Lateral patellar luxation in dogs: a retrospective study of 65 dogs

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Keywords
Patellar, luxation, dog, lateral

Summary
Objective: To report the signalment and clinical features of dogs with non-traumatic lateral patellar luxation and to report the complications and outcomes following surgery.

Methods: A multicentre retrospective study was performed. Medical records were reviewed and the signalment, clinical features, and treatment of dogs presenting with lateral patellar luxation were recorded. In dogs treated surgically, the outcome and complications were investigated.

Results: Sixty-five dogs (95 stifles) were included; 39 were male and median age at presentation was 10 months. Breeds were classified as small (n = 6), medium (n = 23), large (n = 27), and giant (n = 9). Lateral patellar luxation was classified as grade I (n = 14), II (n = 41), III (n = 29), and IV (n = 11). Conformational abnormalities were noted in 34 stifles; genu valgum was the most common (n = 28). Higher-grade luxation was associated with a younger age at presentation (p = 0.032) and genu valgum (p = 0.01). Surgery was performed on 58 stifles, 22 of which sustained one or more complications; 16 complications were managed conservatively, four with implant removal and six with revision surgery. Surgeon-assessed outcome was good or excellent in 47 of the 51 dogs available for review.

Conclusions: Non-traumatic lateral patellar luxation is a disease of predominantly medium and large breed dogs. It has several similar clinical features and can be surgically treated in a similar manner to medial patellar luxation with similar types of complications and outcomes expected.

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Materials and methods

The medical records of dogs that were presented to one of four veterinary referral centres (Willows Referral Service, Weighbridge Referral Centre, NorthWest Surgeons and Andy Miller and Associates) with lateral patellar luxation between November 1998 and April 2011 were reviewed. Dogs with a history of previous pelvic limb trauma or surgery were excluded from the study. Data retrieved included signalment, grade of patellar luxation, presence of unilateral or bilateral disease, duration of clinical signs, presence of concomitant stifle disease, presence of grossly visible pelvic limb conformational abnormalities and the details and outcome of treatment.

The presence and type of conformational abnormalities were determined from the records of the initial physical examination because standardised preoperative images were not available. Similar to pre-
vious studies, the affected breeds were divided into four categories according to Kennel Club standards (i.e. small, medium, large and giant breed dogs) (4, 7, 16). Patellar luxation was graded in severity on a scale of I-IV as previously described (17).

In dogs that were treated surgically, the ratio of patellar tendon to patella length (PT:P), concomitant stifle abnormalities, the method of surgical treatment, complications, and surgeon-assessed outcome were also evaluated. The PT:P was measured from non-luxated mediolateral stifle radiographs in accordance with a previously reported technique (14).

Surgical procedures, when performed, were at the surgeon's discretion and with the full and informed consent of the owners. A craniomedial or craniolateral parapatellar arthrotomy was performed in all animals (18). Surgical techniques included block or wedge recession sulcoplasty, tibial tuberosity transposition, lateral release, medial imbrication and distal femoral osteotomy. In dogs that had bilateral correction, the interval between the surgical procedures was dependent on postoperative limb function, wound healing, and level of client perceived disability.

Follow-up data assessed included all re-examinations, treatments, and recorded client communications by the attending surgeon. Postoperative complications were defined as those managed surgically or non-surgically. Surgically managed complications were then subcategorized as those cases in which revision surgery was performed or recommended to the owner, and those that had implant removal.

Surgeon-assessed outcomes were graded as excellent (no lameness), good (intermittent mild lameness), fair (moderate lameness), or poor (severe or non-weight bearing lameness) as previously described (6, 8).

### Statistical analysis

All statistical analyses were performed using commercial software\(^a\). Data were reported as mean and standard deviation or median and range. Differences between measured variables were tested using Chi-square or Fisher's exact test for categorical variables and the Mann-Whitney U or Kruskal Wallis ANOVA for continuous variables. Statistical significance was set at \(p < 0.05\). All data were compared and assessed for significant associations.

### Results

Sixty-five dogs with 95 limbs affected by lateral patellar luxation were included in the study. Thirty-nine (60%) dogs were male (11 were neutered) and 26 (40%) were female (10 were neutered). The median age at presentation was 10 months (range: 2.5–120 months) (Table 1), and the median weight was 19.9 kg (range: 1.75–56 kg). Thirty-two different breeds were recorded as being grade I (14/95 stifles), grade II (41/95 stifles), grade III (29/95 stifles), and grade IV (11/95 stifles). Surgical correction was performed in 58/95 stifles with grade I (n = 4), grade II (n = 26), grade III (n = 20), and grade IV (n = 8) lateral patellar luxation. Dogs with higher-grade luxations were significantly more likely to be presented at a younger age than dogs with lower-grade luxations (\(p = 0.032\)). Of the bilaterally affected dogs, 24 had the same grade bilaterally whilst six had different grades in each limb. Combinations included grades I and II (n = 3), grades I and III (n = 1), and grades II and III (n = 2). Of the eight bilaterally affected dogs that were presented with the complaint of unilateral lameness, there were three dogs with different grades in each limb.

Grossly visible pelvic limb conformational abnormalities were recorded in 34/95 stifles. These deformities included genu valgum (n = 28), external rotation of the distal limb with a ‘cow hocked’ appearance (n = 5), and hypoflexion of the hocks (n = 2). A higher-grade of luxation was associated with the presence of visibly apparent conformational abnormality (\(p = 0.04\)), particularly with the presence of genu valgum (\(p = 0.01\)) (Table 1).

Hip dysplasia was diagnosed in 18 cases. The presence or absence of stifle osteoarthritis was recorded in 83/95 stifles. Thirty-nine stifles were recorded to have evidence of osteoarthritis.

Corrective surgery was performed on 58/95 stifles. Fifty-one of these stifles had a tibial tuberosity transposition, 29 of which were augmented with a tension band wire. Femoral trochlear sulcoplasty was performed in 46/58 stifles by wedge recession (n = 42) or block recession techniques (n = 4). Medial imbrication was performed in 45/58 stifles and lateral release was performed in 20/58 stifles. Femoral osteotomies were performed to correct distal femoral valgus in three of 58 stifles. There were 15 different combinations of eight different procedures performed. The most common combination was tibial tuberosity transposition, wedge recession sulcoplasty, and medial imbrication (35/58). Fifteen of these also had a tibial tuberosity tension band wire and 15 had a lateral release. Ten

### Table 1 Distribution of significant variables associated with each grade of lateral patellar luxation

<table>
<thead>
<tr>
<th>Grade of luxation</th>
<th>Total stifles</th>
<th>Median age (months)</th>
<th>Stifles with genu valgum</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>14</td>
<td>16.5</td>
<td>3</td>
</tr>
<tr>
<td>II</td>
<td>41</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>III</td>
<td>29</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>IV</td>
<td>11</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>95</strong></td>
<td><strong>10</strong></td>
<td><strong>28</strong></td>
</tr>
</tbody>
</table>

\(^a\) Prism GraphPad Software, Inc, La Jolla, CA, USA

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Dogs with higher-grade luxations were presented at an earlier age, and were more likely to undergo surgical correction. Whilst the reason is unclear, intuitively this is not surprising; higher-grade luxations probably caused more obvious client perceived lameness and hence were more likely to generate a proactive treatment by the surgeon.

Lateral patellar luxation has previously been considered a disease of large and giant breed dogs (4, 9). However, in the present study it was observed more frequently in medium and large breed dogs. Whilst this may reflect a changing demographic in our patient population, there is a paucity of previous population data on lateral patellar luxation with which to compare. The Cocker Spaniel was the most commonly affected breed in our study. Although our study design prevents a direct comment on breed predispositions, this finding is consistent with a previous report (13). However, it should be noted that between the years 2000 and 2011, the Cocker Spaniel was consistently reported as the second most popular breed registered with the United Kingdom Kennel Club, and breed popularity may in part explain the number of Cocker Spaniel dogs in the present study (19).

Genu valgum was present in 29% of affected stifles and was significantly associated with higher-grade luxations. As is the case in some dogs with high grade medial patellar luxation, it would be reasonable to presume that a proportion of these dogs also had femoral and or tibial deformities (20, 21). Unfortunately, the lack of standardized preoperative imaging of the pelvic limbs prevented us from determining whether this was the case. It therefore remains uncertain if genu valgum reflects an underlying bone deformity that plays a role in the development of lateral patellar luxation, or if it is simply a posture adopted by the dog to compensate for patellar instability. Whilst future radiographic assessment of femoral deformity may be useful, CT assessment may be superior particularly in cases with multiplanar deformities or femoral condylar dysplasia (22, 23).

Concomitant hip dysplasia has been associated with patellar luxation and was reported in 28% of our cases (5, 9). Although dogs had bilateral staged surgery. The median interval between surgical procedures was eight weeks (range 5–32 weeks).

Concomitant stifle abnormalities at the time of surgery were recorded in 14 of 58 stifles. These included abrasions or avulsion injuries of the origin of the long digital extensor tendon (n = 8), dysplastic lateral femoral condyle (n = 3), and convex trochlear (n = 3). No additional procedures were performed to treat the long digital extensor tendon injuries.

Suitable mediolateral stifle radiographs were available for evaluation for 33 dogs. The median PT:P was 1.76; the mean was 1.73 (range: 0.96–2.32; 95% CI: 1.61–1.85).

Fifty-seven of 58 stifles were available for postoperative assessment with one case lost to follow-up. The median duration of clinical follow-up was 16 weeks (range: 4–260 weeks). Twenty-two of these stifles sustained one or more complications. Ten stifles had a complication that was managed surgically. These included six with revision surgery and four with implant removal. Multiple complications were recorded in three stifles; no stifle had more than one surgical complication. There were 16 complications that were managed nonsurgically. The types and frequencies of postoperative complications are listed in Table 2.

Table 2

<table>
<thead>
<tr>
<th>Complications</th>
<th>Frequency</th>
<th>Managed conservatively</th>
<th>Managed surgically</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPL</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>LPL</td>
<td>6</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Seroma</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Wound problems</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Implant failure</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Tuberosity avulsion</td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>16</td>
<td>10</td>
</tr>
</tbody>
</table>

MPL = medial patellar luxation; LPL = lateral patellar luxation.

Recurrent lateral patellar luxation was the most common complication and occurred in six stifles, four of which had a revision surgery. Over correction leading to medial patellar luxation occurred in two stifles, one of which had a revision surgery. Three dogs with postoperative medial or lateral patellar luxation that were treated conservatively had subclinical grade 1 luxations and good or excellent outcomes. Tibial tuberosity avulsion fracture occurred in four cases and one had revision surgery. Other complications included wound breakdown and infection (n = 5), implant loosening and failure (n = 4), and seroma (n = 5). One dog with wound infection and three dogs with implant loosening and failure had minor surgical procedures to remove the implants. Complications were more likely to occur in dogs with unilateral luxations (p = 0.03), but were not associated with any other variable.

Surgeon assessed outcome was available for 51/58 stifles; seven stifles had incomplete data sets. Outcome was graded as being excellent (n = 14), good (n = 33), and fair (n = 4). No dog was recorded as having a poor outcome. There were no significant associations between the outcome and any other variable.

**Discussion**

In this study of a large series of cases suffering from lateral patellar luxation, there were several features that were similar to those reported for medial patellar luxation. These included the mean age at presentation, the ratio of unilateral to bilateral patellar luxation, and the distribution of grades (4, 6, 7, 13). The male to female ratio was 1.5:1, which is similar to medial patellar luxation in some studies, but is different to others (4, 6, 8, 12, 13). These similarities may reflect a common aetiopathogenesis.

Dogs with higher-grade luxations were presented at an earlier age, and were more likely to undergo surgical correction. Whilst the reason is unclear, intuitively this is not surprising; higher-grade luxations probably caused more obvious client perceived lameness and hence were more likely to generate a proactive treatment by the surgeon.
patellar luxation and hip dysplasia may occur concurrently, a causative relationship between the two is contentious (7, 10, 17). In the present study, the presence of hip dysplasia was not associated with any other variable, including postoperative complications and outcome.

The PT:P ratio is used in people to assess patellar position and hence diagnose patella alta or baxa; in people lateral patellar luxation is associated with patella alta (24). Previous investigations of PT:P in dogs have demonstrated an association between medial patellar luxation and a high PT:P, which the authors suggested implied patella alta (14, 25). No significant difference was demonstrated between control dogs (i.e. dogs without patellar luxation) and dogs with lateral patellar luxation. However, the numbers of dogs with lateral patellar luxation were small (n = 9) leading to possible type 2 error (14). Whilst there was no control group in our study, interestingly the mean and median PT:P in our study (1.73; 95% CI: 1.61–1.85) was lower than that of the control group (2.02; 95% CI: 1.97–2.06) reported in another study; this may suggest an association between a low PT:P and lateral patellar luxation (14).

It should be noted that the PT:P fails to take into account variations in patient anatomy such as the extent of the trochlear groove, the proximity of the patellar tendon insertion to the tibial joint surfaces, and the femorotibial standing angle. In our opinion, a low PT:P does not necessarily indicate patella baja but instead may represent normal anatomical variation between affected breeds. Further investigation is warranted.

Long digital extensor tendon abnormality was previously described in a case report in which it was suggested that chronic lateral luxation of the patella may lead to mechanical trauma to the long digital extensor tendon (26). No treatment was required in our cases, and the presence of this abnormality was not associated with any other variable such as grade of luxation, nor did it appear to affect the incidence of postoperative complications or outcome.

Previous studies have suggested that dogs with lateral patellar luxation may be at a higher risk for the development of complications than those with medial patellar luxation (13). The incidence of postoperative complications in our study was higher than some other reports of medial patellar luxation (15–29%), and similar to others (40–48%) (6, 8, 13, 27, 28). However, given the large differences in study designs of these reports, direct comparisons between cannot be made.

The types of postoperative complications in the present study were consistent with previous lateral and medial patellar luxation reports (6, 8, 13, 28). Also in agreement with other studies, recurrent patellar luxation was the most common complication, occurring in 11% of cases (6, 8, 13, 28). Though no significant risk factors were identified in our study, recurrent luxation suggests that there was an inadequate appreciation of the underlying pathological changes or that an inadequate corrective procedure had been performed. Uncorrected distal femoral varus has been reported to be associated with recurrent medial patellar luxation in dogs (20). Therefore it seems reasonable to assume that distal femoral valgus may be associated with lateral patellar luxation (15). Previous studies have also demonstrated a lower frequency of reluxation when a tibial tuberosity transposition and sulcoplasty were performed (8, 13). Whereas radiographic and CT assessment of distal femoral angular deformities have been described with reference angles suggested for preoperative planning of corrective femoral osteotomies, there is little in the veterinary literature to aid planning for tibial tuberosity transpositions or sulcoplasties (20, 21, 23, 29). In people, tibial tuberosity transpositions can be planned by measuring the quadriceps angle using standardised radiographs or by using CT overlay of the tibial tuberosity and the femoral condyles (30). Though these techniques may be useful in dogs, the variation in conformation and standing angle between dog breeds would make interpretation challenging (11). Additionally, although it has been suggested that sulcoplasties are performed to ensure that half of the patella is within the trochlear groove, there is little supportive evidence for this recommendation (31).

Interestingly, the dogs with unilateral patellar luxations were more likely to sustain a complication. Given the absence of any other associations between unilateral patellar luxations and other studied variables, we suspect this is a type 1 error. No other significant risk factors for the development of any complication were identified. This is in contrast to previous studies that have reported significant associations between weight, grade of patellar luxation and surgical technique on the incidence of complications after patellar luxation surgery (8, 13).

A good to excellent surgeon-assessed postoperative outcome was found in 92% of dogs. Though this is a subjective outcome measurement and therefore limits the conclusions that can be made, the result is similar to that reported following medial patellar luxation surgery and suggests that lateral patellar luxation surgery carries a similar prognosis (6, 8).

The study was limited by its retrospective design. The use of recorded data relied on the accuracy and completeness of medical records. Variations between surgeons, such as patient assessment, choice of treatment, and management of complications, were unavoidable given the multicentre nature of the study. Though outcome measurements were subjective, given the absence of standardization of perioperative treatment, this limited information was considered sufficient for the purpose of this study. Future prospective cohort studies with standardized patient assessment and surgical treatments, postoperative management and objective outcome measurements may be helpful in describing treatment and outcome of lateral patellar luxation more accurately.

In conclusion, non-traumatic lateral patellar luxation was observed in all breed categories, but predominantly in medium and large breed dogs. It has several similar clinical features and can be surgically managed in a similar manner to medial patellar luxation with similar types of complications and outcomes expected.

Conflict of interest
None declared.
References


