Canine patellar luxation part 1: pathophysiology and diagnosis

Author : Albane Fauron, Karen Perry

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ABSTRACT

Patellar luxation (PL) is a commonly diagnosed canine orthopaedic condition and, in the majority of dogs, is a developmental condition, as opposed to a traumatic one, resulting from skeletal abnormalities.

Medial patellar luxation (MPL) is the most common form of PL in dogs of all sizes. Lateral patellar luxation is less frequent and reported to occur more often in medium to large breed dogs. Luxations are graded on a four-point scale. Diagnosis is based on the clinical presentation and thorough orthopaedic examination.

Concomitance of cranial cruciate ligament (CrCL) pathology has been reported in 13% to 25% of dogs presenting for MPL and the integrity of the CrCL should be systemically assessed in these cases. Although radiology is not required for a diagnosis, it remains critical in the identification of any underlying skeletal abnormalities.

Patellar luxation (PL) is reported to be one of the most commonly diagnosed canine orthopaedic conditions in the UK and frequently encountered in general practice (Ness et al, 1996).

Figure 1. While medial patellar luxation (MPL) is more common in all breeds, lateral patellar luxation (LPL) is more common in larger breeds. This figure shows a St Bernard that presented with grade II LPL on the left and a cavalier King Charles spaniel that presented with grade II MPL on the right.

In the vast majority of dogs, this is a developmental rather than traumatic condition resulting from skeletal abnormalities affecting the alignment of the quadriceps mechanism (Piermattei et al, 2006).

Historically, PL has been recognised most commonly in small breed dogs, but its incidence among medium and large breed dogs appears to be increasing (Hayes et al, 1994; Alam et al, 2007).

Medial patellar luxation
(MPL) is the form of PL recognised most frequently in dogs of all sizes. Clinical signs range from subclinical instability to severely bilaterally affected dogs who may be completely unable to extend the stifle with severely impaired locomotor function.

Pathophysiology

Despite extensive research in this area, the aetiopathogenesis of PL remains incompletely understood (Harasen, 2006; Gibson et al, 2006; Rousk, 1993).

The over-representation of certain breeds suggests a genetic component in the disease aetiology, further supported by the high prevalence of bilateral cases in the absence of trauma (LaFond et al, 2002; Wangdee et al, 2013; Alam et al, 2007).

PL is typically regarded as a developmental disorder. Most luxations are not congenital per se, since they are not actually present at birth; rather, they result from a variety of congenital musculoskeletal abnormalities of the pelvic limbs (Piermattei et al, 2006). The deformities that predispose to the development of PL are present at birth, but the actual luxation tends to occur later in life.

Specific abnormalities postulated to contribute to development of PL include:

- coxofemoral joint conformation (abnormal angles of inclination and anteversion, decreased acetabular coverage and hip dysplasia)
- distal femoral torsion and angulation
- deviation of the tibial crest
- tightness/atrophy of the quadricep muscles
- shallow femoral trochlear groove (Hulse, 1981; Piermattei et al, 2006; Trotter, 1980)

Developmental PL is not considered an isolated disease of the stifle, but rather a sequelae of complex skeletal abnormalities affecting overall limb alignment (Towle et al, 2005). Failure to recognise and correct all the significant components affecting a dog may contribute to increased rates of recurrence of luxation and suboptimal limb function postoperatively.

In the case of MPL, coxa vara and decreased femoral anteversion are thought to be the main underlying abnormalities (Rousk, 1993).

Coxa vara is defined as a decreased angle of inclination between the femoral neck and longitudinal axis. Anteversion refers to the orientation of the femoral neck in relation to the femoral condyles. It is suggested that, as a result of these underlying disorders, the quadriceps femoris group is displaced medially.

In a growing animal, this muscular displacement has an effect on the distal femoral physis and femoral varus of varying severity, and internal rotation of the tibia can occur (Kowaleski et al, 2012; Harasen, 2006). This combination of deformities results in genu varum, or a “bow legged stance”, and causes the patella to luxate medially.

Conversely, proposed skeletal deformities associated with lateral patellar luxation (LPL) include coxa valga and an increased angle of anteversion. Opposing external torsion of the tibia may result and exacerbate malalignment of the quadriceps mechanism (Omlstead, 1993). The combination of skeletal deformities results in genu valgum and lateral luxation of the patella.

Early in a dog’s life, the patella exerts pressure on the femoral trochlea and these retropatellar forces are responsible for shaping a trochlear groove of adequate width and depth. Thus, if PL occurs early enough, a shallow or absent trochlear grove may result, further compounding the problem (Rousk, 1993).

In a juvenile or adult animal, intermittent PL and reduction may cause progressive wearing of the medial or lateral trochlear ridge with medial and lateral PL respectively, further increasing patellar instability (Kowaleski et al, 2012).

Because the skeletal abnormalities associated with PL are considered to be inherited, it is

generally recommended affected individuals should not breed. However, as the clinical signs associated with PL are often not recognised until later life, this may come too late for many cases.

While the vast majority of PL cases are developmental in origin, incidences of both medial and lateral traumatic PL have been reported (Remedios et al, 1992; Hayes et al, 1994).

The history typically relates to an episode of acute onset discomfort, with or without evidence of an overt traumatic incident, followed by moderate to severe lameness. These cases should be thoroughly assessed for any concomitant soft tissue and orthopaedic morbidities, including integrity of the cranial cruciate ligament and other supportive ligamentous structures of the stifle (Piermattei et al, 2006).

Signalment

Historically, PL has been recognised most commonly in small breed dogs. The Orthopaedic Foundation for Animals (OFA) named Pomeranians as the highest incidence of PL, with 37.2% of dogs affected during an evaluation lasting from January 1974 to December 2014 (OFA, 2014).

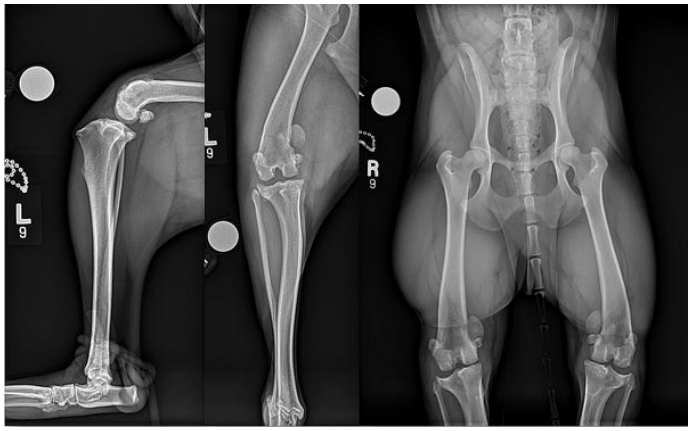

Figure 2. A minimum database of mediolateral and caudocranial views of the stifle with a ventrodorsal view of the pelvis for a four-year-old cross breed dog with grade III medial patellar luxation (MPL) and associated stifle osteoarthritis.

Chihuahuas, poodles, Maltese terriers, cavalier King Charles spaniels and Yorkshire terriers are also consistently over-represented across different studies (Hayes et al, 1994; Alam et al, 2007).

However, the incidence of PL among large breed dogs appears to be increasing. In a study evaluating the incidence and distribution of PL in a group of dogs examined between 1964 and 1969, only 10% of dogs diagnosed with PL were found to be large dogs (Priester, 1972).

In contrast, two subsequent studies – one conducted on 124 dogs between 1982 to 1992 and the other conducted on 134 dogs between 2000 to 2005 – found 39% and 31% of dogs respectively

diagnosed with PL were large breed dogs (Hayes et al, 1994; Alam et al, 2007). Among the large breeds, a predilection seems to be present in Labradors, retrievers and bull terriers (Hayes et al, 1994; Alam et al, 2007; Remedios et al, 1992; Arthurs and Langley-Hobbs, 2006).

Lateral luxation is less common, representing, on average, only 11% to 15% of dogs diagnosed with PL (Hayes et al, 1994; Alam et al, 2007; Arthurs and Langley-Hobbs, 2006). When it does occur, LPL is reported to occur more often in medium and large breed dogs, with one study suggesting an over-representation in cocker spaniels (Arthurs and Langley-Hobbs, 2006).

Conversely, in all of the aforementioned studies, small breed dogs were admitted almost exclusively with MPL (**Figure 1**).

Bilateral cases are common. In the case of medial luxation, bilateral involvement occurs in 50% to 64% of cases (Arthurs and Langley-Hobbs, 2006; Campbell et al, 2010). One study focusing exclusively on Pomeranians found bilateral involvement in 93% of cases (Wangdee, 2013). The same is true of cases of lateral luxation, with bilateral involvement being the most common presentation (Piermattei et al, 2006).

Age at presentation varies greatly depending on the grade of luxation and the associated clinical signs of dogs diagnosed with PL from 3 months to 16 years old (Hayes et al, 1994; Alam et al, 2007; Arthurs and Langley-Hobbs, 2006). However, the majority of lateral luxation cases begin to show clinical signs by five or six months of age (Piermattei et al, 2006).

Classification and clinical features

Clinical signs associated with PL vary with the grade of luxation. PL is typically graded according to the classification system reported by Singleton (1969):

- Grade I – the patella can be luxated manually, but returns to the normal position in the trochlear groove when released. There is no crepitus noted during stifle range of motion and bone deformity is absent. Clinical signs are typically not present.
- Grade II – spontaneous luxation occurs during a normal range of motion, but the patella normally resides within the trochlear groove. Clinical signs may be present, the most typical being a non-painful, “skipping” type of lameness, where the dog will intermittently limp and hold the leg up for a few steps before returning to normal. Dogs might also stretch the leg backwards in an effort to reduce the patella. This condition may progress to a grade III or IV, as erosion on the patellar and trochlear surfaces occur and/or cranial cruciate ligament disease develops.
- Grade III – the patella is permanently luxated, but can be reduced manually. More severe deformities of the tibia and femur may be present. A shallow trochlear groove may be palpable.
- Grade IV – this is a severe condition, with permanent, non-reducible luxation of the patella.

A 60° to 90° tibial rotation, shallow/flattened trochlear groove and displacement of the quadriceps muscle group may be present. If not corrected early in life, severe bone and ligamentous deformities, as well as permanent contracture of the quadriceps femoris muscle group, may develop, making surgical correction more challenging. The owner often complains of an abnormal crouched pelvic limb gait, rather than an intermittent skipping lameness.

Four groups of patients with PL have been defined based on clinical pattern (Piermattei et al, 2006):

- Neonates and older puppies that often manifest clinical signs of abnormal pelvic limb carriage and function as they begin to ambulate. These cases are generally grades III and IV and represent a mechanical lameness. The PL impedes normal function of the stifle rather than producing significant pain. Severely bilaterally affected dogs may be completely unable to extend the stifle and present in a crouched posture with limited pelvic limb function. Bilateral MPL cases exhibit a genu varum stance, while bilateral LPL dogs display a genu valgum stance.
- Young to mature animals that might have exhibited abnormal or intermittently abnormal gaits (including the characteristic “skipping gait”) all their lives, but present due to worsening of the symptoms. These cases typically represent grade II or III luxations. Signs may worsen as the animal gains weight, there is eburnation of cartilage of the medial or lateral trochlear ridge and the underside of the patella, and the luxation becomes permanent or the hip becomes luxated.
- Middle-aged or older dogs with grade I or II luxations may exhibit signs of lameness. If the animal presents acute lameness or acute worsening of a pre-existing lameness, causes for lameness other than PL should be considered (such as cruciate rupture or worsening osteoarthritic changes).
- A significant number of dogs with PL may show no clinical signs. It has been suggested larger dogs are less likely to be asymptomatic than smaller dogs (Harasen, 2006).

Diagnosis

Diagnosis of individual cases is based primarily on physical examination, not on radiographic findings. Gait evaluation at a walk or a trot allows screening for lameness and evaluation of overall conformation and/or skeletal deformity. Careful and thorough physical and orthopaedic examinations are necessary to characterise the grade of luxation and rule out other causes of lameness.

As described by Kowaleski et al (2012), if possible, physical examination is typically performed with the patient standing to evaluate symmetry between limbs and assess the stability of the femoropatellar joint. Gentle palpation usually does not cause pain.

Depending on the severity of the luxation, locating the patella may be difficult and is best achieved by following the patellar ligament proximally from its attachment on the tibial tuberosity until the patella is located. Once located, the patella is isolated and the stifle joint put through a range of motion (flexion, extension, internal and external rotation).

The foot should also be internally and externally rotated while trying to push the patella medially or laterally to identify the grade and direction of luxation. A popping sensation should be felt as the patella luxates and reduces, although, in the presence of a very shallow trochlear groove, this may not be pronounced.

Palpation and manipulation should aim at assessing the following features as their presence may affect the diagnostic and treatment plan, particularly with regards to which forms of imaging and surgery are required:

- instability of the joint
- presence of crepitus
- degree of tibial tuberosity rotation
- limb angulation
- inability to reduce the patella
- inability to extend the limb

Particularly, the stifle should be assessed for evidence of cranial cruciate ligament (CrCL) disease by palpating for effusion, cranial drawer and cranial tibial thrust. Concomitance of CrCL pathology and MPL is well recognised, with 13% to 25% of dogs presenting for MPL having parallel CrCL rupture (Gibson et al, 2006; Campbell et al, 2010).

It has been suggested dogs with MPL have an increased risk of developing CrCL disease due to malalignment of the extensor mechanism and internal rotation of the proximal tibia, which puts continuous tension on the CrCL, predisposing it to deterioration (Gibson et al, 2006; Harasen, 2002).

In addition, MPL can be associated with degenerative joint disease, which produces an enzymatic environment that can lead to degradation of the CrCL (Gibson et al, 2006; Roy et al, 1992).

It is also speculated dogs with severe MPL may have atrophy of the supporting structures of the stifle joint as a result of severe lameness. Atrophy of structures, such as the vastus lateralis muscle or the lateral retinaculum combined with a lack of patellar ligament stability, may contribute to greater joint instability and greater tension on CrCL (Campbell et al, 2010).

Radiographs identify skeletal abnormality

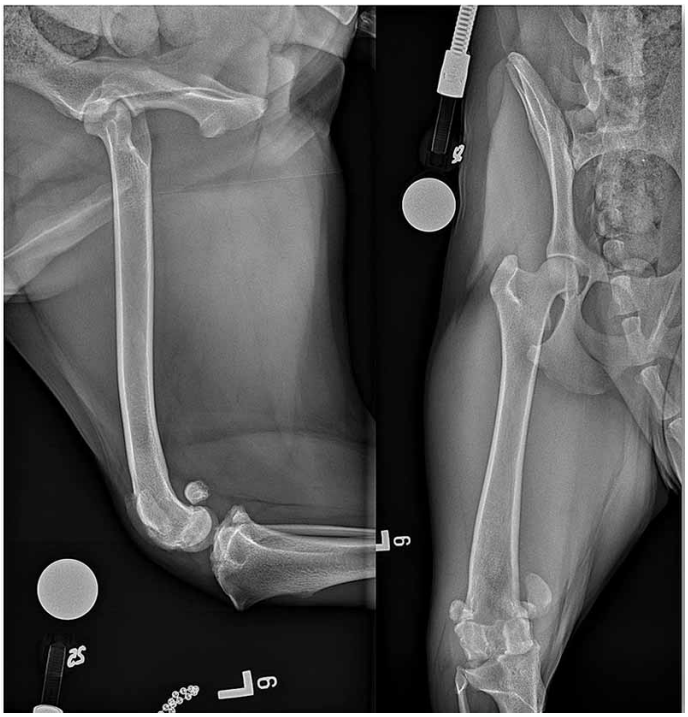

Figure 3. Mediolateral and caudocranial views of the femur of the same dog as in Figure 2 demonstrating a moderate varus angulation of the distal aspect of the femur, which was felt to be contributing to the grade III MPL.

Once the presence of PL has been confirmed and the grade determined, radiological examination is critical in the identification of any underlying skeletal abnormality. It can also be useful to assess the degree of degenerative change present in the stifle joint. In cases of grade I, II, or III PL, positioning of the patient for radiographs may result in reduction of the patella and, therefore, radiographic examination is often not useful for diagnosis of this condition, but hinges on physical examination.

While some surgeons do not perform preoperative imaging in cases of PL, the authors gathered a minimum database of bilateral stifle radiographs and a ventrodorsal view of the pelvis with limbs to evaluate for concomitant conditions, skeletal deformities and to allow surgical planning (**Figure 2**).

In cases where there is a suspicion of femoral varus contributing to the condition, craniocaudal and mediolateral views of the femur are also taken for evaluation (**Figure 3**). To take a satisfactory craniocaudal view of the femur without foreshortening, however, a horizontal beam is required, which is not possible in all facilities. Radiographic safety protocols and legislation must be followed at all times.

Severe skeletal deformities, such as excessive femoral varus and tibial torsion, may necessitate assessment by CT with or without three-dimensional reconstruction to allow for surgical planning. These have not been discussed in detail in this article, but high quality radiographs, in addition to a

comprehensive orthopaedic examination,
should allow the identification of such cases requiring advanced imaging and more complex corrective surgical techniques.

The second part of this article will detail the decision-making process regarding the cases requiring surgical treatment. The surgical options will be discussed, concentrating on those readily practicable in general practice.

- Canine patellar luxation part 2: treatments and outcomes

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