pISSN 1598-298X / eISSN 2384-0749
*J Vet Clin* 35(3) : 71-76 (2018)
http://dx.doi.org/10.17555/jvc.2018.06.35.3.71

Journal of Veterinary Clinics
www.ksvc.or.kr

# Surgical Correction of Medial Patellar Luxation including Release of Vastus Medialis without Trochleoplasty in Small Breed Dogs: A Retrospective Review of 22 Cases

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(Received: April 12, 2018 / Accepted: May 29, 2018)

**Abstract :** In 22 dogs with medial patellar luxation (MPL) of grade 3 or lower, resection of the vastus medialis oblique muscle, patellar anti-rotational suture, fascia lata overlap, and tibial tuberosity transposition (TTT) were undertaken to stabilize the patella without trochleoplasty. Data including signalment, clinical symptoms, details of the affected hindlimb, preoperative and postoperative patellar luxation grades, postoperative recovery time, and postoperative complications were obtained from medical records. The grade of lameness was evaluated preoperatively and postoperatively. Mean (± SEM) grade of medial patellar luxation was 2.64 ± 0.11 preoperatively and 0.2 ± 0.27 postoperatively. Mean (± SEM) grade of lameness was 1.73 ± 0.27 preoperatively and 0.18 ± 0.15 postoperatively. Patellar reluxation occurred in 1 of 22 (4.5%) cases requiring additional surgery. At final follow-up, 2 of the 22 (9.0%) dogs, including one with reluxation, had occasional lameness. Client-based questionnaire results demonstrated significant improvements in all parameters. Surgical treatment of MPL that included resection of the vastus medialis oblique without femoral trochlear groove deepening improved surgical outcomes in dogs with up to grade 3 MPL.

***Key words*** **:** patella, luxation, vastus medialis, complications, dogs.

## Introduction

Patellar luxation is one of the most common orthopedic problems in dogs and can result in the development of degenerative joint disease, bone deformity, and lameness (8,11,19). More than 90% of luxations in small breed dogs are medial patellar luxations (MPL), whereas less than 10% of affected dogs have lateral luxations (1,10). The surgical methods for correction of MPL in dogs that have been reported can be divided into two categories: bone and soft tissue reconstruction techniques, respectively. The bone reconstruction techniques mainly consist of trochleoplasty (deepening of abnormally shallow femoral trochlea) and tibial tuberosity transposition (TTT). Soft tissue reconstruction techniques include the release of retinacular tissues, retinacular or fascial overlap, anti-rotational sutures, and quadriceps releases (7,15,17,19). A combination of surgical procedures was found to be more effective in the management of patellar luxation (1).

In most animals, the deepening of the trochlear groove with a trochlear wedge or block recession is usually recommended (7). A retrospective study reported that it was 5.11 times more likely to develop reluxation when trochleoplasty was not performed (5). However, recently studies (3,6,14) suggest that trochlear groove deepening procedures are not always necessary. Surgical treatment without trochleoplasty showed favorable outcomes of shorter recovery time and lesser evidence of degenerative joint diseases on radiographic examinations compared to treatment with trochleoplasty in grade 2 and 3 MPL (6).

In human literature, several anatomical and biomechanical in vitro studies have reported the role of active stabilization of the patella femoral joint to the vastus medialis obliquus (VMO) muscle. Using cadaveric knees, Goh et al. (9) found that relaxation of the VMO causes the patella to displace laterally by 4 mm and increases the load on the lateral condyle. Similarly, when the VMO was relaxed, the force required to displace the patella laterally was reduced by 30% with the knee in flexion (21). In veterinary literature, however, it was recommended that when the dynamic contractions of the cranial sartorius muscle and vastus medialis muscle direct the patella medially, the insertions of these muscles at the proximal patella be released (7).

Recently, Kim et al. (13) investigated the biomechanical outcomes of different soft tissue reconstruction techniques. This report (13) suggested that vastus medialis release could decrease the medial tension on the patella without inducing patellar instability in dogs. In contrast, both medial retinacular and capsule releases could increase patellar instability; moreover, medial retinacular release does not decrease the medial tension on the patella. We hypothesized that the strength of the vastus medialis is an important cause of MPL. We also hypothesized that surgical correction without open-

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ing the capsule shortens recovery time. The purpose of this study was to describe surgical outcomes following surgical correction of MPL, with release of the vastus medialis and without trochleoplasty, in dogs with up to grade 3 patellar luxation.

## Materials and Methods

### Animals

The medical records of 18 dogs with up to grade 3 luxation (22 cases), that underwent surgical correction of the MPL at Chio Hee Bok animal hospital between October 2015 and September 2016, were examined. The preoperative grade of MPL was determined (4,19). The grades are as follows: grade 1 is when the patella can be manually luxated, but returns to normal position when released; grade 2 is when the patella luxates with stifle flexion or on manual manipulation, and remains luxated until stifle extension or manual replacement occurs; grade 3 is when the patella is luxated continually and can be manually replaced, but reluxates spontaneously when manual pressure is removed; grade 4 is when the Patella is luxated continually and cannot be manually replaced. Dogs which had grade 4 MPL were excluded. In all cases, the dogs received surgical treatment for MPL by means of resection of the vastus medialis oblique muscle, patellar anti-rotational suture, and tibial tuberosity transposition (TTT) without any type of femoral trochleoplasty. All the surgeries were performed by the same surgeon, H.B. Choi.

Clinical and radiographic examinations were performed 4 weeks after surgery and postoperative complications were recorded. Major complications were defined as those that required revision surgery, and minor complications were those that did not require further surgery (e.g., seroma, incision irritation, infection). Short-term complications were evaluated 4 weeks after surgery using a client-based questionnaire, which used a visual analogue scoring system modified from Innes and Barr (1988) (12).

### Preoperative medication and anesthesia

The dogs had been fasting for about 12 hours before their operations. They were premedicated with medetomidine (0.02 mg/kg, administered subcutaneously [SC], Domitor®; Pfizer, NY, USA) and were injected with Zoletil® (4 mg/kg, administered intravenously [IV], Virvac, Korea). Cefazolin (25 mg/kg, SC, Hankook Korus Pharm Co, Seoul, Korea) was used as a prophylactic antibiotic.

Normal saline was administered at 10 mL/kg/hour through the cephalic vein during the whole procedure. The heart rate, body temperature, and percutaneous blood oxygen saturation ($SpO_2$) were monitored during anesthesia. A circulating water blanket (Medi-Therm®, Gaymar, NY, USA) with temperature of 38-39°C was used to maintain body temperature. Sedation was reversed using atipamezole (0.05 mg/kg, administered intramuscularly [IM], Antisedn™; Pfizer, NY, USA).

### Surgical procedure

In 18 dogs with patellar luxation, resection of the vastus medialis oblique muscle, patellar anti-rotational suture, fascia lata overlap and TTT were done without trochleoplasty to stabilize the patella. The dog was positioned in lateral recumbency with the affected leg down and parallel to the operating table in order to explore the medial aspect of the stifle joint. A lateral para-patellar approach to the stifle was taken.

The vastus medialis oblique muscle was exposed between the cranial and caudal parts of the semitendinosus muscle. The VMO was elevated using a mosquito forceps (Fig 1A) and its insertion was resected using electrocautery (Fig 1B).

For the transposition of the tibial tuberosity (TTT), an incision was made in the periosteum, medially along the tibial tuberosity and the crest, including the distal attachment. The tuberosity and crest osteotomies were performed 3 to 4 mm from the insertion of the patellar ligament tuberosity. After the osteotomy was complete, the stifle joint was extended to decrease the tension on the patellar ligament. The tuberosity was, then, transposed laterally to achieve realignment of the patellar ligament. Two K-wires were placed in the widest portion of the tuberosity and were driven toward the caudal medial tibial condyle (Fig 1C).

For the patellar anti-rotational suture, the fascia lata was exposed along the cranial border of the biceps muscle to expose the lateral fabella by caudal retraction and elevation

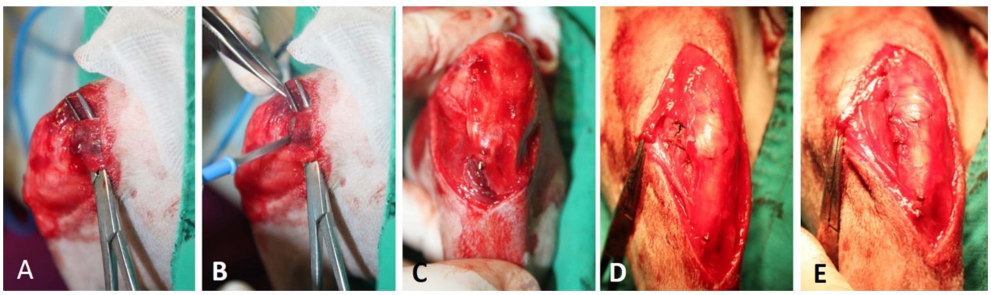


**Fig 1.** Surgical procedure in Dog No. 6 with right-side patella luxation. A. Vastus medialis oblique muscle was exposed between the cranial and caudal parts of semitendinosus muscle. Vastus medialis oblique muscle was elevated using mosquito forceps. B. The insertion of vastus medialis oblique muscle was resected using electrocautery. C. Two K-wires was placed in the widest portion of the tuberosity. D. For patellar anti-rotational suture, the fascia lata was exposed along the cranial border of the biceps muscle to expose the lateral fabella by caudal retraction and elevation of the biceps. A Nylon (2-0) thread was passed behind the lateral fabella and around the patella. E. The cranial part of the fascia lata was pulled caudally over the surface of the biceps muscle and sutured in place with a simple pattern.

of the biceps. A nylon (2-0) was passed behind the lateral fabella and around the patella (Fig 1D), and was tied tightly enough to prevent rotation. The fascia lata overlap method was performed as in previous reports (13,16). For the overlap technique, the cranial part of the fascia lata was pulled caudally over the surface of the biceps muscle and was sutured in place with simple pattern or/and Lembert pattern of sutures.

Following wound lavage, the fascia and the subcutaneous tissue were closed with a monofilament absorbable suture (Maxon™ 4-0, COVIDIEN, MA, USA) and the skin was sutured using a monofilament non-absorbable suture (Blue-Nylon® 3-0, Ailee corp, Busan, Korea).

**Postoperative management**

Prednisolone (0.25 mg/kg, PO, twice daily [bid], solondo®, Yuhan Co., Korea), cefadroxil (25 mg/kg, PO, bid, Cefaxil®; Koruspharm, Jecheon, Korea) or amoxicillin (15 mg/kg, PO, bid, pharmaamoxicillin, Koreapharma, Korea), and famotidine (0.5 mg/kg, PO, bid, Famotidine®; Nelson, Korea) were given for 10 days.

After medical treatment, the sutured site was disinfected with 0.1% povidone-iodine. Modified Robert jones bandage was maintained for 7 days and activity was restricted to specific physical rehabilitative exercises and leash walking for 6 to 8 weeks.

**Medical data collection**

Data including signalment, clinical symptoms, affected hindlimb details, preoperative and postoperative patellar luxation grade (15,16), postoperative recovery time, and postoperative complications were obtained from medical records. Lameness was evaluated by grades of lameness preoperatively and postoperatively. Visual lameness of the dogs was evaluated at stance, walk, and trot respectively, before surgery and 4 weeks after surgery. Lameness was graded using the visual analogue score: 0/5 = Normal gait pattern; 1/5 = Mild lameness, needing a trained eye to see; 2/5 = Moderate lameness with a normal stride length and partial weight-bearing; 3/5 = Moderate lameness with shorter stride length and partial weight-bearing; 4/5 = Severe lameness with toe-touch weight-bearing and minimal use of the limb; 5/5 = Not weight bearing (2).

Clinical and radiographic examinations were performed 4 weeks after surgery and postoperative complications were recorded. Major complications were defined as those that required further surgery or treatment. Patellar reluxation was categorized as a major complication. Other complications were considered minor, including licking the incision, seroma, wound inflammation, pin migration, and dehiscence. In addition, short-term complications were followed-up till a minimum of 4 weeks after surgery and were evaluated using the client-based questionnaire, which used a visual analogue scoring system adapted from previous studies (Table 1) (12,18). Recovery time was defined as the time taken from the day of surgery to the day of grade 0 or grade 1 lameness (20). Dogs with lameness or major complication were excluded from the analysis of the recovery time.

**Statistical analysis**

The visual lameness score was measured preoperatively

**Table 1.** Client questionnaire modified from previous studies (12,18)

| Owner : | Animal name | Case No. |
|---|---|---|
| **Part 1 - The situation before your dog had a problem:** | | |
| 1. How active was your dog? | | |
| Not at all (Score 0) | _____ | Always exercising (Score 10) |
| **Part 2 - The situation before surgical correction was performed.** | | |
| 1. How would you grade the overall disabling effect of your dog problem *before* surgery? | | |
| No disability (Score 0) | _____ | Completely disability (Score 10) |
| 2. Did your dog show skipping when walking or running. | | |
| No (Score 0) | _____ | Extreme (Score 10) |
| 3. How well could your dog jump? | | |
| Unable (Score 0) | _____ | No problem (Score 10) |
| **Part 3 - The situation now (after surgical correction)** | | |
| 1. How disabled is your dog now? | | |
| Complete recovery (Score 0) | _____ | Much Worse (Score 10) |
| 2. Does your dog show skipping when walking or running. | | |
| No (Score 0) | _____ | Extreme (Score 10) |
| 3. How well can your dog jump *now*? | | |
| Unable (Score 0) | _____ | No problem (Score 10) |
| 4. How active is your dog now? | | |
| Not at all (Score 0) | _____ | Always exercising (Score 10) |

and 4 weeks postoperatively. Statistical analysis was performed using SPSS 21.0 (SPSS Inc, Chicago, Ill, USA). Wilcoxon signed rank test was used to investigate the change from preoperative lameness. $P < 0.05$ was considered to be statistically significant. The results of the recovery time, the patellar luxation grade and the lameness grades were expressed as means ± standard error (SEM). The other results were expressed as means ± standard deviation.

## Results

Twenty-two surgical procedures were performed on 18 dogs. The mean bodyweight of the dogs was 3.57 ± 0.82 kg (range: 1.9 kg to 5.5 kg), and the mean age was 2.44 years (range: 8 months to 11 years). There were 8 females (36.4%) and 14 males (63.6%). The most commonly represented breed was the Maltese (6) followed by the Pomeranian (4), the Chihuahua (4), the Miniature Poodle (2), the Yorkshire Terrier (1), and a mixed breed (1). Surgical corrections were performed on 9 left (9/22, 40.9%) and 13 right stifle joints (13/22, 59.1%). The MPLs were bilateral in 12 of 18 dogs (66.6%) (Dog no. 1-4, 7, 10, 12-17) (Table 2). In four dogs (Dog no. 1- 4) with bilateral MPL, surgical corrections were performed on both sides with a minimum interval of 4 weeks between the first and second surgery (dog no. 1, 2, and 4: 4 weeks; dog no. 2: 4 months). The preoperative grade of MPL was 2.64 ± 0.10 (mean ± SEM, median, 3.00) with fourteen cases of grade 3 MPL; whereas, the postoperative luxation grade was 0.18 ± 0.14 (mean ± SEM, median, 0.00). The grade of lameness was 2.77 ± 0.26 (mean ± SEM, median, 3) preoperatively and 0.14 ± 0.10 (mean ± SEM, median, 0.00) postoperatively (Fig 2). The mean recovery time was 5.6 ± 0.37 days (mean ± SEM) (Table 2)

The overall frequency of complications in this study was 9% (2 of 22 cases). The major complication that occurred was in a Pomeranian (dog no. 4), where grade 2 MPL in the left hindlimb became grade 3 lateral patellar luxation with intermittent lameness 6 weeks after surgical correction. This dog

**Table 2.** Clinical details of animals included in the study

| Dog no. | Breed | Age | Sex | Weight (kg) | Affected limb | MPL grade | | Lameness | | Recovery time (day) | Complications |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Pre-OP | Post-OP | Pre-OP | Post-OP | | |
| 1 | Maltese[+] | 8M | F | 2.9 | Left | 3 | 0 | 5 | 0 | 5 | |
| | Maltese | 9M | F | 3.1 | Right | 3 | 0 | 3 | 0 | 4 | |
| 2 | Pomeranian[+] | 8M | F | 3.7 | Right | 3 | 0 | 2 | 0 | 4 | |
| | Pomeranian | 12M | F | 3.9 | Left | 2 | 0 | 2 | 0 | 5 | |
| 3 | Poodle[+] | 1Y | M | 3.8 | Right | 2 | 0 | 1 | 0 | 6 | |
| | Poodle | 1Y1M | CM | 3.8 | Left | 2 | 0 | 2 | 0 | 7 | |
| 4 | Pomeranian[+] | 2Y | M | 3.6 | Left | 2 | 3 | 2 | 2 | 4 | Intermittent lameness 6 weeks post-OP, **LPM grade 3** |
| | Pomeranian | 2Y1M | CM | 3.9 | Right | 2 | 1 | 1 | 0 | 5 | MPL Grade 1 |
| 5 | Chihuahua | 3Y | F | 2.4 | Left | 3 | 0 | 1 | 0 | 8 | |
| 6 | Poodle | 3Y | F | 3.6 | Right | 2 | 0 | 4 | 0 | 5 | |
| 7 | Chihuahua[+] | 1Y | CM | 4.1 | Right | 2 | 0 | 2 | 0 | 5 | |
| 8 | Maltese | 4Y | M | 3.2 | Right | 3 | 0 | 4 | 0 | 6 | |
| 9 | Pomeranian | 2Y | CM | 2.9 | Right | 3 | 0 | 2 | 0 | 5 | |
| 10 | Yorkshire Terrier[+] | 5Y | CM | 1.9 | Right | 3 | 0 | 4 | 0 | 5 | |
| 11 | Mixed | 11Y | F | 5.5 | Left | 3 | 0 | 4 | 0 | 11 | |
| 12 | Maltese[+] | 2Y | CM | 4.5 | Left | 3 | 0 | 1 | 0 | 3 | |
| 13 | Maltese[+] | 3Y | CM | 4.0 | Left | 3 | 0 | 3 | 1 | 5 | |
| 14 | Pomeranian[+] | 2Y | F | 2.5 | Right | 3 | 0 | 3 | 0 | 7 | |
| 15 | Maltese[+] | 4Y | CM | 2.6 | Right | 2 | 0 | 4 | 0 | 5 | |
| 16 | Maltese[+] | 2Y | CM | 4.2 | Right | 3 | 0 | 4 | 0 | 4 | |
| 17 | Chihuahua[+] | 1Y 2M | CM | 4.3 | Right | 3 | 0 | 3 | 0 | 5 | |
| 18 | Chihuahua | 1Y | CM | 4.3 | Left | 3 | 0 | 4 | 0 | 5 | |

*follow-up, 6 weeks after surgery. LPM, Lateral patella luxation; [+]bilateral MPL

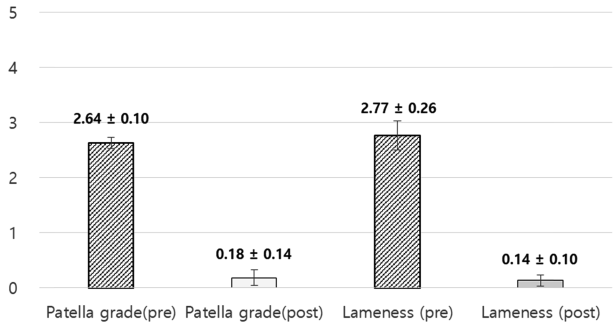


**Fig 2.** Preoperative grade of patella luxation and luxation (Mean ± SEM).

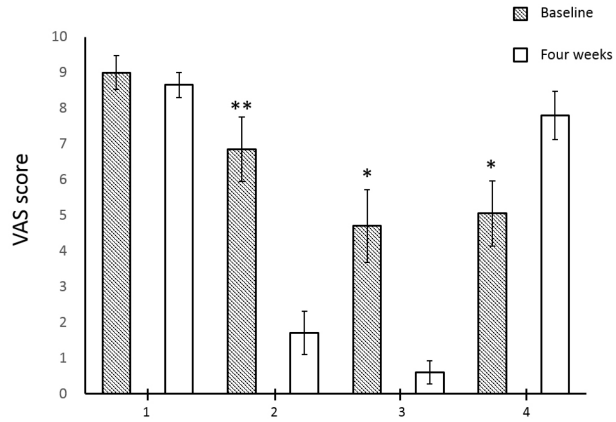


**Fig 3.** VAS scores from client questionnaire evaluating function 4 weeks after surgery. 1, change form normality in activity level; 2, change from entry in disability level; 3, change from entry in level of joint stiffness; 4. Change from entry in level of ability to jump. *$p < 0.05$, **$p < 0.01$.

had a corrective procedure with trochleoplasty for patellar reluxation on the left side and the patellar luxation resolved after the second surgery. In the same dog, reluxation on the right side occurred as a minor complication where the grade 2 MPL in the right side became grade 1 with lameness score of 0; revision surgery was not required.

The questionnaires were used on 20 cases, except the left sided correction of dog no. 4, and were analyzed. The results of the owner assessment are shown in Fig 3.

## Discussion

The results of our study demonstrated that treatment of MPL including releasing VMO without trochleoplasty was successful in most dogs with up to grade 3 MPL. Postoperative lameness scores at four weeks and until the end of the study decreased significantly in comparison with the preoperative scores. The prognosis was generally good for luxations up to grade 3, and the surgical outcomes for these patient were successful in over 90% of cases.

The ratio of unilateral to bilateral patellar luxation we described was similar to previous reports (2,8,15,17,19). Maltese (5/6, 83.3%) and Pomeranian (3/4, 75%) breeds showed a high incidence of bilateral luxation (5/6, 83.3%). While in a previous report (24) Pomeranians showed a high incidence of bilateral luxation (93%), the Maltese was not identified as a breed prone to bilateral MPL. The higher incidence of MPL in males compared to females corroborated previous studies (1,2,10,14).

In this study, the mean recovery time was 5.6 ± 0.37 days (mean ± SEM) which was shorter than compared to previous studies (3,6) in which trochleoplasty was not included. Yoon et al. (6) reported that the mean recovery time without trochleoplasty was 3.4 ± 1.5 weeks. This difference may be because the medial joint capsule and retinaculum release procedures were not included in our study. However, further studies are needed to evaluate whether trochleoplasty and capsule resection are affected to recovery time.

Recurrent patellar luxation was 9% in our study, which is similar to previous studies (2,25) which reported reluxation rates ranging from 10 of 131 (7.6%) stile joint to 25 of 52 (48.1%) stifle joints. However, the lowest rates of reluxation reported in studies (6,14) after surgical treatment of MPL without trochleoplasty ranged from 2 of 27 (11.1%) cases to 31 of 91 (34.1%) cases. In addition, all complications were reported in one Pomeranian dog in our study. Bidirectional patellar luxations (23) have been reported in Pomeranian dogs suggesting that predisposition may be related to the incidence of the lateral reluxation.

Analysis of radiographs obtained preoperatively and those taken 4-weeks after surgery did not reveal any significant change. A previous study (6) found a significant difference in degenerative joint disease score between patellar luxation correction with and without trochleoplasty 3 months after surgery, the non-trochleoplasty group having lower scores. Another study (20) showed that at a mean of 33 months after performing a combination of surgical procedures to treat MPL, osteoarthritis had progressed significantly in surgically treated as compared to untreated stifle joints.

The surgical outcome was assessed using a client-questionnaire modified from that used in previous studies. As previous studies stated that owners' perceptions were based on their respective dog's overall function which was affected by both hind limbs, the questionnaire was modified to report only the affected limb. Dogs with bilateral MPL were excluded from the analysis. Dog no. 4, that had revision surgery, was excluded from analysis because while the questionnaire was answered 4 weeks after surgical correction, the relaxation occurred 6 weeks postoperatively.

The limitations of this study were that the short (4-weeks) follow-up period was insufficient to assess progression of OA, and as the depth of the femoral trochlear groove not measured, its relation to postoperative complications could not be assessed. Pre-surgical and intra-operative assessment of the trochlear depth is very important for performing femoral trochleoplasty (1). It has been suggested that the femoral trochlea should be recessed sufficiently so that 50% of the patella is seated within the trochlear ridge (22). The surgical procedure described in this study may not be appropriate for cases of MPL grade 4. Further research in this area should include a longer radiographic follow-up period to determine whether surgical techniques without trochleoplasty are related

to the progression of OA and whether trochlear groove depth is related to postoperative complications. Ideally, dogs with MPL grade 4 should be included and surgery with and without trochlear groove deepening should be compared.

The findings of our study supported surgical correction of MPL including releasing of internal vastus medialis without trochleoplasty in dogs with up to grade 3 MPL. This study suggests that trochlear groove deepening procedures may not always be necessary in most dogs with up to grade 3 MPL and releasing the VMO is one option when choosing a combination of surgical techniques.

## Conflict of interests

The authors report no financial or other conflicts of interest related to this report.

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