Management of medial patellar luxation in dogs: what you need to know

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An overview of the causes, diagnosis and treatment of one of the most common orthopaedic diseases seen in general practice

INTRODUCTION

The patella is an ossification in the tendon of insertion of the quadriceps femoris muscle. It works along with the femoral trochlea as a pulley, redirecting the line of action of the quadriceps tendon. For the patella to be stable and to move in the most efficient direction, axial alignment of the extensor apparatus with the underlying skeletal elements is necessary. The extensor apparatus is composed of the quadriceps femoris muscle, which originates in the ventral aspect of the ilium and the proximal femur. It converges on the patella, and continues as the patellar ligament, which finally attaches to the tibial tuberosity. Other periarticular elements, such as joint capsule and femoropatellar ligaments, also increase the stability of the femoropatellar articulation.

Medial patellar luxation (MPL) is one of the most common diseases affecting the canine stifle. Although it can be seen in large-breed dogs, including Labradors, small-breed dogs are more commonly affected, with Yorkshire Terriers and poodles over-represented. It is also remarkable that MPL is more common than lateral patellar luxation (LPL), representing 75-80 per cent of cases and reaching up to 98 per cent in small breeds, according to some research. Bilateral MPL affects 20-25 per cent of all MPL cases, but some authors increase this percentage up to 50-65 per cent. Regarding large breeds, although MPL is more frequent as well, the percentage of LPL in these breeds is higher than in small-breed dogs. In terms of sex predisposition for MPL, small-breed females and large-breed males are more affected. In cats, MPL is also more common than LPL.

AETIOLOGY AND PATHOGENESIS

MPL can be traumatic or 'congenital', with congenital being most common. Strictly speaking, MPL is a developmental disorder, since the vast majority of cases develop this disease as a result of the skeletal deformities that are present at birth. As a result, breeding is not advisable in affected dogs.

Although the underlying cause of MPL is not entirely understood, some investigations suggest coxa vara (decreased angle of inclination of the femoral neck) and diminished anteversion angle (relative retroversion) are the main causes. The typical deformities of MPL include:

Figure 1: Alignment of quadriceps mechanism with underlying skeletal elements in a normal dog and in a dog with MPL.

malalignment of the quadriceps femoris muscle, coxa vara, femoral varus, genu varum, shallow trochlear groove with poorly developed or absent trochlear ridges, hypoplasia of the medial femoral condyle, medial displacement of the tibial tuberosity, internal rotation of the tibia, proximal tibia varus, and internal rotation of the foot (see Figure 1).

Under normal alignment, the patella exerts pressure on the articular cartilage of the trochlear groove during growth, creating a groove with adequate depth and width. The absence of this physiological pressure in MPL cases leads to trochlear hypoplasia. Intermittent luxation and reduction wear the medial trochlear ridge, which results in more instability and tendency to luxation.

Shortening of the limb because of hip luxation or femoral head excision may cause laxity of the extensor mechanism, these animals being more prone to MPL.

It has been suggested that the quadriceps mechanism is a secondary stabiliser of the stifle, preventing cranial translation of the tibia. Due to this role, chronic patellar luxation could lead to increased stress on the cranial cruciate ligament (CCL) and eventual degeneration and rupture. Combination of CCL rupture and MPL is a relatively common finding, especially with increased severity of patellar luxation (Campbell et al, 2010). Tibial tuberosity transposition-advancement has been suggested as a technique to resolve both conditions at the same time (Yeadon et al, 2011). Patellar luxation has also been reported as a complication of surgical intervention for management of CCL rupture.

CLINICAL PRESENTATIONS

Clinical signs vary according to the grade of luxation (see Table 1).

Table 1.

Grade 1	**Commonly an incidental finding on routine physical examinations.** **The patella can be manually luxated, but it returns to the trochlear groove immediately upon release of manual pressure.** **There is no crepitus noted during stifle range of motion, and bony deformity is absent.** **Clinical signs are typically not present.**
Grade 2	**Spontaneous luxation occurs with clinical signs of non-painful, 'skipping' type lameness.** **Mild deformities develop (internal rotation of the tibia and abduction of the hock).** **May progress to grade 3 luxation as progressive cartilage erosion on the patellar and trochlear surfaces occurs, and/or CCL disease and rupture occurs.**
Grade 3	**Patella is luxated most of the time but can be reduced manually.** **More severe bony deformities, including: marked internal tibial rotation and S-shaped curve of the distal femur and proximal tibia.** **A shallow trochlear groove may be palpable when the patella is luxated.** **Lameness is related to the degree of cartilage erosion from the articular surface of the patella and medial trochlear ridge of the femur.** **Abnormal, 'crouched' gait rather than intermittent lameness. The leg is used in a semiflexed, internally rotated position.** **Often bilateral.**
Grade 4	**Permanent and non-reducible luxation of the patella.** **If not corrected early in life, severe bony and ligamentous deformities develop, making later surgical correction more challenging.** **Severe bony deformities: tibia rotated from 60 degrees to 90 degrees relative to the sagittal plane, marked femoral varus, proximal tibia varus, and internal tibial rotation are noted.** **'Crab-like' posture, and usually carried by their owners rather than walking.**

DIAGNOSIS

Careful physical examination is necessary to characterise the grade of luxation and to rule out concomitant CCL disease or other pathologies that could cause hind-limb lameness. Gait evaluation at a walk and a trot is performed to evaluate overall conformation and to screen for overt skeletal deformity, as well as to determine the degree and character of lameness. These are important factors to take into account when making a therapeutic plan.

Our aims during the physical examination are to assess:

- Instability in both directions
- Most frequent location of the patella
- Inability or ability to reduce the patella
- Presence or absence of crepitus
- Degree of tibial tuberosity deviation
- Limb torsion or angulation
- Range of motion
- Presence or absence of drawer movement.

Initial physical examination is performed with the patient standing. In that way, symmetry between limbs and

Figure 2: (a) Patella isolated between index and thumb in physiologic position; (b) Patella isolated between index and thumb in medially luxated position while applying internal rotation to the limb.

influence of quadriceps femoris muscle contraction during weight bearing on the stability of the patella can be assessed more easily, as well as to evaluate the degree of joint effusion (more common when CCL disease is present). In cases where the joint is quite inflamed, locating the patella can be challenging. Following the patellar ligament from its attachment on the tibial tuberosity can help in these cases. Once located, the patella is isolated between thumb and index finger of one hand, while the other hand grasps the tibia and lifts the foot from the floor. Flexion, extension, internal and external rotation is applied to the stifle and at the same time manual lateral and medial pressure is performed on the patella to identify the direction and grade of luxation (see Figures 2a and 2b). Muscle tension can prevent luxating the patella. In such cases the physical examination can be performed in lateral recumbency. To assess CCL disease, cranial drawer and tibial thrust examination are carried out. It is also important to assess the position of the patella within the trochlear groove; if riding too high (patella alta) or abnormally low (patella baja), this will need to be addressed during surgical correction. Pain when applying caudal pressure over the patella also needs to be evaluated. The depth of the trochlear groove can be assessed by palpation after luxating the patella. The alignment of the quadriceps mechanism should be assessed with the animal in dorsal recumbency, by visually evaluating the alignment of the quadriceps muscle, patella, patellar ligament and tibial tuberosity, while the hip, stifle and tarsus are kept in extension (see Figures 3a and 3b). If the animal does not co-operate, sedation is administered to complete the orthopaedic evaluation and radiographs are taken of the limb.

Radiographic survey helps to document luxation and assess the degree of degenerative changes present in the stifle joint; it is also essential to identify and qualify skeletal abnormalities in severe cases. Careful radiographic position is critical to avoid false positive limb deformity on radiographs. If the luxation grade is low and skeletal

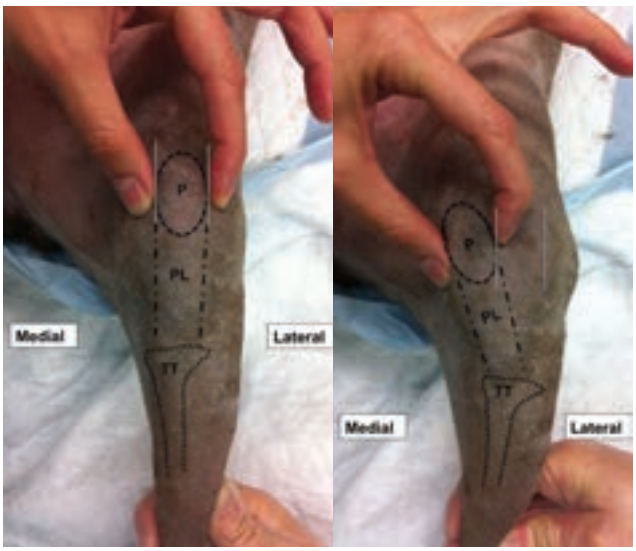

Figure 3: (a) Alignment between patella (P), patellar ligament (PL) and tibial tuberosity (TT) with the patella in the trochlea. Note the medial position of the TT and medial deviation of the patellar ligament in spite of the reduction of the patella; (b) Alignment between patella, patellar ligament and tibial tuberosity with the patella medially luxated from the trochlea. Note the marked medial direction of the patellar ligament.

Figure 4: (a) Medio-lateral radiographic view of the stifle in a dog with MPL. The patella is reduced in the trochlea; (b) Posterio-anterior radiographic view of the stifle of a dog with MPL. The patella is medially displaced from the trochlea.

abnormalities are mild, orthogonal radiographs views of the stifle alone are sufficient (see Figures 4a and 4b). However, in severe cases in which skeletal deformity is present, orthogonal views of the femur and the tibia (from the hip to the tarsal joint), in addition to orthogonal views of the stifle, are necessary to characterise the deformities and to accurately assess the joint (see Figure 5). Alternatively, computed tomography (CT) study with 3D reconstruction of the skeletal elements can be used to qualify deformities.

TREATMENT

In some cases, selecting between conservative treatment and surgical treatment is clear-cut. Conservative treatment, including rehabilitation to enhance quadriceps

Figure 5: Ventro-dorsal radiographic view of the hindlimbs in a dog with right MPL. Notice the medial deviation of the tibial tuberosity and genu varum.

mechanism, is warranted in grade 1 luxation cases with no associated clinical signs. On the other hand, in grade 3 or grade 4 luxation cases, surgical treatment is warranted early in the course of the disease.

In more complex cases where it is not easy to select between both treatments, surgery is indicated if significant episodes of lameness last two to three weeks or longer, if there are three or more significant episodes of lameness that occur in a short time frame (ie. over one month), or if lameness is worsening. If the episode of lameness is mild and infrequent, and the degree of osteoarthritis is mild and non-progressive, conservative treatment may be indicated, with re-evaluation if severity or frequency of lameness increases. In very young patients with significant growth potential, avoiding bony reconstructive techniques is essential until maturity is reached, because distal femoral or proximal tibial physis could be damaged. In severe cases of immature patients, a two-stage repair should be considered. In the initial stage only soft tissue reconstruction techniques and trochlear chondroplasty are recommended and other techniques should wait until the patient reaches skeletal maturity.

SURGICAL TREATMENT

Surgical correction of MPL is based on realignment of the quadriceps mechanism and stabilisation of the patella within the trochlear groove of the femur. A variety of soft-tissue and osseous techniques can be used to achieve these goals. A combination of various techniques is usually used in the same case to correct MPL. Soft tissue techniques alone are likely to cause failure and osseous techniques minimise the risk of post-operative reluxation (Arthurs et al, 2006). The decision on which techniques to use is based on the radiographic findings (ie. bone deformities, medial displacement of the tibial tuberosity) and intraoperative evaluation (ie. depth of femoral trochlea, medial displacement of tibial tuberosity, alignment of quadriceps mechanism).

A lateral arthrotomy is performed for MPL to explore the joint, especially the CCL and the articular cartilage of the caudal aspect of the patella and medial trochlear ridge (see

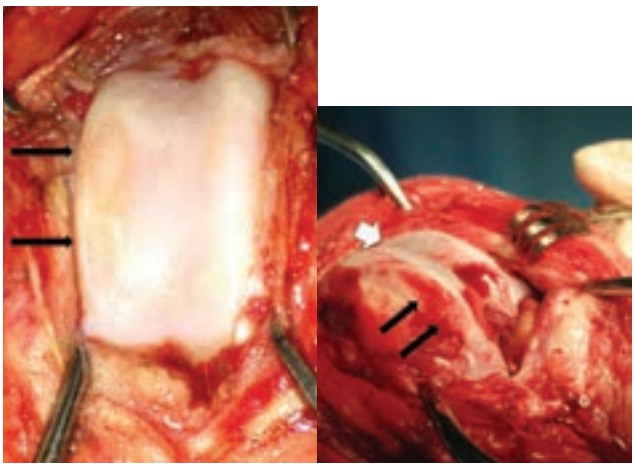

Figure 6: (a) Intraoperative view of mild erosion in the medial trochlear ridge in a dog with MPL (black arrows); (b) Intraoperative view of a stifle with grade 4 MPL with severe erosions (black arrows) and shallow trochlear groove (white arrow).

Figures 6a and 6b). In one study it was found that two-thirds of dogs with patellar luxation had cartilage erosions, especially heavier dogs and those with grade IV patellar luxation (Daems et al, 2009) .

OSSEOUS TECHNIQUES

Trochleoplasty

The aim of these techniques is to modify the shape of the trochlear groove, obtaining enough depth and width to allow approximately 50 per cent of the patella to protrude above the trochlear ridges. Besides the techniques described below, there are new ones that have been reported, such as: rotating dome trochleoplasty (Gillick et al, 2007), medial ridge elevation wedge trochleoplasty (Fujii et al, 2013), rotation of the femoral trochlea (Pinna et al, 2008), and RidgeStop or patellar groove replacement (PGR) in advanced OA cases.

Trochlear sulcoplasty

This is the simplest technique. The articular cartilage and several millimetres of subchondral bone are removed with rongeurs. This technique results in complete loss of hyaline cartilage lining of the femoral trochlea; although it is a successful technique in small dogs, they may show quadriceps femoris muscle atrophy, palpable crepitus, severe erosion of the cartilage of the patella as early as four weeks after surgery and return to function is slower compared with other techniques. Although the deeper trochlea becomes covered with fibrocartilage, the filling of the defect is more unpredictable.

Trochlear chondroplasty

This 'cartilage flap' technique is useful only in puppies up to six months of age as, in mature animals, the cartilage becomes thinner and more adherent to the subchondral bone, making flap dissection difficult. A rectangular cartilage flap is elevated from the groove, the subchondral bone removed from beneath it, and the flap pressed back into the deepened groove (see Figure 7).

Figure 7: Elevation of the cartilage flap during trochlear chondroplasty in a puppy.

Trochlear wedge recession

A V-shaped wedge, including the groove, is removed from the trochlea with a saw. The resulting defect in the trochlea is widened by another saw cut on one edge to remove a second piece of bone. When the original bone wedge is replaced, it is recessed into the defect, creating a deeper groove still covered with hyaline cartilage. The osteochondral wedge remains in place because of the net compressive force of the patella and friction between the cancellous surfaces of the two cut edges. The sides of the defect become lined with fibrocartilage.

Trochlear block recession

The sides of the piece removed are parallel. Using a power or manual saw, two parallel incisions in cartilage and bone are made far enough apart to accommodate the width of the patella, ensuring that the trochlear ridges are maintained (usually just axial to the top of the trochlear ridges). An adequate-sized osteotome or power saw is used to make the cut from just proximal to the origin of the caudal cruciate ligament, connecting the previously made lateral cuts, to the proximal aspect of the trochlea. Great care must be taken to prevent dropping and contaminating, or fracturing the loosened block. This segment of bone and cartilage is removed and wrapped in a bloody sponge while trabecular bone is removed from the femur to recess the block. Alternatively, the proximal aspect of the block may remain attached and flipped proximally to allow recession of the trochlea. The lateral cuts can be deepened 2-3mm and another layer of cancellous bone removed with the osteotome (see Figure 8). The block is then pressed back into this recessed femur and cancellous graft packed into the gaps at the side of the block if necessary to prevent wobbling (see Figure 9).

In a study by Johnson et al (2001) it was found that trochlear block recession increased proximal patellar depth and patellar articular contact with the recessed proximal trochlea, it recessed a larger percentage of trochlear surface area, and resulted in a greater resistance to

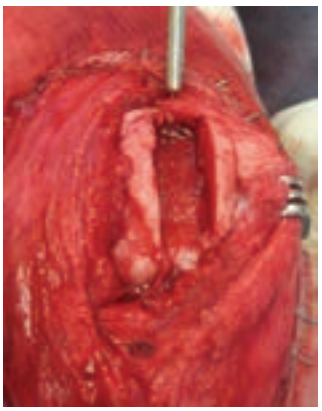

Figure 8: Intraoperative view of block recession trochleoplasty after elevation of the trochlear block in a stifle with grade 4 MPL and severe osteoarthritis.

Figure 9: Intraoperative view after replacing the trochlear block removed in trochlear block recession technique in the same stifle as Figure 8.

patellar luxation in an extended position as compared with trochlear wedge recession. The authors routinely perform the trochlear block recession technique.

TIBIAL TUBEROSITY TRANSPOSITION

This technique corrects the abnormal line of action of the patellar ligament in MPL, which runs oblique from proximolateral to distomedial (see Figure 3a). The exact attachment of the patella tendon is identified by palpation. The periosteum on the medial aspect of the tibia is incised along the proposed line of osteotomy and the tibialis cranialis muscle elevated laterally. The osteotomy starts at a point midway between the cranial aspect of the tibial plateau and the insertion of the patella tendon, and extends to the distal aspect of the tibial crest. The osteotomy is performed with a manual or oscillating saw until the distal extent of the tibial crest, preferably leaving the distal periosteal attachment intact. Then the tuberosity is transposed laterally to achieve realignment with the stifle extended. Careful evaluation of the alignment between the quadriceps muscle, patella, patellar ligament and tibial tuberosity is performed with the dog in dorsal recumbency. It may be helpful to apply a straight instrument over these structures to make sure they are aligned. Two Kirschner wires of adequate size are placed to fix the tibial tuberosity in the new position, following a slightly distal and caudomedial direction (see Figures 10a and 10b). The surgeon should make sure these are placed proximal to the point of insertion of the patellar ligament, to decrease the risk of fractures, and that they are engaging sufficient bone at the level of the tibial tuberosity and the caudal tibial cortex. In small dogs, if the distal periostium has been

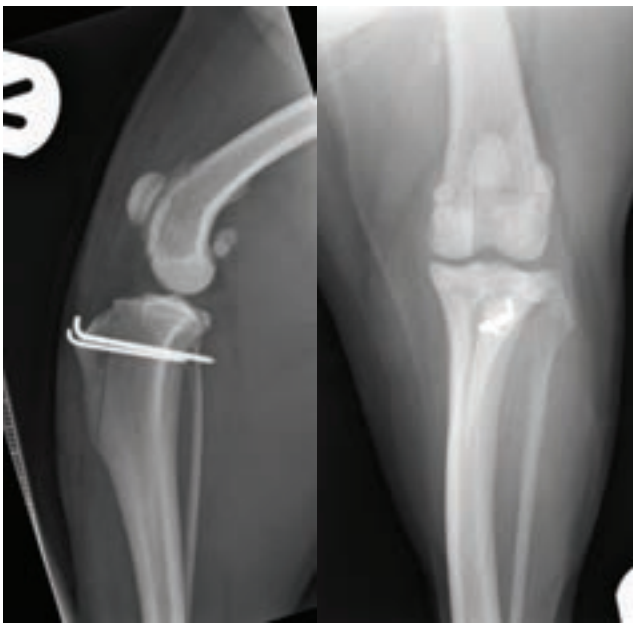

Figure 10: (a) Post-operative medio-lateral radiographic view after block recession trochleoplasty and lateral tibial tuberosity transposition in a dog with MPL. The periostium in the distal aspect of the tibial tuberosity has been preserved, so a tension band has not been applied; (b) Post-operative postero-anterior radiographic view of the same stifle.

preserved, there is no need to place a tension band. In bigger, very active dogs, or if the tibial tuberosity has been transected distally, a tension band is placed to counteract the distraction forces from the patellar ligament. A bone tunnel is drilled distal and slightly caudal to the distal extent of the osteotomy, and orthopaedic wire is placed through the tunnel and around the pins in a figure of eight pattern to create a tension-band wire. This fixation effectively counteracts the distractive force of the quadriceps mechanism (see Figures 11a and 11b). Radiographs are obtained post-operatively and six to eight weeks post-operatively to assess bony healing and verify the stability of the implants.

Figure 11: (a) Post-operative medio-lateral radiographic view after block recession trochleoplasty and lateral tibial tuberosity transposition in a dog with MPL. The periostium in the distal aspect of the tibial tuberosity has not been preserved, so a tension band has been applied; (b) Post-operative postero-anterior radiographic view of the same stifle.

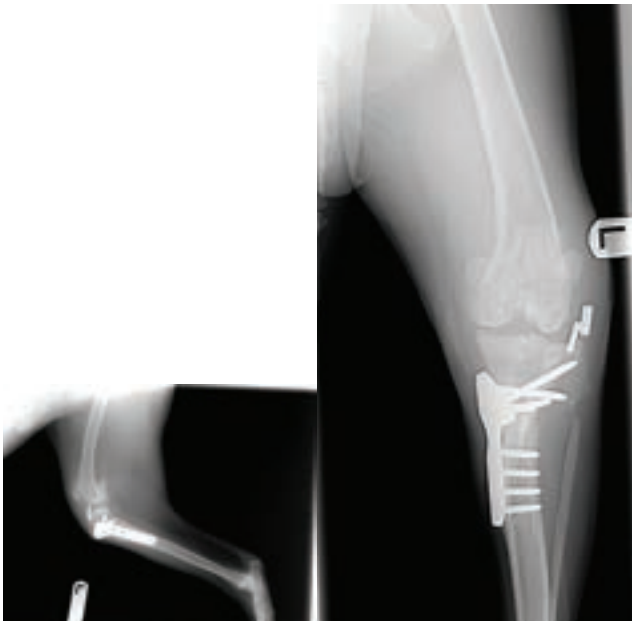

Figure 12: (a) Post-operative medio-lateral radiographic view of the stifle in a dog with grade 4 MPL and severe proximal tibial internal rotation. A block recession trochleoplasty and proximal tibial derotational osteotomy have been performed. Antirotational sutures have been applied; (b) Post-operative postero-anterior radiographic view of the same stifle.

DISTAL FEMORAL OR PROXIMAL TIBIAL CORRECTIVE OSTEOTOMY

This technique is used in cases with significant femoral/tibial varus and/or torsional deformity. It is associated with a very low rate of recurrence in these cases.

Multiple techniques have been described, including laterally based femoral closing wedge ostectomy, medial opening femoral wedge osteotomy, detorsional osteotomy to address isolated bone torsion, and radial osteotomy; plate fixation is the preferred fixation method (see Figures 12a and 12b). Accurate pre-operative measurement must be made to ensure the osteotomy location and magnitude of femoral angulation and torsion.

SOFT TISSUE TECHNIQUES

They are used after bony reconstruction and never as a primary repair except for traumatic patellar luxation, or as the first stage of a two-stage repair in immature patients. In MPL these techniques are based on release of the contracted tissues on the medial side of the patella and imbrication of the lax tissues on the lateral side.

In MPL, medial retinacular release (retinacular refers to the fascia and other fibrous tissues that help to keep the patella in place) and capsulotomy are performed; the medial tissues are released doing an incision in the medial aspect from the tibial attachment of the patellar ligament, continuing proximally, medial to the patella until all the tension on the patella is relieved. The incision is usually left open.

Imbrication of the soft tissues of the lateral side is also used to stabilise the patella. The joint capsule and fascial tissues can be imbricated with horizontal mattress suture pattern using monofilament absorbable suture. If redundant joint capsule is present, a strip of joint capsule (partial capsulectomy) can be removed and the edges sutured with apposing suture patterns.

ANTIROTATIONAL TECHNIQUES

Early correction of the tibial rotation in immature animals may lead to mitigation of the severity, or correction of the deformity during growth. However, in mature animals these techniques are likely insufficient to correct MPL by themselves, unless other concurrent techniques are applied.

Placing a non-absorbable suture (ie. nylon leader line) from the lateral fabella to the tibial crest results in external rotation of the tibia.

POST–OPERATIVE CARE, COMPLICATIONS, PROGNOSIS

Post-operative orthogonal radiographs are imperative to evaluate correction of the patellar luxation and adequate implant placement.

Adequate post-operative analgesia is important for these animals to start using the operated limb soon (ie. opioids, non-steroidal anti-inflammatory drugs [NSAIDs]). Cold packing can be used three times a day for the first 72 hours to decrease pain and inflammation, followed by warm packing and gentle passive range-of-motion exercises two to three times per day (after 72 hours). Activity should be restricted to specific physical rehabilitation exercises and lead walking for six to eight weeks; provided the patient is progressing adequately and the osteotomies are healing, then the animal could be gradually returned to normal activity over a six-week period. Radiographs should be obtained at six to eight weeks to evaluate healing of the tibial crest transposition.

Complications include patellar reluxation, delayed union or fixation failure at the osteotomy sites, infection, and osteoarthritis. Cases treated with tibial tuberosity transposition and femoral trochleoplasty techniques were associated with lower risk of patella reluxation and major complications. In a recent study by Cashmore et al (2014), major complications accounted for 18.5 per cent, with implant-associated complications being the most frequent, followed by patellar reluxation and tibial tuberosity avulsion. Dogs over 20kg and high-grade luxations are more prone to post-operative complications. Gibbons et al (2006) postulated that, in order to reduce post-operative risks in large breed dogs, femoral trochleoplasty, tibial tuberosity transposition and soft tissue techniques should be performed.

Prognosis varies with the grade of luxation: excellent for grades 1 through 3 luxation, and fair to good for grade 4 luxation. However, some cases of grade 4 luxation with severe bone deformity, osteoarthritis, cartilage loss, muscle atrophy, and rotational deformity of the stifle warrant a grave to poor prognosis. Osteoarthritis progresses in spite of surgical correction, but it is usually less severe than with CCLR.

The study by Linney et al (2011) demonstrated that surgical treatment of MPL without trochleoplasty have similar

outcomes to those with trochleoplasty, although cases should be carefully selected.

Recurrent luxation after surgery has been reported in up to 50 per cent of joints. However, most are grade 1 luxations that do not affect clinical function. Most stifle joints function well enough that lameness is not apparent during examination, nor do clients report clinical dysfunction. Early correction of severe deformities will undoubtedly play a major role in ensuring good function.

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Reader Questions and Answers

1: A DOG WITH MPL IS LUXATED PERMANENTLY BUT CAN BE RETURNED TO THE TROCHLEAR GROOVE MANUALLY. WHICH GRADE OF PATELLAR LUXATION DOES THIS DOG BELONG TO?

A: Grade 2
B: Grade 3
C: Grade 4
D: This dog can't be classified.

2: WHAT WOULD BE THE TREATMENT FOR A SIX-MONTH-OLD DOG WITH GRADE 3 MPL?

A: Conservative treatment with re-evaluation if severity or frequency of lameness increase.
B: Surgical two-stage repair, in the initial stage only soft tissue reconstruction techniques and trochlear chondroplasty can be performed and other techniques must wait until the patient reaches skeletal maturity.
C: Surgical repair using all the techniques needed (soft tissue and osseous techniques) to achieve a perfect correction of the MPL.
D: Surgical repair only using osseous techniques.

3: WHICH OF THESE SENTENCES IS TRUE?

A: Large breeds are more affected by MPL than small breeds.
B: Bilateral involvement in MPL is hardly impossible.
C: Lateral patellar luxation is more frequent than MPL.
D: Small-breed females are more affected by MPL than small-breed males.

4: RADIOGRAPHY SURVEY:

A: It is not essential, even severe dogs can be evaluated and treated surgically without radiographs.
B: In severe cases, orthogonal radiographic views of the stifle alone are sufficient.
C: Position is critical to avoid false positive limb deformities.
D: Severe cases need orthogonal radiographs views from mid-femur to mid-tibia.

ANSWERS: 1. B, 2. B, 3. D, 4. C