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Objective—To assess signalment, outcomes, and complications for dogs surgically treated for medial patellar luxation (MPL) with a combination of lateral retinacular imbrication and tibial crest transposition procedures without femoral trochlear groove deepening techniques, and to determine whether osteoarthritis progressed in these patients during the 8-week period following surgery.

Design—Retrospective case series.

Animals—91 dogs.

Procedures—Medical records were reviewed for information on signalment, clinical history, unilateral versus bilateral disease, preoperative and postoperative MPL grades, duration of follow-up, and perioperative and postoperative complications. Radiographs obtained preoperatively and during 8-week follow-up examinations were reviewed and assigned degenerative joint disease (DJD) scores (range, 0 to 3). Data were analyzed to determine factors influencing outcomes. Kaplan-Meier curves were constructed for recurrence of MPL.

Results—Minor postoperative complications were reported for 31 of 91 (34.1%) dogs. Patellar relaxation occurred in 18 of 91 (19.8%) dogs. Relaxation or complications for which additional surgery was recommended developed in 6 of 91 (6.6%) dogs. At last clinical follow-up, 10 of 91 (11.0%) dogs had at least occasional lameness. No difference was revealed between preoperative and postoperative (8-week follow-up) radiographic DJD scores.

Conclusions and Clinical Relevance—Results of surgical treatment of MPL without femoral trochlear groove deepening procedures were comparable to those in studies of surgical treatment that included groove deepening procedures. Radiographic indices of DJD did not increase during the 8 weeks following surgery. These results suggest that trochlear groove deepening procedures are not always necessary, and patients that undergo these techniques should be carefully selected. (J Am Vet Med Assoc 2011;238:1168–1172)

Medial patellar luxation is widely recognized as a common orthopedic problem in dogs. The pathogenesis, clinical signs, surgical options, and short- and long-term results of treatment of these patients have been discussed in other reports. The surgical procedures that are most commonly recommended to correct MPL in dogs at present are a combination of soft tissue reconstruction, femoral trochlear groove deepening, and lateral transposition of the tibial crest. Correction of angular limb deformities is also advocated in the most severe cases.

In many of the studies that reported results for various combinations of these techniques, standardized procedures were not used to determine which patients received each type of surgery. To the authors’ knowledge, no studies have been reported in which a standard surgical procedure was used for correction of MPL in every patient. The objective of the study reported here was to evaluate the results of a series of cases in which treatment was essentially identical, regardless of variations in clinical findings; the treatment selected for evaluation was a combination of lateral retinacular imbrication and TCT, without any type of femoral trochlear groove deepening procedure (even in cases with a visually shallow groove). We sought to assess signalment, outcomes, and associated complications for dogs that received this treatment and to evaluate whether OA progressed during the 8-week period following surgery. Our hypothesis was that luxation recurrence and complication rates following this surgical procedure would be similar to those reported in studies in which the surgical techniques included trochlear groove deepening procedures. We also hypothesized that there would be no progression of OA detected in follow-up radiographs obtained 8 weeks after surgery.

Materials and Methods

Criteria for selection of cases—Medical records of the Norwood Park Animal Hospital from September 1, 1998, to April 30, 2009, were reviewed. All cases

### Abbreviations

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<th>Description</th>
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<tr>
<td>DJD</td>
<td>Degenerative joint disease</td>
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<td>MPL</td>
<td>Medial patellar luxation</td>
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<tr>
<td>OA</td>
<td>Osteoarthritis</td>
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<td>TCT</td>
<td>Tibial crest transposition</td>
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in which dogs received surgical treatment for MPL by means of lateral retinacular imbrication and TCT without any type of femoral trochlear groove deepening procedure were included if the medical records contained sufficient information for data analysis. One patient was excluded because a trochlear wedge recession was performed; this patient had a convex trochlear groove and did not have a detectable medial femoral condylar ridge. Twenty-three patients with previous or concurrent cranial cruciate ligament ruptures in the surgically treated stifle joint were also excluded. The final study population included the records of 91 dogs. Although many of these dogs had bilateral surgical corrections, only the first surgically treated stifle joint was included in order to ensure the data were independent.

Medical records review—Information obtained from the medical records of cases in the study population included age, sex, breed, weight, unilateral versus bilateral patellar luxation, preoperative and immediate postoperative grades to patellar luxation, whether surgery was performed on the left or right stifle joint, surgeon, clinical signs, any complications related to surgery, time of last follow-up, and luxation recurrence. Major complications were defined as those that required additional surgery other than removal of pins and wires (eg, fractures or reluxation). Minor complications were those that did not require additional surgery (eg, wound inflammation or seromas). Cases in which reluxations developed were examined to determine whether additional surgery was required, and this information was recorded. All procedures were performed by 1 of the 2 investigators (WRL or DLH) or by 2 former surgical residents.

Determination of OA progression—Caudocranial and mediolateral radiographs of the stifle joint obtained preoperatively and 8 weeks postoperatively were each evaluated by 2 investigators (WRL and DLH). A previously described DJD scoring system was modified in another study to evaluate OA progression following tibial plateau leveling osteotomy was used. This system was used to assign a score of 0 to 3 to each of 30 factors (including osteophytes in various locations within the stifle joint, enthesopathy of the medial or lateral collateral ligaments or cranial apical patella, medial or lateral soft tissue thickening, meniscal mineralization, intra-articular mineralized osseous fragments, intercondylar avulsion fracture fragments, stifle joint effusion or capsular thickening, condylar remodeling, femoral supratrochlear lysis, subchondral cystic lucencies, and subchondral sclerosis). In the present study, factors were scored from 0 to 3 (0, no change from normal; 1, mild changes; 2, moderate changes; and 3, marked changes). The scores were summed to obtain a total DJD score. The investigators scored radiographs independently of one another and each was unaware of patient or case identification and scores assigned by the other investigator. Radiographs were examined in a randomized order, but because of the presence of implants, investigators were aware of whether radiographs were obtained preoperatively or postoperatively. After evaluation of the agreement between DJD scores assigned by the 2 investigators, the mean values of scores were used for statistical analysis.

Surgical procedures—Patients were administered an NSAID (meloxicam, 0.2 mg/kg [0.09 mg/lb], SC) prior to anesthetic induction. Anesthesia was induced with a combination of ketamine and diazeپam (1.14 mg/kg [0.52 mg/lb] and 0.06 mg/kg [0.027 mg/lb], respectively, IV). Following anesthetic induction, the animals were intubated and given an injection of atropine (0.03 mg/kg [0.014 mg/lb], SC). Anesthesia was maintained with isoflurane in oxygen for the duration of the procedure. After anesthetic induction, the preoperative radiographs were obtained and preservative-free morphine (0.22 mg/kg [0.10 mg/lb]) was administered epidurally at the L7-S1 junction. The affected pelvic limb was clipped and prepared for aseptic surgery in a routine manner. A lateral parapatellar approach to the stifle joint was made, and the cranial tibial muscle was sharply dissected from its origin on the cranioproximal tibia and elevated. An osteotome and mallet were used to create the tibial crest osteotomy, leaving only the distal periosteal attachment. The crest was then transposed laterally until the patella was centrally located within the trochlear groove, and it was also moved distally as needed to create patellar tendon tension that would aid in maintaining reduction. If this transposition proved difficult, a medial retinacular release incision was made to allow lateral movement of the patella and tibial crest. The underlying tibia at the transplantation site was prepared to expose cancellous bone and allow flat seating of the crest (by use of an osteotome, rasp, etc). An appropriately sized Kirschner wire (usually 0.062 or 0.045 mm) was then passed through the crest and into the tibia in a caudodistal direction until it was seated in the far cortex. A 2.0-mm hole was then drilled in the cranial tibia caudal and distal to the osteotomy site. A strand of orthopedic wire (18 to 22 gauge) was passed through this hole and then twisted down in a figure-8 pattern, creating a tension band on the Kirschner wire. The exposed Kirschner wire was bent proximally and cut to leave a small palpable protrusion for later removal. The twisted orthopedic wire was bent down and covered by soft tissues. It was positioned near the exposed Kirschner wire to facilitate later removal.

The joint capsule was sharply dissected from the overlying fascia cranial and caudal to the incision, and the joint capsule was then closed routinely. The fascial layer was imbricated by overlapping the cut edges and closed in a modified Mayo mattress suture pattern. Routine subcutaneous and skin closure was then performed. Following surgery, a transdermal fentanyl patch was placed on the patient according to a published dose recommendation and additional opioid medications were given IV, IM, or SC as needed. The day after surgery, patients were discharged from the hospital with meloxicam (0.1 mg/kg [0.045 mg/lb], PO, q 24 h) and cefpodoxime (3 to 10 mg/kg [2.27 to 4.5 mg/lb], PO, q 24 h) for 10 days each.

Statistical analysis—Commercially available software was used for data management and statistical analysis. Because the data were not normally distributed, nonparametric statistical methods were used. Scatterplots, Spearman correlations, and Friedman tests were used to evaluate agreement in DJD scores between
the 2 observers. The Friedman test was used to compare the preoperative and 8-week postoperative DJD scores. Kaplan-Meier curves, the log-rank test, and univariate and multivariate Cox proportional hazards regression analysis (with likelihood ratio P values) were obtained to determine whether age, sex, weight, or preoperative luxation grade were associated with patellar luxation. For dogs that had bilateral surgery, the first stifle joint that underwent the surgical procedure was the only one used in statistical analyses, in order to avoid violations of the assumption of statistical independence. For all analyses, values of P < 0.05 were considered statistically significant. Values are reported as mean ± SD and median (range).

**Results**

Ninety-one dogs were included in the study. The female-to-male ratio was 1.8:1 (58/91 [63.7%] were female), which was similar to ratios reported in previous studies.6 Ages of dogs ranged from 1 to 13 years (mean age, 3.1 ± 2.4 years). Mean weight was 13.0 ± 11.0 kg (28.7 ± 24.1 lb) with a median of 8.5 kg (18.8 lb; range, 1.7 to 52.7 kg [3.8 to 116.0 lb]). The most commonly represented breed was mixed (20/91 [22.0%]), followed by Cavalier King Charles Spaniel and Maltese (8/91 [8.8%] each); Toy and Miniature Poodles (7/91 [7.7%]); Chihuahua, Yorkshire Terrier, and Labrador Retriever (6/91 [6.6%] each); and Bichon Frise, Boston Terrier, and Pug (3/91 [3.3% each). Other breeds were represented by 1 dog each. The MPLs were bilateral in 46 of 91 (50.5%) cases and unilateral in 45 of 91 (49.5%); stifle joint surgery was performed in the left hind limb in 46 of 91 (52.7%) cases and in the right hind limb in 43 of 91 (47.3%). In cases where surgery was performed in both stifle joints, numbers are reported for the first surgery. Fifty-three (58.2%) of the surgeries were performed by 2 former surgical residents. The mean preoperative luxation grade was 2.8 ± 0.6 (median, 3.0 [1 to 4]); preoperative luxation grades were not recorded for all dogs (n = 74). One of these 74 (1.4%) dogs had a grade 1 luxation, 18 (24.3%) had grade 2 luxations, 51 (68.9%) had grade 3 luxations, and 4 (5.4%) had grade 4 luxations (possible range, 1 to 4).

The most commonly reported minor complication was inflammation secondary to licking the incision (13/91 [14.3%]), followed by seroma formation (10/91 [11.0%]), generalized wound inflammation (8/91 [8.8%]), pin migration (7/91 [7.7%]), suture reaction (3/91 [3.3%]), infection (2/91 [2.2%]), dehiscence (2.2%), cellulitis (1/91 [1.1%]), and overcorrection (1.1%). Overall, minor complications were reported in 31 of 91 (34.1%) dogs. Conditions requiring early removal of pin and wire were not considered complications because removal of these implants was standard procedure for all dogs at the 8-week follow-up visit.

Twenty-one of 91 (23.1%) dogs remained at least intermittently lame after the perioperative and initial recovery period or became lame again after initially recovering. Of these, 5 were later determined to have cranial cruciate ligament tears in the affected limb, 4 others improved after removal of the Kirschner and orthopedic wires, and 2 dogs required revision surgery.

At last clinical follow-up, the remaining 10 (11.0%) dogs had 24.1% lameness.

The time from surgery to recurrent luxation or last clinical follow-up was evaluated (Figure 1). Eighteen of 91 (19.8%) dogs had recurrent patellar luxation following surgery. For the dogs with recurrence, mean time from surgery to recurrence was 6.9 ± 10.4 months (median, 2.2 months [range, 0.3 to 31.1 months]). Luxation grades at the time of recurrence were recorded for 15 dogs (9 grade 1 luxations, 5 grade 2 luxations, and 1 grade 3 luxation). Six (6.6%) dogs required additional surgery for patellar luxation: 1 had a tibial crest fracture and 5 had reluxations (one of the owners of these 5 dogs declined further surgery, but it had been deemed necessary by the surgeon). Three of the 5 dogs that had a second surgery had complete resolution of patellar luxation and lameness, 1 had a continued grade 1 luxation without clinical lameness, and 1 had a continued grade 1 luxation with lameness. The mean duration of clinical follow-up for the 73 dogs without recurrence was 13.5 ± 20.3 months (median, 3.4 months [range, 1.8 to 86.9 months]). No significant relationships were found between recurrence and age, sex, weight, or preoperative luxation grade.

The DJD scores assessed by the 2 investigators were highly correlated, both preoperatively and 8 weeks postoperatively (r = 0.99 and P < 0.001 for each time point). Friedman tests assessing differences between the investigators’ scores were nonsignificant both preoperatively (P = 0.83) and 8 weeks postoperatively (P = 0.25). The mean DJD score was 3.3 ± 3.6 (median, 2.0 [range, 0 to 18]) preoperatively and 3.5 ± 3.2 (median, 2.0 [range, 0 to 13]) 8 weeks postoperatively (these values were not significantly different).

**Discussion**

Procedures to deepen the shallow femoral trochlear groove that often accompanies MPL have been described, and their clinical use has been documented.1,3,4,6,11,13,15–17,20,26 These procedures include trochlear sulcoplasty, trochlear chondroplasty, and tibial wedge and block reces-
The most recent advancements in technique (block and wedge recession) and the technique used in very young dogs (trochlear chondroplasty) attempt to preserve intact hyaline cartilage; nevertheless, all trochlear deepening procedures cause some degree of hyaline cartilage morbidity. It has been established that damaged hyaline or articular cartilage is permanently replaced with fibrocartilage. In addition, even damage to cartilage surfaces within the joint that do not directly articulate can lead to an inflammatory cascade that likely plays a part in the progression of OA.

The successful clinical use of trochlear groove deepening procedures has been extensively described. Such procedures were reported to result in a larger percentage of the patellar body being located within the trochlear groove, but to the authors’ knowledge, no documentation of the long-term effects on joint biomechanics and subsequent formation or progression of OA has been undertaken. The results of some studies suggested a high rate of success for dogs that underwent trochlear groove deepening surgery (in various combinations of TCT, soft tissue release, and imbrication), but the assignment of dogs into these groups was completely determined by surgeon preference, rather than randomization. This makes it impossible to determine whether the difference in success rates reported is attributable to surgical technique or to confounding by other variables.

Analysis of radiographs obtained preoperatively and those taken during the 8-week follow-up examination did not reveal any statistically significant change in radiographic DJD scores during this period. This does not rule out the possibility that the analysis failed to detect a difference or that arthritis progression may develop > 8 weeks after surgery. A previous study found a small but significant progression of OA 8 weeks after tibial plateau leveling osteotomy was performed. Another study showed that at a mean of 33 months after undergoing a combination of procedures to correct MPL, OA had progressed significantly and comparably in surgically treated and untreated stifle joints. Another study showed evidence of DJD at a median of 3.6 years after surgery in 40 of 52 (76.9%) stifle joints of dogs that previously underwent surgical treatment for MPL; however, comparisons to preoperative radiographic findings were not made.

Patellar luxation after surgery was reported in 18 of 91 (19.8%) dogs in the study reported here. Previous studies have reported relaxation rates ranging from 10 from 131 (7.6%) stifle joints to 25 of 52 (48.1%) stifle joints. The smaller reported number came from a study in which investigators only counted patellar relaxation if it required surgical intervention. Thus, the relaxation rate among dogs in the present study appears to compare very favorably with those of previous studies. The proportion of cases in which additional surgery was recommended for patellar relaxation or other major complications in the present study (6/91 [6.6%]) also compares favorably with those of previous reports (8/70 [11.4%] dogs to 17/131 (13.0%) stifle joints). In addition, continued lameness in 10 of 91 (11.0%) dogs in the study reported here compares favorably with previous studies in which poor or unsatisfactory results were reported for 1 of 13 (7.7%) dogs to 14 of 142 (9.9%) dogs, and in which 4 of 34 (11.0%) dogs were reported to be least occasionally lame.

The described minor complication rate of 34.1% of cases in the present study is slightly higher than those reported in other studies (reports ranged from 23/131 [17.8%] stifle joints to 20/70 [28.6%] dogs). This is likely attributable to the fact that the authors made an attempt to be liberally inclusive of any complications, no matter how minor these were.

Although most previous studies have reported a relationship between high preoperative grades of patellar luxation and high rates of luxation recurrence, no such relationship was detected in the study reported here. One possible explanation for this is that preoperative patellar luxation grade was not recorded in some cases in the present study. A relationship might have been found if these data were complete. Another possibility is that the simplicity and repeatability of the surgical procedures used in cases selected for the present study resulted in fewer possibilities for postsurgical breakdown, regardless of preoperative patellar luxation grade.

Limitations of the study reported here include the retrospective nature of the data, the short (8-week) follow-up period for progression of OA, and the fact that relative depth of the femoral trochlear groove was not measured in dogs of these cases. Further research in this area should include a longer radiographic follow-up period to determine whether trochlear alterations may be related to the progression of OA and whether avoiding them reduces or eliminates OA progression. In addition, an attempt should be made to measure relative trochlear groove depth so an objective cutoff for recommendation of deepening procedures can be determined. Ideally, dogs in such a study should be randomly assigned to surgery with or without trochlear groove deepening.

The findings of the present study supported our hypothesis; treatment of MPL without addressing trochlear depth was successful in most dogs in this group. Meticulous realignment of the extensor mechanism through adequate TCT is probably the most critical aspect of this procedure, supplemented by techniques such as the tension-band wire and lateral retinacular imbrication. The authors do not advocate complete avoidance of trochlear deepening procedures, but we hope that our results encourage careful thought regarding the selection of dogs that will undergo these techniques.

References