam on the lateral surface of the tarsometatarsal joint is incised to expose the calcaneus, the fourth tarsal bone, and the base of the 5th metatarsal bone. In the clinical case, the articular cartilage from the tarsometatarsal and proximal intertarsal joints is thoroughly removed with a bone curette or high speed burr, following the contours of the bone ends. Cancellous bone is harvested from a suitable site. The graft is placed within the prepared joints and additional graft may be added after the plate is secured. The base of the 5th metatarsal bone and a portion of the fourth tarsal bone are smoothed with the oscillating saw to provide a smooth surface for the plate. An appropriately contoured 8 hole 3.5 DCP is placed on the
lateral surface of the calcaneus, the 4th tarsal bone and the 5th metatarsal bone. The plate is positioned with three screw holes over the calcaneus and three screw holes over the metatarsal bones. A screw is placed through the proximal plate hole into the calcaneus. The plate position is checked and a screw is placed through the distal plate hole into the fifth and fourth metatarsal bones. The remaining plate holes are filled. The third screw in the calcaneus should also secure the talus.

**Pantarsal Arthrodesis using a 12 hole 3.5 DCP**

The landmarks for the incision are the distal diaphysis of the tibia, the medial malleolus, and the metatarsal bones. The angle for the pantarsal arthrodesis is predetermined by observing the normal standing angle of the tarsus in the individual patient. The angle is usually between 135 and 145 degrees. The foam is incised on the medial aspect of the tarsal joint. The foam is retracted to expose the cranial surfaces of the distal one third of the tibia, the tarsal joint and the proximal one half of the third metatarsal bone. The medial collateral ligament is cut to gain access to the joint surfaces. In the clinical case, the articular cartilage of the talocrural joint surfaces, the proximal intertarsal joint surfaces and the tarsometatarsal joint surfaces is thoroughly removed with a bone curette or high speed burr, following the contours of the bone ends. Cancellous bone is harvested from a suitable site. The graft is placed within the prepared joints and additional graft may be added after the plate is secured. A 12 hole 3.5 DCP is positioned. It has been precontoured to provide 140 degrees of joint angle to the cranial surface of the tibia, the talus, the central tarsal bone and the third metatarsal bone. The acute bend in the plate is positioned over the neck of the talus. There should be enough plate holes for a minimum of five screws in the tibia and three screws in the metatarsal bone. The level of the distal metatarsal plate screw is marked. The plate is removed and the drill is centered on the metatarsal bone to prepare the first screw hole. The plate is secured with three screws in the metatarsal bone, plate and joint alignment are checked and the plate is secured to the tibia. The remaining plate holes are filled. At least two plate screws should penetrate the calcaneus to secure the joint. The axial alignment of the limb and the angle of the arthrodesis are critically observed.

**Distal Femoral T Fracture repaired with a 3.5 Reconstruction Plate**

This is the fracture to repair in this exercise. The landmarks for the incision are the distal diaphysis of the femur, the patella and the proximal tibia. The foam is incised on the lateral aspect of the stifle. To expose the distal one third of the femur and the proximal portion of the tibia. The intra articular fracture is reduced anatomically and temporarily fixed with reduction forceps. A 3.5 mm lag screw is placed across the fracture line to achieve compression. The supracondylar fracture is reduced. It is stabilized with a laterally applied eight hole 3.5 reconstruction plate contoured to match the distal femur. The fracture reduction and fixation are critically evaluated.

**Transverse Fracture of the Calcaneus repaired with a Tension Band Wire, or a 2.7 DCP**

This is the fracture to be repaired in this exercise. The landmarks for the incision are the tuber calcanei and the lateral surface of the base of the 5th metatarsal bone. The foam is incised on
the lateral surface of the calcaneus to expose the fracture. A transverse hole is drilled in the proximal and the distal segments. This positioning of the holes and subsequently the wire avoids irritation of the superficial digital flexor tendon. A wire is placed through the distal hole. Two K-wires are inserted through the proximal bone segment to exit at the fracture. The fracture is reduced and the K-wires driven distally. The tension band wire is secured. The K-wires are cut and bent. The wires could also be retracted cut and countersunk. Alternatively a 2.7 DCP may be placed on the lateral surface of the calcaneus to compress the fracture.
Treatment of Rupture of the Common Calcaneal Tendon

Katja Voss, Dr. med. vet; Curzio Bernasconi, Dr. med. vet. FVH ECVS

Introduction
The common calcaneal tendon (achilles tendon) consists of three tendons, which are the tendons of the gastrocnemius and flexor digitalis superficialis muscles and a common tendon formed by the biceps femoris, semitendinosus and gracilis muscles. The gastrocnemius and the common tendon insert on the calcaneus, the tendon of the flexor digital superficialis muscle runs over the calcaneus and inserts plantar on the digits. The common calcaneal tendon is an important part of the achilles mechanism. In animals with an intact achilles mechanism extension of the stifle joint automatically leads to extension of the tarsal joint.

The cause for achilles tendon rupture is trauma, usually caused by sharp objects. After rupture of the achilles tendon the tarsal joint can be abnormally flexed while the stifle joint is being held in extension. The presence of thickening of the tendon or open wounds also helps with the clinical diagnosis. Traumatic avulsion of the proximal insertion of the gastrocnemius muscle can lead to a similar clinical entity. In this rare occasion stress radiographs reveal a dislocation of the fabellae towards distal.

The patient should be operated as soon as possible. Delaying of the surgery leads to adhesion formation between the tendons, decreases their natural gliding function and complicates tenorrhaphy because of muscle contracture. Primary end-to-end tenorrhaphy is performed with non-absorbable suture material. Tendon suture techniques compress the longitudinal collagen bundles of the tendon in order to reduce the risk of pulling out of the suture. The locking-loop technique is suitable for small tendons, the three-loop-pulley technique is more appropriate for larger tendons.

Lyophilized Swine Intestinal Submucosa (SIS) is now available. This material shows high tensile strength and does not interfere with wound healing. Its soft mesh structure acts as a scaffold for revascularization while preserving the budding capillaries from mechanical injuries. SIS placed around the tenorrhaphy side can enforce the repair. It is anchored to the tendon with simple interrupted sutures.

In the initial healing phase, the tendon repair must be protected by immobilization of the tarsal joint. This is best done with a transarticular external fixator. After 4 weeks the newly formed scar tissue begins with longitudinal orientation of the collagen bundles. At this time removal of the external fixator and a gradual decrease of the external stabilization is indicated, for example by placing an external

Fig. 1: Locking-loop

Fig. 2: Three-loop-pulley
splint for 1 or 2 weeks. All together, activity is restricted until three month postoperatively.

**Operation**

**Tenorrhaphy:**
- Lateral skin incision, identification of the tendons, section of the tendons
- Tendon repair with locking-loop (Fig. 1) or three-loop-pulley suture (Fig. 2), gentle tissue handling, SIS if necessary
- Closure of subcutis and skin with a simple interrupted suture pattern or open wound management in the presence of large and/or contaminated wounds.

**Placement of the external fixator, type II:**
- Pin 1: skin incision medioproximal to the tibia. Pre-drilling the pinhole as caudal as possible (more bone substance because of triangular shape of the proximal tibia) and slightly directed towards distal (more stability). Insertion of a centrally positive threaded full pin
- Pins 3 and 4: skin incision medial and lateral to the metatarsus. Placement of the smooth pins in the proximal metatarsal bones 2 and 3, respectively 4 and 5. The angle of insertion is slightly towards dorsal to be able to engage two metatarsal bones.
- Connection of the pins and the connecting bars, respecting the physiologic joint angle (130-150°). The angle is measured preoperatively on the healthy leg, while the animal is standing. In cases with a lot of tension on the tenorrhaphy, the tarsus is immobilized in a slightly hyperextended position.
- Pin 2: Skin incision mediodistal to the tibia. Pre-drilling the pinhole, slightly directed towards proximal. Insertion of positive threaded pin (half or full pin). Connection with the side bars.

**Special instrumentation**
- Nonabsorbable suture material with a cutting needle, for example Prolene 2-0
- Vet BioSIS®, Fa. Cook
- External fixator: Threaded and unthreaded pins, connecting bars, connecting clamps

**References**
Diagnostic approach to the spinal patient
Frank Steffen, Dr.med.vet. Diplomate ECVN

The very first approach to every patient with a suspected neurological disorder is a full neurological examination. The aim of the neuroexam is to assess the functional integrity of the central and peripheral nervous system. The neurological tests are best recorded in a form, to ensure that no aspect of the examination is missed.

Suggested approach to the spinal patient:
1. neurological examination
2. localisation of the lesion
3. List of differential diagnosis
4. Additional diagnostic testing
5. Treatment

Spinal diseases may manifest as a variety of dysfunctions depending on their localization in the spinal cord. The same specific disorder may be present with different clinical signs i.e. a spinal cord neoplasm at the C2 - level may result in spastic tetraparesis, whereas the same tumor in the lumbar intumescence produces a flaccid paraparesis. Thus, the first step is the neurological examination with subsequent localization before the etiological diagnosis is done.

The spinal cord is functionally and anatomically divided in four divisions. These divisions include (spinal cord segements):

- Cervical (C1-C5) UMN
- cervical enlargement (C6-T2) LMN
- thoracolumbar (T3-L3) UMN
- lumbar (L4-Cd5) LMN

A disorder of each of the four regions results in a combination of neurologic signs that is specific for the division involved (not for the disease causing it). The functional difference of upper motor neurons (UMN) and lower motor neurons (LMN) may be used to localize lesions to one of these divisions.

Neurons of the UMN are located in the brain with their axons forming descending pathways in the spinal cord white matter that synapse with interneurons that connect it to the LMNs within the gray matter. UMN divisions are the cervical and the thoracolumbar region. Typical symptoms for these dysfunctions include loss or depression of voluntary movement, normal or exaggerated spinal reflexes, increased muscle tone and disuse atrophy of muscles.

Example: A dachshound with Paraplegia of the hindlimbs, increased patellar reflex and urinary retention and intact deep pain sensation has suffered an incomplete spinal cord lesion in the T3-L3 area (= UMN lesion of the hind limbs)

LMN regions are the cervical and lumbar enlargement. LMN-symptoms include depression or loss of voluntary motor activity, decreased or absent spinal reflexes and muscle tone and rapid, severe atrophy of affected muscles due to denervation.
Example: A Doberman with Tetraparesis, decreased spinal reflexes in the front limbs, increased spinal reflexes in the hind limbs, decreased proprioception in all 4 limbs. Localisation: Spinal cord lesion C6-T1 (= LMN of the front limbs. For the hind limbs this is a UMN type lesion as axons of the UMN pass through the C6-T1 area, where the lesion is located)

After localization of the spinal problem to one of the four divisions (= neuroanatomical diagnosis) the various potential disorders causing it should be anticipated by considering signalement, history and results of physical exam. Disorders may be divided in major categories each having specific characteristics that helps to rule it in or out of the list of differential diagnosis.

**The major disease categories** for the spinal cord include vascular, inflammatory, traumatic, neoplastic, degenerative disorders and anomalies. The list can be considerably shortened if some basic information such as age, breed, course (acute or chronic), presence of hyperesthesia and localisation within the spinal cord is taken into account.

Based on this initial list of possible diseases, ancillary diagnostic procedures should be instituted to reach a specific diagnosis. These investigations in advised order of completion are noncontrast vertebral radiography, cerebrospinal fluid analysis and myelography. Additional procedures such as electrodiagnostic testing or advanced imaging modalities (CT and MRI) are added to the list, depending on the problem being evaluated.

**Noncontrast vertebral Radiography.** This "survey examination" is essential in the accurate diagnosis of spinal disorder. In view of future problems, that are not manifest at the time of presentation and possible multiple lesions escaping the neuroexam it is advisable to radiograph the entire spine. Correct technique, exact projections and proper positioning are essential. Further diagnostic steps may follow depending on the results of plain radiographs (i.e. culture of blood and urine following detection of a discospondylitic lesion or a biopsy of a vertebral neoplasm).

**Cerebrospinal fluid analysis.** This laboratory exam should include cell count and differentiation and estimation of protein content. Collection sites may be cervical and lumbar (lumbar collection may be of advantage, because CSF flow occurs from cranial to caudal and caudal lesions may not produce abnormal "cervical CSF"). CSF changes may be seen mainly in inflammatory or necrotizing spinal cord lesions. Rarely neoplastic, vascular and degenerative lesions cause abnormalities.

**Myelography.** This examination may still be seen as the most useful procedure as it helps to recognise many disorders affecting the subarachnoid space. Patterns of myelographic alteration may used to differentiate intramedullary, extradural and intradural-extradural lesions. Myelography is not an easy procedure to perform and requires quite a degree of routine, otherwise it results in undesired consequences such as injury to cord tissue and uninterpretable radiographs. A lumbar site of injection is preferred for dogs and cats with disorders at any level of the vertebral column (an exception may be the examination of the cauda equina, where lumbar injections may produce extradural contrast leakage resulting in artifacts difficult to interpret). Use of dynamic techniques and completion of oblique projections may enhance the diagnostic sensitivity of the procedure.

**Epidurography.** This technique is of value in evaluating the lumbosacral junction, i.e. when the dural sac ends cranial to the Ls junction or is elevated form the ventral vertebral floor. Radiographic signs of narrowing, elevation, deviation, or obstruction of the epidural contrast
medium column involving greater than 50% of the vertebral canal diameter has been reported to be consistent with significant compression of neural tissue.

**Discography.** Discography consists of injecting contrast medium into the nucleus pulposus. It is easily performed at the Ls junction; it is extremely difficult to perform at lumbar or thoracolumbar sites. It is not possible to inject more than 0.3 ml of contrast medium into a normal disc. Intradiscal accumulation, focal extravasation and a nonhomogeneous contrast medium pattern within the nucleus pulposus are considered abnormal. One study reported 87% accuracy in diagnosing lumbosacral disc herniation i.e. in detecting lateral disc protrusions impinging the nerve roots.

**Electrophysiologic testing.** Electromyographic abnormalities are recorded only in LMN-lesions. It may be used in mapping the affected spinal cord segments or nerve roots. EMG may help to distinguish between disuse atrophy and atrophy of muscles secondary to denervation. Determination of sensory and motor nerve conduction velocities are of value in the identification of the nerve roots affected by a spinal cord disease. Spinal cord evoked potentials are recordable along multiple areas of the spine by stimulating a peripheral nerve. Ascending evoked potentials are moving through fast conducting fibers in the dorsal columns and dorsolateral funiculi of the spinal cord. Near the site of spinal cord damage a so called evoked injury potential is recorded which is indicating the severity of the lesion. In one recent study, the technique was evaluated in dogs with thoracolumbar spinal cord compression. By comparing the functional and the actual (myelographic) site of compression, the severity of the lesion could be estimated.

Magnetic Motor Evoked Potentials represent the electrical activity in the descending tracts of the spinal cord in response to an external stimulus. MEP are recorded in the spinal cord, peripheral nerve or target muscle. They are very sensitive to detect spinal cord lesions, but one study found them not to be sensitive in predicting the prognosis of dogs with disc protrusions.

**Advanced imaging procedures.** Since the availability of CT- and MRI-scanners, diagnostic sensitivity is increasing and antemortem diagnosis of specific spinal cord diseases such as syringomyelia has provided new insights. It is likely that these modalities become the gold standard for evaluation of spinal cord diseases in near future. CT is of advantage in evaluating the lateral recesses, intervertebral foramen and articular processes. This is especially of value in cases with mineralized tissue suspected to be involved in the disease process (i.e. vertebral osteochondrosis dissecans or malformations of the bony parts of the spine). MRI provides soft tissue contrast that is superior to CT and there is direct visualisation of the spinal cord, cerebrospinal fluid, intervertebral discs, ligaments and nerve roots.
Cervical spinal cord: Ventral slot technique
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Introduction

About 15% of all intervertebral disc protrusions or herniations seen are localized in the cervical region. As in the thoracolumbar area, mainly chondrodystrophic breeds are involved, like Dachshounds, Beagles, Pekingeses. However, with Doberman pinschers and Great Danes, a different cervical disease entity is seen, where various caudal cervical malformations can lead to disc protrusions. This disease entity is known as caudal cervical spondylopathy.
The main clinical symptom is severe cervical pain on manipulation of the neck, and different degrees of neurologic deficits and lameness can be seen ranging from mild paresis of one limb up to complete tetraplegia.
Conservative treatment with cage rest and glucocorticoid therapy only very rarely results in complete restoration and often only transiently. Therefore in nearly all cases surgical decompression is the treatment of choice.
Surgical decompression of the cervical spinal cord can be achieved via different approaches, either from dorsally with dorsal laminectomies or hemilaminectomies or ventrally by discus fenestration and partial corpectomy. The latter technique, also called ventral slot is described here.

Instruments:

- 2 scalpel blades: Nr. 10, 11
- 2 tissue forceps: Adson, DeBakey
- 2 Mosquito hemostatic forceps: Halsted
- 2 self retaining retractors: Gelpi
- periosteal elevator
- single acting rongeurs
- pneumatic or electric burrs
- nerve root retractors
- Bone curette

Additionally, but not in this course:
- Electrocautery
- Syringe for rinsing
- Suction device

Surgical technique:

1. Positioning:
The dog is secured in dorsal recumbency with frontlimbs tied towards caudally. Some padding is put underneath the neck region to slightly elevate or overstretch the cervical region.
Don’t overstretch too much to prevent respiratory problems. The position should be as symmetrical as possible.

2. Approach:
Incise the skin from the larynx to the manubrium. Deepen the skin incision and separate the spincter colli muscle. Hemostasis follows. After blunt separation of the paired bellies of the sternocephalicus and sternohyoideus muscles at midline the trachea and esophagus can be retracted towards the left side. Take care not to damage the recurrent laryngeal nerve, which lies directly laterally to the trachea. After tracheal retraction bluntly separate further at the midline until the longus colli muscle is seen.

3. Orientation:
Count the vertebra either from cranially by starting with the prominent transverse processes of the atlas or from caudally by palpation of the prominent transverse processes of the sixt cervical vertebra. Identify the intervertebral disc to operate on by palpation and cut the longus colli tendon of insertion caudal to the ventral crest with a short transverse incision. Continue to bluntly separate the longus colli muscle from the ventral crests of the vertebral bodies cranial and caudal to the intervertebral disc. Prepare only as far laterally as needed for the creation of the ventral slot which should not exceed 50% of the vertebral bodies width. This way the vertebral arteries can be preserved.

4. Ventral decompression:
With a number 11 scalpel blade create a window into the ventral annulus fibrosus. Create a medial bony window including 50% of the cranial and 30% of the caudal vertebral bodies length and ideally around 30% of the vertebral bodies width. Using the burr and water for cooling during the procedure, removal of the bright ciscortex reveals a darker cancellous bone. The transcortex is seen again as bright structure, and care should be taken not to break through it inadvertently. By the time the innermost layer of the transcortex is very thin and soft on palpation, remove the remaining dorsal annulus fibrosus with the number 11 scalpel blade by incising it rectangularly. With fine bony curettes enter the vertebral canal and remove protruded disc material. Take care not to lacerate venous sinus vessels which lie laterally on the vertebral floor.
5. Closure:
Adapt the paired bellies of the sternocephalicus and sternohyoideus muscles with simple continuous sutures. Use simple interrupted sutures for subcutis and skin.
Hemilaminectomy for thoracolumbar discus
Barbara Haas, Dr. med. vet, Fachtierärztin Kleintiere

Thoracolumbar lesions account for round 85% of the intervertebral disc problems in dogs. The most commonly affected breed is the Dachshund. The age incidence for clinical disease in chondrodystrophoid breeds is highest at 3 to 6 years. Thoracolumbar disc lesions occur most commonly between T11-T12 and L1-L2.

Medical treatment is reserved for animals that experience back pain or mild paresis, for animals with chronic loss of pelvic limb deep pain, and for dogs whose owners decline surgical treatment. Dogs that retain deep pain after thoracolumbar disc extrusion usually respond favourably to decompressive surgery.

Decompression is indicated when extrusion of disc material into the spinal canal results in ataxia, paresis, or paralysis. Optimal results depend on early intervention and gentle surgical technique. Hemilaminectomy, minihemilaminectomy, and pediculectomy are used most commonly. All of these three methods have their specific advantages and disadvantages. They may be easily combined with prophylactic fenestration.

Dorsal approach to thoracolumbar discs

The skin incision is made slightly off the dorsal midline and extends two to three vertebrae cranial and caudal to the vertebrae to be exposed.

The subcutaneous tissue is incised to the muscle fascia and retracted laterally with the skin. The lumbar fascia is incised slightly away from the dorsal spinous processes.

Lateral retraction of the lumbar fascia exposes the longissimus lumborum and multifidus muscles caudally and spinalis and semispinalis muscles cranially.
The multifidus, interspinalis, and rotators longi muscles are elevated from the spinous processes and vertebral arches one vertebra cranial and caudal to the affected vertebrae with a periosteal elevator. The muscle elevation is continued to the lateral aspect and ventral to the articular processes.

Fascicles of the longissimus thoracis et lumborum muscle attach to the accessory process of the vertebrae. In the thoracic region these fascicles divide and also attach to the ribs. The dorsal branches of the spinal nerves are located just ventral to these tendinous insertions. The intervertebral disc space is located caudoventral to these tendinous insertions. A small blood vessel is severed at each articular process.

Hemilaminectomy is initiated by unilateral removal of the articular processes with large rongeurs.

Application of gentle cranial traction to the dorsal spinous process of the cranial vertebra and caudal traction to the dorsal spinous process of the caudal vertebra using towel clamps produce a widening of the intervertebral space that enables insertion of one jaw of a small Lempert rongeurs. The spinal cord is exposed by removal of bone from the ipsilateral portions of the pedicles and dorsal laminae of the involved vertebrae. Lembert and Love Kerrison rongeurs and small bone curettes are useful for completing the hemilaminectomy. With these instruments, cutting force is always applied in such a way that if the instrument slips, it moves away from the spinal cord rather than toward it.

Using a pneumatic drill and burs it is important to pay close attention to changes in color and texture of the bone being drilled toward the vertebral canal. After the outer white cortical bone is brushed away, a thick layer of reddish brown trabecular bone is encountered next, followed by a thin inner layer of white cortical bone and finally a translucent inner periosteal layer. Careful lavage and suction are needed to maintain a clear field throughout the drilling process.
When all bone has been removed the spinal cord is exposed covered by pial blood vessels and transparent dura mater. Sometimes it is possible to see extruded disc material compressing the spinal cord. The disc material is removed by a combination of gentle suction and use of a thin tartar scraper to scoop material from beneath the spinal cord. The venous plexus is visible on the floor of the vertebral canal. Care must be taken to avoid damaging the venous structures. Closure is started by suturing the dorsal fascia of the thoracolumbar musculature. The subcutaneous tissue and skin are closed in separate layers. Dead space must be avoided since seroma formation is often a complication.

**Instruments**

- Needle holder
- Scalpel blade number 10
- Metzenbaum scissors
- Adson tissue forceps
- Adson periosteal elevator
- Gelpi retractor
- Moskito
- Different Rongeurs
- Striker with different sized burrs

J. P. Bray, H. Burbridge; The Canine intervertebral disk, Part two: Degenerative Changes- nonchondrodystrophioid versus chondrodystrophioid disks, Journal of the American Animal Hospital Association; 1998; 135-144
P. Muir, K.A. Johnson, P.A. Manley R. T. Dueland; Comparison of hemilaminectomy and dorsal laminectomy for thoracolumbar intervertebral disc extrusion in dachshund; Journal of small animal practice 1995; 36; 360-367
H. W. Scott; Hemilaminectomy for the treatment of thoracolumbar disc disease in the dog: A follow up study of 40 cases; Journal of small animal practice 1997 ; 38; 488- 494
J. Tomlinson, K.L. Schwink; Surgical Approaches to the Spine; in Slatter, Textbook of small animal surgery, 1993; 1038-1048
J.P. Toombs, M. S. Bauer; Intervertebral disc disease, in Slatter, Textbook of small animal surgery, 1993; 1070-1087
J. C. Yovich, R. Read, C. Eger; Modified lateral spinal decompression in 61 dogs with thoracolumbar disc protrusion; Journal of small animal practice 1994; 35; 351-356
Spinal stapling for fractures and luxations
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Introduction

Spinal fractures or luxations in the thoracolumbar region are mostly caused by bending and torsion forces. Initial treatment and manipulation are important measures in order to minimize additional trauma to the spinal cord. The indication for surgical stabilisation depends on neurostatus and its development, size of the animal, age and activity. Dorsal stabilisation of the spinal cord is advantageous because this is the tension side. We present a laminar fixation relying on the tension band principle. The approach to the lamina is minimal to spare as much epaxial musculature as possible. A K-wire is passed through the lamina of the bigger of the two vertebrae, which are adjacent to the two vertebrae belonging to the instability. This K-wire is bent like a "U" and molded close to the lamina and the dorsal aspects of the facets. After fixation, a cerclage wire is passed in a figure "8" manner through the laminae of the two vertebrae at the instability. The instability is reduced, the wire crossed and twisted above the K-wire.

The technique is rather quick. It allows mobility of the spinal cord. The implants are small and are not removed. Results of more than 50 cases show more than 90% recovery and only two cases, where the neurostatus deteriorated.

Technique (fracture/luxation at lumbar vertebrae 1 and 2, dog 30 kg)

1. Identify the last rib
2. Incise the skin over 6 spinal processes, centered over lumbar 1 and 2
3. Incise the fascia paramedian on both sides of the processus spinosus, spare the interspinal ligament
4. Detach the expaxial musculature from the spinal processes and the facets in a caudocranial direction, until the mammillary and articular processes are visible. Avoid further detachment. Use Gelpi retractors.
5. Insert a long Kirschner wire (25 cm, Ø 1.6 mm) into the lamina at the most ventral point possible at lumbar 3. Avoid penetration into the spinal canal by studying the exact anatomy (Fig 1). In order to achieve precise horizontal positioning, the K-wire must pass skin and musculature first. After having passed the bone, it is deviated with a retractor, drawn out of the musculature and repositioned
6. Bend the K-wire to a "U" and mold it exactly alongside the laminae. The K-wire must lie exactly on the bone between articular facets and lamina. The K-wire ist fixed at thoracic 13 with a cerclage wire.
7. Drive two holes in lumbar 1 and 2 at the same position as the K-wire. Pass a cerclage wire (1.0 to 1.2 mm) in figure-8
through the holes and cross it over the K-wire. Reduce the fracture or luxation and twist the cerclage wire. The fracture or luxation will automatically remain in the correct position, if the holes at the same height.

8. If necessary, mini-hemilaminectomy or pediculectomy can be performed to decompress the spinal cord.

9. In young dogs with soft bone quality, four additional cerclage wires can be placed around the transverse processes or ribs and the K-wire. By means of this, the forces are more evenly distributed.
Dorsal Laminectomy for Cauda Equina syndrome
Renate Dennler, Dr. med. vet.

In most dogs the spinal cord ends in the L₆ vertebra. The individual spinal nerves descend from their spinal cord segment to exit via respective foramina. So the vertebral canal of the low lumbar and sacral spine contains not spinal cord but these caudally trailing nerves, referred to as the cauda equina.

The L₆, L₇ and S₁ nerve roots form the sciatic nerve after exiting the foramina. S₂ and S₃ nerve roots contribute to the pudendal nerve controlling urinary and fecal continence. Lesions in the lumbosacral region can lead to compression of neural structures in the vertebral canal and intervertebral foramina. The related clinical problems are referred to as lumbosacral disease or cauda equina syndrome. Common problems are back pain, reluctance to exercise, difficulty in rising, sitting or jumping, lameness (root signature, referred pain), gait abnormalities of the pelvic limbs, or lower-motoneuron neurological deficits as well as paresthesia and hyperesthesia. Lower urinary tract, tail and anus may also be affected.

A number of pathological conditions can cause compression and ischemia of the nerve roots. Only the most frequently encountered disorders may be mentioned here:

- Hansen Typ II disc protrusion at the L₇/ S₁ intervertebral space
- Stenosis of the vertebral canal (acquired or congenital)
- Instability and malalignment between L₇ and S₁, spondylosis
- Soft tissue proliferation, usually of the joint capsules or ligamentous structures

Larger breeds of dogs, particularly German shepherds, are affected. Especially involved are young working dogs that have been heavily trained.
Diagnosis
A thorough physical, orthopaedic and neurological examination, including rectal examination, are essential.

Survey radiographs in the anaesthetized patient should be taken as some specific diseases may be visible. Be careful as many clinically normal dogs have radiographic abnormalities of the lumbosacral junction.

Myelography is useful in assessing the low lumbar spine. In most dogs, the subarachnoid space extends beyond the lumbosacral junction. Cervical injection is preferred. Flexion-extension can demonstrate lesions. Epidurography is another possibility to show lesions. Usually, an obstruction or dorsal deviation of the column is noted. Other possibilities are discography, CT and MRI. Abnormal findings in electromyography confirm the presence of neurological disease, but not the etiology.

Treatment
A nonsurgically treatment with rest and anti-inflammatory medication can lead to improvement but is usually unacceptable in working dogs. By dorsal laminectomy and foramenotomy, decompression and of the cauda equina and spinal nerves is achieved. This procedure provides pain relief with improvement of mild gait abnormalities and minor neurological deficits. Surgery does not resolve the problem of instability but may contribute to this problem.

Material
Scalpel blades no. 10, 11, 15
Metzenbaum scissors
Adson forceps
Gelpi retractor
Power bur
Rongeurs of different sizes
Probes
Currettes of different sizes
Needle holder
Absorbable suture material

Procedure
1. Position the dog in ventral recumbency. The pelvic limbs are drawn forward. The back is extended over a sandbag to open the space between the vertebral laminae.
2. The skin incision is made from the spinous process of L₅ to the caudal end of the fused spinous processes of the sacrum. The superficial fascia is incised in the same line.

3. The deep lumbodorsal fascia is incised around the spinal processes. The epaxial musculature is elevated from the spinous processes and retracted with self-retaining Gelpi retractors.

4. The caudal half of the spinous process of L₇ and whole S₁ are removed with rongeurs.

5. The laminectomy is made with the power bur to the inner cortical bone. It should be restricted to the dorsal lamina. Do not touch the articular processes at this stage. Then the ligamentum flavum is removed by scalpel blade no 11. Be careful not to penetrate too deep and to damage the underlying neural structures.

6. The final shelf of bone is thinned with the bur and then carefully removed with rongeurs.

7. The cauda equina can now be inspected. A protruded disc is palpated by running a probe along the floor of the vertebral canal. The anulus fibrosus can be incised with a no 11 blade just medial to the venous sinuses and then be removed. The nucleus pulposus is removed with curettes.

8. If a foramenotomy is necessary, this can be done now. The articular processes should be preserved if possible, as removal contributes to instability. The laminectomy can be extended laterally and the foramen be explored with a probe and enlarged with a curette. The foramen lies cranial to the disc.

9. The laminectomy is covered by a fat graft and the wound is closed in a routine fashion.

**Aftercare**

The dog should strictly be restricted to rest and leash walking for 4 weeks, followed by gradual build up in another 2 months. Animals that are permitted to excessive exercise, frequently recover poorly.

Laminectomy and foramenotomy provide a quick relief from pain. Dogs in a early stage of disease with lameness and mild neurological deficits usually recover very well. Dogs in a later stage of the disease with more severe deficits have a guarded prognosis for full recovery.
Sacrococcygeal luxations
Tomas Guerrero, Dr. med. vet.; Curzio Bernasconi, Dr. med. vet. FVH ECVS

Introduction

Fractures of the sacrum or fracture/luxations at the basis of the tail are secondary to trauma and are observed especially in the cat. These lesions are often associated with several neurological deficits. Of special clinical importance are micturition disorders. Nevertheless, reports about surgical management of these patients are rare. The necessity of reduction and stabilization of these fractures or fracture/luxations has been advocated. Described surgical repairs are dorsal decompression, stabilization with wires or pins and tail amputation. Stabilization with wire or pins can be difficult due to the dimensions of sacral and coccygeal vertebrae in the cat.

A surgical stabilization has been used at the Veterinary Surgical Clinic of the University of Zurich. It is usually performed by means of an internal sling using suture material (polypropylene) mounted on a small half-circle non-cutting needle.

Surgical technique

1. Dorsal midline incision of the cutis and subcutis on the sacrococcygeal area.
2. Two paramedial incisions lateral to the spinal processes are made.
3. Blunt dissection and lateral retraction of the dorsal musculature allows visualization of the luxated vertebra (usually the first coccygeal vertebra).
4. Two holes are drilled in the base of the spinal process of the second sacral vertebra using a 0.8 K-wire
5. The end of the suture material is passed through one hole and the needle around a transverse process of the first caudal vertebra.
6. The suture material is cut in the middle and the ends of the loop are held with Mosquito forceps.
7. The same procedure is repeated on the opposite side, using the contralateral transverse process and the second hole in the spinal process (fig 1).
8. The luxated vertebra is repositionated and the knots are tied.
9. Correct reposition is judged by observing the position of the articular facets.

Sacral fractures between sacral vertebra 2 and 3 can be fixed using a nonresorbable suture or hemicerclage passes through two holes placed in the basis of the spinal process of the second and third sacral vertebra.
Fig. 1: Dorsal view of the sacrococcygeal skeletal region of a cat after reposition and internal fixation with an internal sling.

Special instruments

- Kirschner wire
- Jacob's pin chuck and key
- bone-holding forceps
- periosteal elevator

References


