MEDIAL PATELLAR LUXATION: OPTIMIZING OUTCOME
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Key Points
- Identifying and treating each abnormality present in an individual patient reduces the risk of recurrence.
- Distal femoral varus is an increasingly common complicating factor in large breed dogs with medial patellar luxation.

Medial patellar luxation (MPL) is a developmental disorder in dogs. It may occur as a traumatically induced injury in any breed, and is being seen with increasing frequency in large breed dogs. Medial luxation accounts for 75-80 percent of cases of patellar luxation, with bilateral involvement in 20-25 percent. Concurrent rupture of the cranial cruciate ligament occurs in 15-20 percent of cases.

Functional Anatomy of the Normal Quadriceps/Patellar Mechanism
The patella is an ossification in the tendon of insertion of the quadriceps, which functions to redirect the line of action of the quadriceps tendon much like a pulley redirects a cable. In order for the patella to perform this function efficiently, proper axial alignment of the extensor apparatus is mandatory. The extensor apparatus originates at the tuberosity for the origin of the rectus femoris on the ventral aspect of the ilium, cranial to the acetabulum. The remainder of the quadriceps group originates from the proximal femur, converges on the patella, continues as the patellar tendon, and inserts on the tibial tuberosity. Muscular contraction of the quadriceps results in the patella being drawn onto a straight line from the origin of the rectus femoris to the tibial tuberosity. Thus, for the patella to be stable, the extensor mechanism must align with the underlying skeletal elements including the femoral shaft, the trochlear groove, and the tibial tuberosity. The peri-articular soft tissues such as the joint capsule and femoro-patellar ligaments add secondary support to the femoro-patellar articulation.

Skeletal Abnormalities Associated with Patellar Luxation
A variety of anatomic abnormalities can be present in the patient with MPL. These include coxa vara (a diminished angle of inclination of the femoral neck), genu varum (a bowlegged stance in which the knees are abnormally separated), distal femoral varus in which the distal femur bows toward midline, external torsion of the distal femur, a shallow trochlear sulcus, proximal tibial varus or valgus in which the proximal tibia bows toward midline or away from midline respectively, internal tibial torsion, and medial displacement of the tibial tubercle.

Physical Examination
Surgical correction is usually indicated in all cases of Grade III or IV, and most cases of Grade II MPL. The goals of surgery are to align the extensor mechanism and deepen the trochlear sulcus to create a stable femoro-patellar articulation. The combination of techniques required is dependent upon the specific abnormalities of each patient. A thorough physical examination is imperative to guide the clinician in the interpretation of diagnostic imaging studies, and to select an appropriate treatment plan. Coexisting conditions such as hip dysplasia with subluxation or luxation of the femoral head, partial or complete rupture of the cranial
cruciate ligament, and torsional malformation of the tibia or femur must be identified clinically to ensure appropriate imaging is obtained and a rational treatment plan is devised.

**Diagnostic Imaging**

Accurate radiographic assessment of limb alignment is difficult, and requires general anesthesia and precise patient positioning to avoid positioning artifact. A complete radiographic evaluation includes at least a lateral and ventro-dorsal view of the pelvis including the femora and proximal tibia, and an axial view of the femur for femoral anteversion calculation. In some cases, cranio-caudal and medio-lateral views of the femur, and caudo-cranial and lateral views of the tibia including the stifle and tarsus may be required.

A well-positioned ventro-dorsal view of the pelvis including the femora and proximal tibiae is the most important view for determination of femoral varus deformity. It is imperative that the femora be parallel to the spinal axis and the radiographic cassette. In cases in which diminished hip range of motion limits hip extension, the x-ray beam and cassette can be angled such that the x-ray beam is perpendicular to the long axis of the femur, and the cassette is perpendicular to the beam. Alternatively, the patient can be elevated in a v-trough, or a horizontal beam, cranio-caudal femur can be obtained. In a well-positioned view, the fabellae appear bisected by the femoral cortices, the vertical walls of the intercondylar notch are distinct parallel lines, and the lesser trochanter is only partially visible. The angle of femoral varus (or valgus) is determined by the intersection of the proximal femoral mechanical axis, and the distal femoral mechanical axis. The proximal axis is determined by finding the center of the femoral diaphysis at 3-4 points just distal to the lesser trochanter; these points are connected with a line, which represents the proximal femoral mechanical axis. The distal mechanical axis is determined by identifying the transcondylar axis, and then drawing a perpendicular to this axis, which bisects the intercondylar notch (Figure 1). The intersection of these lines determines the varus angle at the point of maximal curvature.
Figure 1: A well-positioned VD pelvic radiograph of a patient with Grade IV MPL and femoral varus. The varus angle (V) is determined by the intersection of the proximal and distal femoral mechanical axes. Note bilateral femoral head subluxation.

The axial view of the femur is obtained by positioning the patient in dorsal recumbency and flexing the hip joint such that the x-ray beam is directed down the center of the femoral diaphysis, with the cassette under the hip joint. The angle of anteversion is determined by the intersection of the transcondylar axis and an axis through the center of the femoral head and neck (Figure 2).

Figure 2: Axial view of the femur. Note that the angle of anteversion (A) determined by this method does not discriminate between neck version and femoral torsion.

Since these radiographic views are difficult to obtain, and are highly sensitive to radiographic positioning artifact, several exposures of each view should be obtained. A variation of more than 2-3 degrees between radiographs or between left and right femurs in a symmetrically affected patient suggests positioning or measurement artifact.

In cases in which tibial torsional or angular abnormalities are evident, caudo-cranial and lateral views of the tibia including the stifle and tarsus should be obtained. Recently, computed tomographic evaluation of tibial torsion has been described, and this technique was found to be more accurate than the radiographic technique described by Slocum.

Reconstructive Techniques

Various techniques have been devised to correct the anatomic abnormalities associated with patellar luxation. Soft tissue techniques such as fascial release, fascial imbrication, and anti-rotational sutures can be used to augment anatomic reconstructive techniques, but should not be relied upon as the sole method of correction.

Trochlear chondroplasty: In the immature animal (<9 months of age), a flap of hyaline cartilage is raised from the trochlear sulcus, the subchondral bone is removed, and the flap is reseated.

Trochlear sulcoplasty: The sulcus is deepened by débridement of the articular cartilage and subchondral bone with a bone rasp or high-speed bur. The defect is replaced by fibrocartilage over time.
Trochlear wedge recession (TWR): Using an X-acto hobby saw, or similar fine-toothed saw, an osteochondral wedge is developed from the trochlear sulcus. Additional cut(s) are made to remove slice(s) of cartilage and bone so that the original wedge can be seated deeper in the trochlear sulcus.

Trochlear block recession: A rectangular osteochondral block is developed from the trochlear sulcus using a saw and osteotome. Additional subchondral bone is removed allowing the block to be seated deeper in the trochlear sulcus. This technique is reported to preserve a greater surface area of the hyaline cartilage within the trochlear sulcus than the trochlear wedge recession.

Tibial tuberosity transposition (TTT): The tibial tuberosity and associated patellar tendon insertion is osteotomized, leaving the distal periosteal attachment intact. The tuberosity is moved to align the quadriceps mechanism, and reattached with 2 K-wires and figure-8 tension band.

Femoral osteotomy: In cases with significant femoral varus, valgus, or torsional deformities, the femur must be straightened by angular and torsional correction. Multiple techniques have been described including the laterally based closing wedge ostectomy, the medial opening wedge osteotomy, and the radial osteotomy; plate fixation is usually employed.

**Lateral Closing Wedge Femoral Osteotomy for Distal Femoral Varus Correction**

1. Measure the varus angle and determine the point of maximal curvature from well-positioned radiographs. Compare this to the accepted normal value of 0-10 degrees to determine if femoral varus is contributing to misalignment of the extensor apparatus.
2. Measure the anteversion angle from the axial view, and compare this to the normal value of 27 degrees to determine if femoral torsion is contributing to the misalignment of the extensor apparatus.
3. Determine if medial displacement of the tibial tuberosity and/or tibial torsional abnormalities are present.
4. Carefully assess the integrity of the cranial cruciate ligament. If rupture of the cranial cruciate ligament is present, internal tibial torsion is present, and the tibial tuberosity is medially displaced, a TPLO procedure with internal tibial torsional correction can be utilized to stabilize the stifle and lateralize the tibial tuberosity. If no tibial torsion is present, consider a TTT and a lateral suture. An alternative technique is a TPLO with internal torsional correction combined with a de-rotational proximal tibial osteotomy. Finally, lateral translation of the tibial tuberosity segment following TPLO/CCWO or TCWO and tibial tuberosity transposition can be performed.
5. Perform a lateral approach to the femur and stifle joint, carefully elevating the joint capsule from the lateral femoral condyle in the area of planned bone plate application.
6. Plan the femoral osteotomy ensuring that the distal femoral segment is large enough to accommodate at least 3 plate screws without interference of the implants with the stifle joint. Score the proposed osteotomy lines on the bone with the bone saw.
7. The TPLO jig can be applied on the cranial aspect of the femur with the distal pin immediately proximal to the cartilage of the trochlear groove, and the proximal pin within the span of the bone plate. If no femoral torsion is present, the jig pins are placed parallel to the
cranio-caudal plane of the femur. If a femoral torsional abnormality is present, the jig pins are applied parallel to the cranio-caudal plane of the proximal femur. The frame of the jig is placed medially. A stainless steel ruler and electro-cautery can be utilized to score an axial line on the femoral cortex to ensure no torsional abnormality is created during the surgical procedure.

8. Complete the ostectomy and reduce the proximal and distal segments. Torsional correction can be accomplished by bending the distal jig pin with hand-held plate bending pliers if a jig is used, or manual alignment can be performed. Place K-wires to maintain reduction; placement from disto-lateral to proximo-medial, and proximo-cranial to caudo-distal avoids the area of bone plate application.

9. Contour and apply a 7 hole narrow or broad LCDCP to the lateral aspect of the femur, ensuring that the implants do not interfere with stifle joint function. Keep the distal screws in the caudal aspect of the femur to ensure they are not encountered during the TWR.

10. Perform a TWR if necessary, the cancellous bone, which is removed, can be used as an autogenous cancellous bone graft at the ostectomy site.

11. Closure is routine.

12. Perform a TTT and/or stabilize the stifle if necessary.

Figure 3: Postoperative cranio-caudal and lateral radiographic images of the same patient as in Figure 1 following femoral varus correction, TWR, TTT and lateral fabello-tibial suture placement.

**Postoperative care, prognosis, complications**

A soft padded bandage is usually applied for 2-3 days post-operatively. Activity is restricted to leash walks only for 4-6 weeks while bony healing occurs at the correction sites. Prognosis varies with grade of luxation; it is good for grade III, and fair to good for grade IV. Complications include delayed union or fixation failure at the osteotomy sites, reluxation of the patella, and degenerative joint disease. Most cases do well clinically despite slow radiographic progression of osteoarthritis.
References


