Vertical Patellar Position in Large-Breed Dogs with Clinically Normal Stifles and Large-Breed Dogs with Medial Patellar Luxation

ALLEN L. JOHNSON, DVM, Diplomate ACVS, KRISTYN D. BROADDUS, DVM, JOE G. HAUPTMAN, DVM, MS, Diplomate ACVS, SARAH MARSH, LVT, JAIME MONSERE, LVT, and GUSTAVO SEPULVEDA, MS, DVM

Objective—To further define vertical patellar position, as measured by the ratio of patellar ligament length to patellar length (L:P), in large-breed dogs with clinically normal stifles and compare that to the L:P of large-breed dogs with medial patellar luxation (MPL).

Study Design—Retrospective study.

Sample Population—Large-breed dogs (n = 50) with clinically normal stifle joints and 30 large-breed dogs with MPL.

Methods—Large-breed dogs with clinically normal stifle joints or MPL were identified and divided into groups (NORM and MPL, respectively). L:P values were determined for each dog by 4 observers from single lateral stifle radiographs. L:P was compared between NORM and MPL groups and 95% confidence intervals (CIs) were calculated.

Results—All 4 observers found a significantly higher L:P (more proximally positioned patella) for the MPL group compared with the NORM group. Overall mean (± SEM) L:P were: NORM, 1.71 ± 0.020 and MPL, 1.87 ± 0.025. The 95% CI was determined to be 1.45–1.97 for the NORM group and 1.57–2.17 for the MPL group.

Conclusions—Large-breed dogs with MPL had a significantly more proximal vertical patellar position compared with large-breed dogs with clinically normal stifles. Large-breed dogs with L:P values > 1.97 are considered to have patella alta.

Clinical Relevance—Proximal displacement of the patella within the femoral trochlear groove may play a role in MPL in large-breed dogs.

INTRODUCTION

PATELLA ALTA is defined as the proximal displacement of the patella within the femoral trochlear groove.1,2 In human orthopedics, patella alta has been associated with recurrent patellar dislocation, subluxation, chondromalacia, and pain in the anterior aspect of the knee.3-7 Limited information is available regarding potential clinical conditions associated with patella alta in the dog. It has been speculated that patella alta may play a role in canine patellar luxation.1,2 If the patellofemoral articulation moves completely proximal to the femoral trochlear groove during stifle extension, the buttressing effects of the trochlear ridges would be lost, resulting in an increased risk of luxation as the patella begins to move distally within the femoral trochlear groove during stifle flexion.

A quantitative method to define the vertical position of the patella in large-breed dogs has been described.1 Vertical patellar position was defined by the ratio of the length of the patellar ligament to the length of the patella (L:P). The L:P proved to be a repeatable measurement of
vertical patellar position, independent of stifle angles (75–
148°) on a single lateral stifle radiograph. Mean L:P was
determined to be 1.68 with a 95% confidence interval (CI) of 1.33–2.03 in 13 clinically normal large-breed dog
cadaver stifle specimens. To our knowledge, vertical pa-
tellar position (L:P) has not been reported in a larger
population of large-breed dogs with clinically normal sti-
fles or medial patellar luxation (MPL).

Our objectives were to further define the L:P in a large
group of large-breed dogs with clinically normal stifles
and compare that with the L:P of a group of large-breed
dogs with MPL. Our hypothesis was that large-breed
dogs with MPL would have a significantly higher L:P
(more proximally positioned patella within the femoral
trochlear groove).

MATERIALS AND METHODS

Large-Breed Dogs with Medial Patellar Luxation

Medical records (9/1/93–10/1/01) were reviewed to identify
large-breed dogs with MPL. Information retrieved was: breed,
age, weight, type of luxation (medial versus lateral), presence
of other orthopedic abnormalities, and preoperative radi-
ographs. Inclusion criteria for the MPL group were: large-breed
dog (20–50 kg), skeletally mature (≥1 year of age), document-
ed non-traumatic MPL in at least 1 stifle, no other orthopedic
abnormalities in that stifle, and presence of a good quality
straight lateral radiograph of that stifle.

Large-Breed Dogs with Clinically Normal Stifles

Medical and radiographic records for the same time period
were retrieved for large-breed dogs with clinically normal sti-
fles on physical examination that also had lateral stifle radi-
ographs. Inclusion criteria for this group (NORM) included:
large-breed dog (20–50 kg), skeletally mature (≥1 year of age),
no documented stifle abnormalities on orthopedic examina-
tion, and the presence of a good quality straight lateral stifle
radiograph with no radiographic abnormalities. Dogs with
radiographic evidence of stifle joint effusion or osteoarthrosis
were excluded from the NORM group. Dogs with orthopedic
abnormalities not specifically involving the stifle were included
in the NORM group.

Radiograph Evaluation

Single lateral stifle radiographs from each dog (NORM,
M.P.L. groups) were randomized and examined by 4 different
observers (A.J., S.M., J.M., G.S.) blinded to which group each
stifle radiograph originated. Two observers (S.M. and J.M.)
are licensed veterinary technicians, 1 was a radiology resident
(G.S.), and 1 an ACVS diplomate (A.J.) who originally de-
scribed the L:P measurement in dogs. Each observer mea-
sured the L:P on each radiograph as described Fig 1.

Length of patellar ligament (L) was measured on the caudal
aspect of the patellar ligament from the origin on the distal
portion of the patella to the insertion on the tibial tubercle.
This point of insertion is associated with a small indentation
on the tibial tubercle, which was used for reference. Length of
the patella (P) was determined using the measurement for
the longest dimension of the normal patella. L:P was calcu-
lated using the following equation, L:P = L/P. All measure-
ments were performed 3 times by each observer using a
digital caliper (Mitutoyo Digimatic Caliper, Mitutoyo Corp.,
Tokyo, Japan); therefore, each dog had 3 L:P values from
each observer.

Data Analysis

Data were analyzed by means of split-plot ANOVA (SAS
PROC MIXED; SAS Institute Inc., Cary, NC) according to
the model

\[
L : P = \text{mean} + \text{Group} + \text{Dog(Group)} + \text{Observer} + \text{Group} \times \text{Observer} + \text{Error}_2 + \text{Repetition}
\]

Data comparing groups were reported as mean (± SEM);
\( P < .05 \) was considered significant. Variances (\( \sigma^2 \) = standard
deviation (SD)\(^2 \)) caused by the random factors of dog, ob-
server, and repetition were estimated (SAS PROC MIXED).
The 95% confidence limits of the population were estimated
by mean ± 1.96 × SD.
RESULTS

Dogs With Clinically Normal Stifles (NORM)

Fifty dogs were identified that fit the inclusion criteria for the NORM group. Mean (± SD) body weight was 35.0 ± 6.0 kg (range, 20.5–46.8 kg) and mean age was 7.1 ± 3.4 years (range, 1.0–14.6 years). Thirty (60%) dogs were clinically normal without evidence of any orthopedic disease, 11 (18.3%) had evidence of canine hip dysplasia, 6 (12%) had evidence of cranial cruciate ligament rupture in the opposite stifle, 1 had elbow osteoarthritis, 1 had intervertebral disc disease, and 1 had neoplasia in the distal tibia. Breeds were: Labrador Retriever (33), mixed breeds (7), Rottweiler (3), and 1 each of German Shepherd Dog, Malamute, Chesapeake Bay Retriever, Gordon Setter, Airedale, Golden Retriever, and Irish Setter.

MPL Dogs

Thirty dogs were identified that fit the inclusion criteria for the MPL group. Mean (± SD) weight was 34.4 ± 7.7 kg (range, 21.4–50.0 kg) and mean age was 1.8 ± 1.0 years (range, 1.0–4.0 years). Breeds were: Labrador Retriever (9), mixed breed dogs (9), Akita (4), Golden Retriever (3), and 1 each of Rottweiler, English Setter, Catahoula Hound, Great Pyrenees, and Weimaraner.

L:P

Including data from all observers (Table 1), mean (± SEM) L:P were: NORM, 1.71 ± 0.020 and MPL, 1.87 ± 0.025 (P < .001). Analysis of the data from each observer showed a significant (P < .05) difference between observers, although each observer found a statistically significant higher L:P for the MPL group compared with the NORM group. The 95% CI L:P were: NORM, 1.45–1.97 and MPL, 1.57–2.17. Variance for observer (0.007) was 28% of the overall variation (0.0040 in NORM and 0.0141 in MPL).

<table>
<thead>
<tr>
<th>Observer</th>
<th>NORM</th>
<th>MPL</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.J.</td>
<td>1.69 ± 0.018</td>
<td>1.88 ± 0.030</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>S.M.</td>
<td>1.79 ± 0.022</td>
<td>2.02 ± 0.031</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>J.M.</td>
<td>1.72 ± 0.026</td>
<td>1.86 ± 0.031</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>G.S.</td>
<td>1.64 ± 0.020</td>
<td>1.72 ± 0.037</td>
<td>.01</td>
</tr>
<tr>
<td>All</td>
<td>1.71 ± 0.020</td>
<td>1.87 ± 0.025</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

DISCUSSION

All 4 observers found a significantly higher L:P (more proximally positioned patella) for the MPL group compared with the NORM group, but there were significant differences between observers for measurements in both groups. The overall variance from observer was 28% of the variation of the data with variance because of observer in the MPL group (0.0141) being 3.5 times higher than the variance because of observer in the NORM group (0.0040). The higher variation between the observers in the MPL group compared with the NORM group was expected because of the presence of degenerative joint disease in many of the dogs with MPL.

Osteophytosis on the distal aspect of the patella make it difficult to determine the length of the normal patella (P). The observer must estimate where the normal distal margin of the patella ends and where the osteophyte begins. Prominent osteophytes at the distal aspect of the patella make this determination difficult and less precise. If anything, observers would tend to over-estimate the length of the patella in MPL dogs because of an osteophyte on the distal patella, which would falsely lower the L:P. This further supports the finding that large-breed dogs with MPL have a higher L:P (more proximally positioned patella) compared with large-breed dogs with clinically normal stifles.

One major limitation of our study was an inability to truly blind the observers to which group each stifle radiograph originated. All stifle radiographs were randomized in attempts to blind the observers, but the L:P measurements cannot be obtained without visualizing the complete stifle joint on the radiograph. Most dogs in the MPL group had some degree of degenerative joint disease, evidenced by osteophytosis and joint effusion. By definition, none of the NORM group dogs had radiographic evidence of osteophytosis or joint effusion. Therefore, it was impossible to truly blind the observers. In attempts to make the study more objective, 3 observers (S.M., J.M., G.S.) had limited knowledge of the purpose of the study and were merely instructed on how to perform the measurements on any given stifle radiograph. Another limitation was the retrospective nature of the study. Many large-breed dogs with MPL had to be excluded because a good quality straight lateral stifle radiograph was not available for review.

We evaluated large-breed dogs because it has been our clinical impression that large-breed dogs with MPL often appear, subjectively, to have some degree of patella alta. Also, the incidence of MPL in large-breed dogs appears to be increasing in our clinical patients. In a study in which investigators evaluated the incidence of patellar luxation from 1964 to 1969, only 8.9% (48 of 542) of dogs with patellar luxation were considered large breeds.
 (> 18.2 kg). By contrast, a similar study conducted from 1982 to 1992 revealed that 38.7% (48 of 124) of dogs with patellar luxation were considered large breeds and 81% of those had MPL.

Our results indicate that the normal vertical patellar position, based on L:P measurement, in large-breed dogs is between 1.45 and 1.97 (95% CI). These results are very similar to the 95% CI of 1.33–2.03 found in a previous study evaluating L:P in an in vitro model of normal large-breed dogs. Data from our study would indicate that dogs with L:P values > 1.97 could be definitively diagnosed with patella alta, whereas large-breed dogs with L:P values < 1.45 could be diagnosed with patella baja (distally positioned patella). To our knowledge, L:P has not yet been evaluated in small breed dogs; therefore, the use of L:P to diagnose patella alta or baja in small-breed dogs may be inaccurate.

Our results indicate that proximal displacement of the patella within the femoral trochlear groove may play a role in MPL of large-breed dogs; however, it cannot be determined whether proximal displacement of the patella is a potential cause of MPL or an effect of chronic MPL. While it seems unlikely that the patellar ligament would undergo plastic deformation and elongate secondary to repeated MPL, long-term evaluation of L:P in individual dogs with MPL would be necessary to prove that assumption.

Dogs with marked proximal displacement of the patella may have a patellofemoral articulation that moves completely proximal to the femoral trochlear groove during stifle extension; resulting in a loss of the buttressing effects of the trochlear ridges. In humans, patella alta has been shown to result in patellofemoral incongruity, leading to chondromalacia and substantial pain in the anterior aspect of the knee. Chondromalacia may also exist in dogs with patella alta but, to our knowledge, has not yet been reported.

Evaluation of vertical patellar position is warranted in large-breed dogs with MPL. In dogs with MPL and concurrent proximal displacement of the patella within the femoral trochlear groove, it may be advisable to distally transpose the tibial tubercle, in addition to any necessary medial or lateral corrections, to place the patella in a normal vertical position within the femoral trochlear groove where the trochlear ridges can more effectively buttress the patella. Theoretically, this would decrease the risk of recurrent patellar luxation, as well as, improve the congruity of the patellofemoral joint. However, clinical results of distally transposing the tibial tubercle have not been scientifically evaluated to date.

REFERENCES