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Published in:
Dansk Veterinaertidsskrift

Publication date:
2015

Document version
Også kaldet Forlagets PDF

Citation for published version (APA):
Allpass, M., & Miles, J. E. (2015). Case report - curved femoral osteotomy for management of medial patellar luxation. *Dansk Veterinaertidsskrift*, 98(12), 32-36.

Case report – Curved femoral osteotomy for management of medial patellar luxation

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Sammendrag

Medial patellaluxation kan forårsages af femoral varus hos hund. Førhen har patienter med excessiv femoral varus været korrigeret ved en lateralt placeret femoral kile-osteotomi. Her præsenteres en case, hvor en buet osteotomi blev anvendt til behandling af medial patellaluxation.

Summary

Medial patellar luxation in dogs can be caused by distal femoral varus. Typically, patients with excessive femoral varus have been treated with a closing wedge osteotomy. We present a case in which curved femoral osteotomy was used to resolve clinical signs associated with medial patellar luxation.

Background

Patellar luxation is the dislocation of the patella outside the femoral trochlea. The patella can luxate medially, laterally or bidirectionally, and can appear as a uni- or bilateral disorder (1,2). Canine patellar luxation can be categorized as either traumatic or congenital in origin (2-6). The pathophysiology and pathoanatomy of congenital patellar luxation are complex and not yet completely understood, though many musculoskeletal deformities have been shown to predispose the dog to medial patellar luxation (MPL) in particular (6-8).

Excessive distal femoral varus is associated with MPL (9-16). Dogs suffering from MPL, particularly high grades of MPL, have greater femoral varus angles (FVA) than normal dogs (9,10,12). The FVA of normal dogs has not been clearly established, and appears to vary with breed (9,10,12,17-21). The cut-off between normal FVA and excessive varus is unclear, and indications for surgery remain controversial (14). Recommendations are based solely on clinical experience, with FVA cut-off values in MPL patients of $\geq 10^\circ$ (17) and $\geq 12^\circ$ (10,19) proposed as justifying surgical intervention.

Excessive femoral varus can be reduced surgically, but there is no agreement on the ideal postoperative FVA. While some propose reducing the FVA to match the contralateral femur (18), many patients are affected bilaterally (6,8). Others suggest the use of reference angles for normal dogs, but these are not available for all breeds. Alternatively, the FVA can be reduced as close to 0° as possible without creating a valgus deformity (10,11,15).

Previous reports of femoral varus correction in the dog have used a closing wedge femoral osteotomy (10,11,15). This surgical method can be demanding in small breed dogs, as the wedge to be removed from the lateral aspect of femur is very small. In contrast, a curved femoral osteotomy has some theoretical advantages (Figure 1 and Table 1) (22). Curved osteotomy in the sagittal plane is widely used in the management of cranial cruciate ligament deficiency by tibial plateau leveling osteotomy (TPLO) (23), but the application of curved osteotomies to canine angular limb deformities has only been reported a few times (24-26). To the authors' knowledge no studies have been published concerning curved osteotomy for correction of distal femoral varus.

Case presentation and results

Patient information and anamnesis

A 4 year 10 month old intact female Bichon Havanais, weighing 7.8 kg was presented at the University Hospital of Companion Animals, Copenhagen University with acute onset left hind limb lameness first observed one week earlier after jumping from the boot of a car. The dog had previously been diagnosed with low (uncertain) grade MPL by another veterinarian. The owners also reported that the dog appeared uncomfortable and unwilling to walk.

Preoperative assessment and planning

On clinical examination moderate left hind limb lameness was confirmed. A bilateral bow-legged stance was observed, and the axis connecting the hip, patella and tibial tuberosity indicated varus of both femora. A left-sided MPL of grade 3/4, using Koch's grading scheme (27), was recorded. No patellar instability was detected in the right stifle. No other hind limb abnormalities were identified.

Radiographs of the entire femur (cranio-caudal and mediolateral projections) and of the stifle (caudocranial and mediolateral projections) were obtained under sedation. For the cranio-caudal femoral view, the patient's back was elevated to ensure the femur was parallel to the radiographic

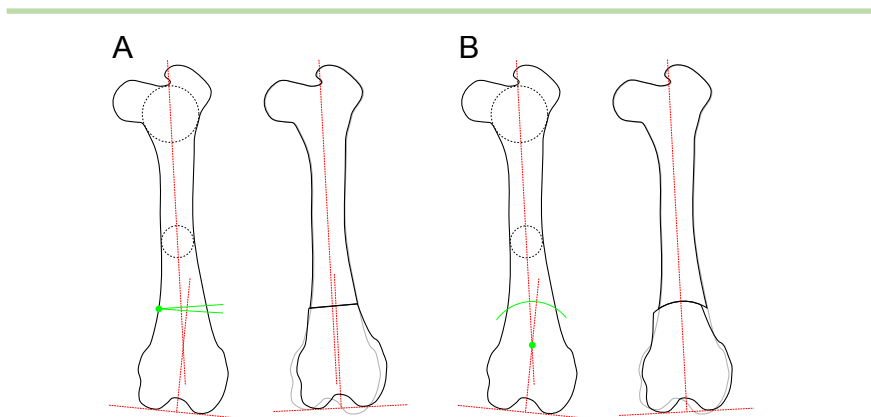


Figure 1. Schematic overview of the principles in closing wedge osteotomy (A) versus curved femoral osteotomy (B). A; the wedge osteotomy is performed by removing a wedge from the lateral aspect of the femur. In the case of canine femoral varus, the centre of rotation and angulation (CORA) is often located close to the joint, necessitating the placement of the osteotomy proximal to the CORA, resulting in translation; i.e. imperfect alignment of the distal and proximal long femoral axes. B; in the curved osteotomy technique translation can be avoided since the curved osteotomy can be performed proximally while still being centred over the CORA.

plane, and the beam was centred on the mid-diaphysis. According to the literature (9,14,16-20), this view is acceptable when;

1. 50 % or the tip of lesser trochanter is evident
2. The femoral condyles are symmetric and the walls of the intertrochlear fossa are parallel
3. The fabellae are symmetrically situated and bisected by their respective femoral cortices

4. The patella is centred in the trochlea (in the absence of luxation)

Femoral varus was measured as 10° using the Symax method (28). Briefly, the distal femoral long axis (PFLA) is defined by a line connecting the centres of two circles, one centred over the proximal femoral metaphysis, and the second centred over the diaphysis at one half the length of the femur (see Figure 2). The transcondylar axis (TCA) is defined as a line connecting the most distal points of the femoral condyles. The distal femoral long axis (DFLA) is perpendicular to the TCA and passes through the centre of the intercondylar notch. The centre of rotation and angulation (CORA) lies at the intersection of the PFLA and DFLA (see also Figure 2) (9,17-22). The CORA is the point at which the centre of the curved osteotomy should be placed in order to correct the varus defect without translation (22). The distance of the CORA from the intercondylar notch was determined to be 2 cm in the current case.

The chord length at the osteotomy site (amount of rotation) necessary to reduce the FVA to 0° was calculated as 2 mm for a 12 mm radius saw blade using the following formula:
 $Chord\ length = 2 \sin\left(\frac{FVA}{2}\right) \times r$, where r is the radius of the saw blade.

Surgical method

The patient was fasted for 12 hours prior >

Table 1. Theoretical advantages and disadvantages of curved osteotomy and wedge procedures in correction of angular deformities.

Advantages/disadvantages	Curved osteotomy	Wedge osteotomy
Adjustability intraoperatively, versatility	Good	Poor
Bone shortening/lengthening	Not necessarily, but possible	Inherent property
Bone-to-bone contact	Good	Potentially poor
Concurrent correction of rotational deformities	Not usually possible	Possible
Equipment required	Specialized equipment necessary	Specialized equipment necessary
Inherent stability	Good	Poor
Technical difficulty, osteotomy	Requires training, but osteotomy simpler to perform	Requires training; alignment can be awkward and time consuming.
Technical difficulty, reduction	Osteotomy site offers some stability during reduction. Use of jig recommended	Less stability at osteotomy site. Use of jig recommended

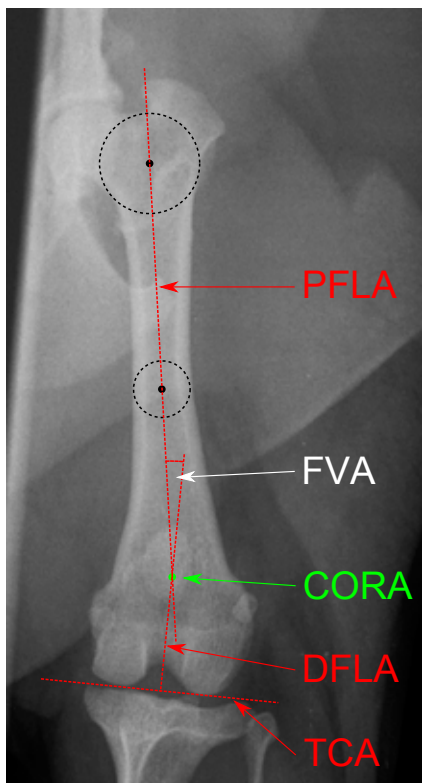


Figure 2. Preoperative craniocaudal radiograph of the left femur. Proximal and distal femoral long axes have been defined according to the Symax method. Femoral varus angle measured here was 10°. PFLA; proximal femoral long axis, DFLA; distal femoral long axis, TCA; Transcondylar axis, CORA; center of rotation of angulation, FVA; femoral varus angle

to surgery, and premedicated with methadone (0.3 mg/kg IV), diazepam (0.3 mg/kg IV) and atropine (0.02 mg/kg IM). Anaesthesia was induced with ketamine (2.5 mg/kg IV) and propofol (2 mg/kg IV). Additional intra-operative analgesia was provided using an epidural of bupivacaine (0.5 mg/kg) and morphine (0.5 mg/kg) diluted to 1 ml/4.5 kg with isotonic saline. A fentanyl patch (25 µg/hour) was applied to the left thorax to provide postoperative analgesia. Perioperative antibiotic prophylaxis was obtained using cephazolin (20 mg/kg IV).

The entire left hind limb from the hip to the hock was clipped and disinfected, and the dog was positioned in dorsal recumbency. A standard lateral parapatellar surgical approach to the stifle joint and the lateral aspect of femur was performed (29). Arthrotomy confirmed the cruciate ligaments to be intact, and identified slight proximomedial abrasions to the trochlea. The trochlea was judged to be of

satisfactory depth relative to the patella. Intraoperative evaluation of limb alignment revealed satisfactory alignment of the patella, tibial tuberosity, hock joint and foot, but confirmed excessive distal femoral varus.

The CORA and proposed site for the osteotomy were located by measurement from the intercondylar notch. The cranial femoral cortex was marked with a bone scribe and a curved osteotomy was performed with a radial saw blade (Colibri II system, Synthes, Zuchwil, Switzerland) centred on, and proximal to, the CORA. Sterile saline solution flushing was used to prevent heat damage.

After completion of the osteotomy, a second mark was made on the proximal cranial cortex 2 mm from the first mark. The distal segment was rotated along the osteotomy site to align the marks and eliminate the femoral varus. Reduction was accomplished by manual reduction with aid from bone holding forceps and patellar forceps. Pointed bone holding forceps were placed across the condyles for aid in manual stabilization of distal bone segment and lower limb for plating osteosynthesis (see Figure 3).

A 2 mm 6-hole »String of Pearls« plate (Orthomed SOP plate) was contoured to the shape of the distal femur, and fixed to the bone with 3 screws on either site of

the osteotomy. Satisfactory patellar stability was achieved without the need for further stabilising procedures (e.g. tibial tuberosity transposition).

Joint capsule, muscle and subcutaneous layers were apposed with 3-0 PDS™ and the skin closed with 4-0 Monocryl™ using an intradermal pattern.

Postoperatively the patient received carprofen (4 mg/kg IV).

Postoperative imaging and care

Radiographs were obtained immediately postoperatively to evaluate alignment at the osteotomy site and implant placement, and for measurement of the FVA. Osteosynthesis was judged to be satisfactory, and the postoperative FVA was 4°. The patella was stable within the trochlea and no crepitus or alterations in joint range of motion were detected.

The dog was hospitalized until the following day for monitoring of analgesic requirements. Non-steroidal anti-inflammatory treatment was continued orally using carprofen (4 mg/kg once daily for 7 days). Cryotherapy (3-4 times daily) was used for 3 days postoperatively to reduce swelling and discomfort. The patient rapidly regained limb use and was discharged with instructions for restricted exercise. The fentanyl patch was removed on the fourth postoperative day.



Figure 3. Intraoperative picture showing the manual reduction during plate mounting. See text for further details.

Follow-up

Initial follow-up was performed via telephone until the patient returned to the hospital 7 weeks postoperatively. The owners reported progressively decreasing lameness and increasing well-being. The patient was nearly free of lameness the day after discharge. The 7-weeks follow-up examination revealed slight left patellar instability, but it was not possible to luxate the patella out of the trochlea. No lameness or pain was evident on palpation and manipulation of the limb. Wound healing was unremarkable. Joint range of motion was normal.

Radiographs were obtained under sedation as earlier described. Postoperative FVA of 4° was maintained, and the osteotomy site had healed, with moderate callus formation visible on the mediolateral projection (Figure 4).

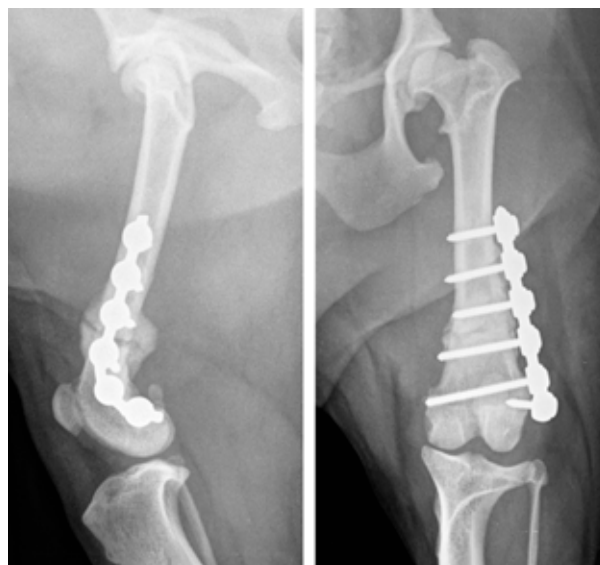
Follow-up examination approximately 24 months postoperatively found no evidence of lameness related to the operation, with a grade 1/4 medial patellar luxation in the left stifle and grade 2/4 in the right stifle. Clinical examination of the stifles was otherwise unremarkable. Bilateral hip pain related to pre-existing hip dysplasia was evident, and was considered the likely explanation for lameness following longer walks. Management with non-steroidal anti-inflammatory analgesia, physiotherapy and weight control was recommended.

Discussion

In this case report a novel method of distal femoral osteotomy for correction of MPL in a small breed dog is reported with good clinical outcome.

The apparent acute onset of lameness in this patient was attributed to worsening of pre-existing MPL due to trauma to the lateral soft tissue restraints on the patella. The choice of surgical intervention and selection of technique was based on the severity of clinical signs and apparently normal alignment of the rest of the hind limb. Little evidence exists on the appropriate cut-off value of FVA between normal and abnormal and a varus angle of 10° was considered excessive in this dog. The Symax method used here has been shown to produce slightly lower FVA values than other measuring techniques (28).

Figure 4. Radiographic imaging seven weeks postoperatively. The femoral varus angle was measured as 4°. Note the slight external rotation of the femur which could result in minor overestimation of the varus angle.



Although the surgical intent was to reduce FVA to 0°, a postoperative FVA of 4° was achieved. Considering the good clinical outcome, the uncertainty connected with radiographic assessment of FVA (16,19,28), and other results of postoperative FVA after distal femoral osteotomy (10,11,15), this reduction was considered acceptable. Slight patellar instability was evident at follow up 7 weeks postoperatively, but no symptoms connected to this were present. Recurrent instability is not unusual following patella luxation surgery, but often requires no further treatment. Radiographic assessment of the osteotomy site and implants revealed no implant failure, though moderate callus formation is seen on the mediolateral view. This is likely due to slight instability at the osteotomy site which would provoke increased callus formation. At 2 years postoperatively the patient had grade 1/4 MPL in the operated stifle, along with bilateral hip pain due to hip dysplasia.

In contrast to the closing wedge osteotomy, curved femoral osteotomy offers some theoretical advantages, but still presents some challenges.

A key advantage is intra-operative adjustability, which is not possible with the wedge osteotomy without further shortening of the femur. In contrast, the curved osteotomy permits repeated readjustment of alignment until the surgeon is

satisfied. The curved interface ensures good bone contact at the osteotomy site and restricts inadvertent rotation during reduction, but can hinder correction of femoral torsion if present.

Both corrective surgeries require relatively specialized equipment, although the straight saw needed for the wedge osteotomy is somewhat simpler to use and maintain. Both surgeries require careful planning and execution to obtain optimal results, but performance of the curved osteotomy is simpler as only one cut is required. In comparison, marking and alignment of the two cuts needed for wedge osteotomy risk introduction of under- or overcorrection and iatrogenic deformities if the planes of the cuts are not properly aligned. An optimally performed wedge osteotomy should provide similar bone to bone contact to the curved osteotomy; however, if cut alignment is suboptimal, compensation may be required during reduction by leaving a small gap under the plate to prevent overcorrection of the varus. The alternative would be to perform an additional, narrower osteotomy, which is extremely difficult.

Although the curved osteotomy offered slightly more inherent stability during reduction than a wedge osteotomy, this advantage was minimal in this small patient due to the narrow width of the femur restricting the curvature of the

osteotomy. We would expect better stability in larger patients. Use of a jig to stabilise the two fragments during osteotomy, reduction and plating is recommended, based on subsequent experience. This significantly reduces surgery time. Several commercial jigs are available, customized for curved osteotomy techniques, but it is also possible to fashion a jig using external fixator clamps and pins.

In addition, we found that bone marking presented some challenges; to maximise visibility, the marks had to be relatively wide compared to the calculated distance between them, which could have compromised precision. Using a larger radius saw blade would increase the calculated distance and thus enhanced precision at the cost of reduced stability. Similar issues exist with accurate marking for closing wedge osteotomy.

Conclusion

This case report details the successful surgical management of MPL caused by excessive femoral varus in a small breed dog using curved distal femoral osteotomy and plating osteosynthesis. This technique can be considered for small breed dogs in which excessive distal femoral varus is considered to be a major contributing factor to patellar instability. ■

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