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Lateral Patellar Luxation Post Hip Replacement/Simlett-Moss et al

Case Report

Lateral Patellar Luxations Following Bilateral Hip Joint Replacement in a Dog

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\*It is with great sadness and regret that ASM sadly passed away in July 2020 and therefore this manuscript is being submitted in her memory and as testament to her great diligence and care with her patients.

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Abstract

**Case Description** A 2-year-old male neutered crossbreed was presented with a seven-month history of left pelvic limb lameness. Following a diagnosis of bilateral hip dysplasia, staged hybrid total hip replacements (THR) were performed 16 months apart. An ipsilateral grade II lateral patellar luxation (LPL) developed within 24 hours after each THR. Both LPLs were successfully treated by block recession sulcoplasty.

**Clinical Findings** Subjective gait analysis showed an abnormal pelvic limb gait following each THR. Clinical examination detected a grade II LPL on each operated limb. Computed tomography of both pelvic limbs revealed mild trochlear sulcus hypoplasia but no other skeletal abnormalities.

**Treatment and Outcome** Trochlear block recession sulcoplasty was performed ten and four weeks respectively after THR. Long-term follow-up twelve months after the last surgery found minimal (0–1/10) lameness, no pain on clinical examination in both PLs and an overall low client-based metrology instrument mobility score of 2 (Liverpool Osteoarthritis in Dogs (LOAD)).

**Conclusion** This case report documents that in predisposed dogs, with hypoplastic trochlear ridges, LPL can occur secondary to THR and can be successfully managed by standard techniques to address the. Furthermore, despite anecdotal verbal reports of medial patellar luxation occurring secondary to THR in dogs, this is the first published report of the management of any patellar luxation subsequent to THR.

**Keywords**

total hip replacement

lateral patellar luxation

dog

Introduction

Total hip replacement (THR)1,2 has been reported to provide consistent, excellent outcomes for dogs and cats with coxofemoral joint pathology.3,4 Reported post-operative complications include implant luxation, septic and aseptic loosening, sciatic neuropraxia and femoral fracture.3–8 Similar complications are reported following THR surgery in people.9 During THR, intraoperative medial patellar luxation in dogs was noted in 4 out of 78 procedures in one case series,8 being corrected by rectus femoris release at its proximal origin in all cases. No reports of LPL associated with THR, either inter-or peri-operatively, have been published in either human or veterinary literature.

Naturally occurring patellar luxation in dogs may be medial, lateral, or bidirectional.10,11 Medial patella luxation is commonly associated with conformational deformities including quadriceps mechanism malalignment, genu varum, coxa vara, femoral varus, shallow trochlear sulcus, poorly developed lateral or medial trochlear ridges, medial displacement of the tibial tuberosity.10,12 Conversely, femoral valgus, genu valgum, coxa valga, increased angle of femoral anteversion, hypoplastic lateral trochlear ridge, long proximal tibia, and patellar baja may be associated with LPL (LPL).12 The anatomical abnormalities as described above can cause a malalignment of medial-lateral forces acting on the patella versus alignment of the trochlear sulcus resulting in patellar luxation.13 Four grades of patellar luxation are recognized14: with the higher grades typically cause more debilitating lameness, inability to ambulate and development of osteoarthritis. Lateral patellar luxation is seen most commonly in large-breed dogs, although it can occur in dogs of any size.10,11

Surgical options for correction of LPL include femoral osteotomy to correct femoral malalignment, femoral sulcoplasty, tibial tuberosity transposition, lateral release, medial imbrication and tibial corrective osteotomy.10 While THR surgery may result in adjustments in force direction through the patellar mechanism via changes in limb rotation, acetabular anteversion or retroversion, and femoral neck length15,16; consequential post-operative patellar luxation and its management has not previously been reported.

Case Description

A two-year-old, 14.4kg male neutered poodle cross was presented to the referral center with a seven-month history of left pelvic limb lameness. On orthopaedic examination, a moderate to severe pain response was elicited on extension of both coxofemoral joints and moderate bilateral proximal pelvic limb muscle atrophy was present. No lameness was observed on walking or trotting, but a mild swaying gait was evident. Liverpool Osteoarthritis in Dogs (LOAD) clinical metrology score17 was 14 indicative of a moderate impairment to mobility. General clinical examination was otherwise unremarkable. On the same day a short anesthetic was performed, to take four standard radiographs (Fig. 1) for diagnosis and THR templating (Biomedtrix, Boonton, NJ, USA). Radiographs showed changes consistent with bilateral hip dysplasia and secondary osteoarthritis (Fig. 1(A-D)). The dog’s owners opted for THR surgery.

Left-sided THR and Associated Lateral Patellar Luxation

A left-sided THR was performed under standard premedication, anesthesia induction and maintenance protocols. . An epidural anesthetic with bupivacaine 1mg/kg (Marcain, Aspen) and morphine 0.1mg/kg (Duramorph, West-Ward) was given. Cefuroxime 10mg/kg q90m (Zinacef, GlaxoSmithKline) was administered throughout anesthesia and subsequently every 8 hours for 24 hours. Meloxicam 0.1mg/kg IV (Metacam, Boehringer Ingelheim) was given at the completion of the procedure.

A hybrid total hip replacement was performed with a 22mm cementless acetabular cup (BioMedtrix BFX, Boontown, NJ), cemented #5 femoral stem and 14mm (+3mm) femoral head implant (BioMedtrix CFX, Boonton, NJ). Satisfactory implant positioning was confirmed by radiography (Fig. 2). Acetabular angle of retroversion (AR), angle of lateral opening (ALO) and angle of femoral inclination (AI) were measured according to Dyce et al.18 The AR was 19.4°, ALO 46.7°. and AI 135° and the femoral stem appeared appropriately anteverted. The cement mantle around the femoral stem measured 2–4mm and was classified as grade A (excellent) according to Ota et al.19

The dog began to tentatively weight-bear on the left pelvic limb 24 hours postoperatively, but examination revealed a medium (intermittent) grade II left LPL. It was hoped that the LPL would resolve with normal limb use in the recovery period, so the dog was discharged with detailed instructions (Supplementary material 1).

Ten weeks after the THR procedure, the dog was reassessed. Subjective gait evaluation demonstrated a bilaterally ‘crouched’ pelvic limb gait due to a LPL in the left stifle joint and existing hip dysplasia/osteoarthritis in the right pelvic limb. Orthopaedic examination detected intermittent grade II LPL of the left stifle. The left coxofemoral joint was non-painful with normal range of movement but discomfort was elicited on manipulation of the right coxofemoral joint. The LOAD score was unchanged at 14.

At this time, advanced imaging of the stifle joints was performed to ascertain if any rotational deformities may have been contributing to the LPL. Computed tomography (CT) examination was performed under sedation using an 80-slice CT scanner (Aquilion Prime, Toshiba Medical Systems Europe, Zoetermeer, Netherlands). Slice thickness was set as 0.5mm with a helical pitch factor of 0.638. Transverse images were acquired and reconstructed with a sharp (bone) algorithm. All images were viewed as multiplanar reconstructions in a bone window (W=2700, L=350). The femoral angle of anteversion (FAA) was measured for both sides as described by Barnes et al20 The FAA for the unoperated right femur was 21.9°, and the operated left femur was 19.4°. No normal range for canine FAA has been established, with reported mean variation from 16°-31.3°.21 CT found no angular deformity of the left or right femoral or tibial diaphyses. Measurements for the depth of the trochlear groove and width of the lateral trochlear ridge for both left and right stifles22 are detailed in Fig. 3(A-F) and Table 1. Neither tibial tuberosity was deviated medially or laterally. Pre-operative femoral varus was retrospectively measured (from the THR templating radiographs shown in Fig. 1D) as 9° (left) and 6.7° (right), within previously reported ranges.23 The ratio for left patellar ligament:patella length was 1.77, suggestive of mild patella baja.12 Trochlear groove depth could not be assessed from the pre-operative radiographs.

Thus, it was hypothesized that intermittent grade II LPL resulted from a combination of mild trochlear sulcus hypoplasia and internal femoral rotation causing relative medialisation of the trochlear sulcus versus the quadriceps mechanism alignment axis. Given these observations and the degree of morbidity in this dog’s left pelvic limb function and gait, block recession sulcoplasty24 was planned to correct the LPL, ten weeks following left THR surgery.

The dog was anaesthetised with standard premedication, anesthesia induction and maintenance protocols with an ultrasound-guided femoral/sciatic nerve block with bupivacaine 2mg/kg also being performed. On surgical exploration of the left stifle joint, the distal aspect of the lateral trochlear ridge was confirmed. The tibial tuberosity, alignment of the patellar ligament and quadriceps mechanism were deemed to be appropriate. This was an intra-operative subjective surgeon visual assessment completed by flexing and extending the stifle joint and noting the tracking and position of the patella and the direction of pull of the patellar ligament with reference to the relative positions of the patella (proximal) tibial tuberosity distal and the visible patellar ligament in-between. The patella was measured as 10mm wide intra-operatively. An XACTO saw (Veterinary Instrumentation, Sheffield, UK) was used to create two osteotomies parallel to the trochlear ridges, 12mm apart. A (10mm wide) modular osteotome (Veterinary Instrumentation, Sheffield, UK) was used to create a third osteotomy perpendicular to the first two, creating the block. The block was then press-fit in its original position which yielded a block sulcoplasty 12mm wide and 6mm deep. Manual patellar luxation was not possible through a normal range of motion and prior to soft tissue closure.13 Post-operative radiography confirmed appropriate positioning of the sulcoplasty block. The dog recovered well and was maintained post-operatively with methadone 0.2mg/kg IV q4h and paracetamol 10mg/kg IV q8h (Perfalgan, Bristol Myers-Squibb). The dog was discharged the following day with detailed instructions provided (Supplementary material 2).

A telephone update reported that the dog was mildly lame at two weeks post-operatively but keen to exercise. Follow-up orthopaedic examination at twelve weeks found the patella tracked within the trochlear sulcus and there was mild quadriceps and hamstring atrophy. Subjective gait analysis found a mild (1/10) left pelvic limb lameness. The LOAD score had reduced from 14 to 12. The dog was discharged with instructions for ongoing physiotherapy to improve muscle bulk and continuing oral daily meloxicam for management of right coxofemoral pain.

Right-sided THR and Associated Lateral Patellar Luxation

The dog was re-examined twelve months after left THR surgery and a right-sided THR, to address right-sided hip dysplasia and secondary osteoarthritis, was performed. A right-sided hybrid THR was performed with a 20mm cementless acetabular cup, cemented #5 femoral stem and 13mm(+0mm) femoral head implant.. Satisfactory implant positioning was confirmed except that cup impaction depth was suboptimal; measurements indicated AR 28.9°, AI 135° and ALO 42.8° (Figs. 4A-D). Femoral stem anteversion was appropriate. Recovery from the procedure was uneventful, with tentative weight-bearing on the right pelvic limb 24 hours following surgery. Right stifle grade II LPL was however present immediately after surgery whenever the dog flexed the right stifle. The dog was discharged with detailed instructions (Supplementary material 3) and surgical intervention was scheduled for four weeks after THR if no improvement of the LPL was noted, during this period with medical management.

At four weeks post right THR (as on the left side), no improvement was noted and surgical management of the right grade II LPL was planned as described previously.24 A 12mm wide block sulcoplasty was performed as previously detailed. Congruency after block sulcoplasty was again judged to be excellent and manual luxation of the patella not possible. The dog was discharged 24 hours later with instructions as detailed in Supplementary material 4.

Fourteen days post-operatively normal patellar tracking was confirmed and telephone follow-ups at 3 and 6 months reported progressive reduction in lameness. Final re-examination (33 months after the first THR and left LPL and 12 months after second THR and right LPL surgery) found the dog undertaking two miles of off-lead exercise daily without no reported mobility issues. Subjective gait evaluation found a mild (graded 0–1/10) right pelvic limb lameness and both patellae were in place with normal tracking. A clinical metrology score (LOAD) of 2 revealed a marked improvement from the original score of 14.

Discussion

Lateral patellar luxation (LPL) occurs less frequently than medial patellar luxation, representing ~19% of cases of patellar luxation in medium breed dogs.8 Skeletal deformities associated with LPL include distal femoral valgus, lateral condylar dysplasia, patella baja and genu valgum.11,12,22 LPL occurring in skeletally immature dogs may lead to a shallow or absent trochlear groove resulting in progressive wearing of the lateral trochlear ridge increasing instability and the tendency to luxate.11,25

Patella baja has been associated with LPL12 and was present on pre-operative radiographs in this case, although LPL was not present before THR surgery. Hypoplastic lateral trochlear ridges and bilaterally shallow trochlear grooves were identified at CT examination and surgery. These were not identified on preoperative THR templating radiographs; there was no indication to perform stifle CT any earlier as the dog showed no clinical signs of patellar luxation prior to THR surgery, including multiple detailed orthopaedic examinations by numerous orthopaedic clinicians including board certified surgeons.

We cannot be sure why this dog developed lateral patellar luxation post left and right THR surgery. We reason that this was due to a combination of the hypoplastic lateral trochlear ridges and an imbalance of quadriceps mechanism vs femoral trochlear alignment and that have been exacerbated by the dog holding its femora in a more internally rotated position post THR compared with pre THR. Such changes in femoral axial alignment in the dog would be very difficult to assess accurately in the standing conscious dog and have not previously been reported in dogs. Similar changes in femoral axial alignment after THR have been described in humans, with a mean increase in internal femoral rotation of 11°.15

The alignment of the THR components was considered to be within normal /acceptable limits post-operatively. Assessment of acetabular component positioning post-operatively was very close to the commonly accepted target of 34–45° for ALO5 and 15°-25° of retroversion16 for both hips. The left cup was very mildly open 46.7°, and retroversion was ideal at 19.4°. The right cup had an ideal ALO of 42.8° and slightly more retroverted than ideal with an AR of 28.9°. It is a complex argument to determine the consequence of THR implant positioning and alignment on limb carriage vs hip luxation. Certainly, luxation can occur following malalignment and neck-cup impingement, but an absolute or direct relationship has been difficult to prove.7 It is possible that implant mal-positioning could lead to altered carriage of the femur relative to the pelvis. However, as femoral vs pelvic bone position is constrained by peri-articular soft tissue tension it seems unlikely that THR implant mal-position or relative mal-alignment would lead to altered carriage or position of the femur, and that this would rather be affected by peri-articular soft tissue tension and/or pain. Peri-articular soft tissue tension would be altered by changes in relative neck length with increases in neck length increasing soft tissue tension and reduced or lost neck length resulting in reduced soft tissue tension. A “tight’ THR at the time of reduction typically has increased soft tissue tension and the limb may be held externally rotated in the early post-operative period. By contrast, this dog may have had relative loss of neck length resulting in reduced soft tissue tension and therefore possible internal rotation of the femur but no gross reduction in neck length was identified on the post-operative radiographs.

The surgical management of LPL is primarily aimed at addressing abnormal alignment of patellar tendon/quadriceps mechanism and deepening the trochlear groove.13 However due to a paucity of data on LPL, many conclusions have been extrapolated from MPL data.24 Trochlear block recession sulcoplasty was considered the most important component of correcting the LPL in this case due to the hypoplastic lateral trochlear ridges and consequent shallow sulcus.23 In other words, the judgment of the surgeon was that LPL could be more reliably corrected by block recession sulcoplasty rather than tibial tuberosity transposition; given the shallow trochlear sulcus, the risk with tibial tuberosity transposition would be that under-correction could lead to recurrent lateral patellar luxation whereas over-correction could lead to medial patellar luxation. It is possible that medial tibial tuberosity transposition would have been equally effective in controlling the dog’s LPL. In one evaluation of post-surgical recurrent LPL, sulcoplasty was found to be the only surgical treatment that was shown to significantly reduce re-luxation.24

In conclusion, we report a case of a dog that developed bilateral LPL immediately following staged Biomedtrix® hybrid THR. This is a previously unreported and apparently rare complication of canine THR surgery; it may have occurred due to the presence of predisposing factors to LPL, such as hypoplastic femoral trochlear sulcus/lateral trochlear ridge combined with internal femoral rotation, which was exacerbated by the changing biomechanical forces post-THR. The LPL was successfully corrected by femoral trochlear block recession sulcoplasty in both cases four and ten weeks after THR surgery with complete return to full activity and excellent client reported mobility scores 33 months following the initial THR surgery.

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There was no funding associated with this case study.

Author Contributions

It is with great sadness and regret that ASM sadly passed away in July 2020 and therefore this manuscript is being submitted in her memory and as testament to her great diligence and care with her patients.

ASM/EC/FS/GA: 1) Substantial contributions to the conception, study design, or acquisition of data, as well as participation in the analysis and interpretation of data;

ASM/EC/GA: 2) Drafting of the article or revising it critically for important intellectual content;

EC/GA/FS **(ASM sadly passed away in July 2020):** 3) Approval of the submitted version of the manuscript, all revised versions, and the final version to be published;

EC/GA/FS: 4) Agreement to be publicly accountable for the appropriate portions of the content

Conflict of Interest Statement

The authors have no conflict of interest.

Ethical Statement

Permission to use the case details in this case report were given with full owner consent and used under generic institutional ethical permission for use of clinical case material in research.

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**Fig. 1** Preoperative radiographic ventrodorsal extended hip joint view (**A**), caudocranial left femoral view (**B**), lateral pelvic view (**C**) and mediolateral open-leg left femoral view of the dog. Moderate to severe bilateral subluxation is present, more severe on the left side. Additionally, mild to moderate osteophytosis is noted at the acetabular and femoral head margins. The patellae are in a normal position.

**Fig. 2** Postoperative radiographic ventrodorsal extended hip joint view (**A**), caudocranial left femoral view (**B**), lateral pelvic view (**C**) and mediolateral open-leg femoral view of the dog after left total hip replacement. The radiographs show satisfactory implant positioning with appropriate retroversion of the acetabular angle, angle of lateral opening and femoral inclination. The femoral stem anteversion is good.

**Fig. 3** Transverse computed tomographic images of the right (**A-C**) and left (**D-F**) distal femora reconstructed in a bone algorithm showing the proximal (**A and D**), mid (**B and E**) and distal (**C and F**) part of the femoral trochleae. Hypoplasia of the femoral trochleae is present bilaterally.

**Fig. 4** Postoperative radiographic ventrodorsal extended hip joint view (**A**), caudocranial right femoral view (**B**), lateral pelvic view (**C**) and mediolateral open-leg right femoral view of the dog after right total hip replacement. The radiographs show satisfactory implant positioning with appropriate retroversion of the acetabular angle, angle of lateral opening, femoral inclination, and femoral stem anteversion. Cup impaction depth is considered suboptimal.

Table 1 Trochlear CT measurements from left and right stifles measured from transverse images as described by Towle et al22; the left and right trochlea were similar except that the trochlear grove was deeper proximally on the right side, and the lateral trochlear ridge was higher on the right side at distal and mid locations, but not proximally (see also Fig. 3 (A-F)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Depth of trochlear groove (mm) | | | Height of lateral trochlear ridge (mm) | | |
| Proximal | Mid | Distal | Proximal | Mid | Distal |
| Left | 1.6 | 1.9 | 1.6 | 2.9 | 1.6 | 1.0 |
| Right | 2.5 | 1.9 | 1.6 | 3.0 | 2.1 | 1.9 |