

# Latero-distal transposition of the tibial crest in cases of medial patellar luxation with patella alta

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## Keywords

Medial patellar luxation, patella alta, tibial crest transposition

## Summary

Medial patellar luxation is defined as medial displacement of the patella from the trochlear groove. In dogs, medial luxations account for 75% of all patellar luxation cases, and are frequently associated with patella alta. Common surgical treatments for medial luxation are trochleoplasty and lateral transposition of the crest to drive the patella into the correct anatomical alignment. Postoperative complications for this procedure are estimated to be between 18–29% of cases, with up to 48% of complications involving relaxation. It was

previously hypothesized that in cases of medial luxation involving patella alta, the addition of a distal component to the lateral tibial crest transposition will result in repositioning of the patella into its proper position in the trochlear groove, thus reducing the recurrence of luxation. We performed this modified procedure on 14 dogs (17 limbs) that were suffering from medial luxation combined with patella alta, and our results led to favourable clinical outcomes. This modified surgical procedure places the patella into a more normal proximo-distal anatomical position, is simple to perform, and may become common practice for surgical treatment of medial patellar luxation with an alta component.

the trochlear groove (9–12). Normally, the patella is located within the trochlear groove, so that the trochlear ridges provide buttresses to prevent patella dislocation. Conversely, in dogs with patella alta, the patella is located proximal in the trochlear groove and it can easily luxate when the limb is extended throughout the swing and stance phases (9, 10, 12). Previous studies have provided radiological guidelines for patella alta definition in normal medium to giant breed dogs (9, 11, 12). These guidelines are comprised of two main parameters derived from medio-lateral radiographic views: (i) the ratio between the patellar ligament length (PLL) and the patella length (PL), and (ii) the length of the vertical line (A) connecting the proximal pole of the patella to the transcondylar axis, divided by the patella length. Ratios of PLL:PL greater than 1.97 or 2.06 were found to be predictive for patella alta (11, 12). A ratio of A:PL >2.03 was also suggestive of patella alta (12).

Following the surgical correction of medial patellar luxation by lateral crest transposition, the patella might still be located proximally in the trochlear groove while the stifle is fully extended (10). In this report, we defined such cases, which are clinically detected using surgical observations, as medial patellar luxation with an alta composition. It was previously hypothesized that in such cases a distal transposition in addition to the routine lateral tibial crest transposition would correctly position the patella within the trochlear groove, thus reducing the recurrence of luxation (10).

## Materials and methods

Surgical correction of medial patellar luxation of varying degrees of severity was performed on 42 stifle joints at the Know-

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## Introduction

Patellar luxation is a common orthopaedic abnormality in dogs. This condition can result in osteoarthritis, pain, and lameness (1–4). Multiple anatomical abnormalities have been suggested to contribute to predisposition for patellar luxation, including coxofemoral joint conformation (abnormal angles of inclination and anteversion, decreased acetabular coverage, and hip dysplasia), femoral torsion and angulation, deviation of the tibial crest, tightness or atrophy of the quadriceps muscles, patella alta, and a shallow trochlear groove (5, 6).

Medial patellar luxation is a medial displacement of the patella from the stifle

trochlear sulcus. About three quarters of all cases of patellar luxation are medial in direction and this disorder is more prevalent in small breed dogs (7). Surgical management techniques for medial patellar luxation include combinations of desmotomy, lateral imbrication of soft tissues, trochleoplasty, medial release incisions, and lateral transposition of the tibial crest. Postoperative complication rates of 18–29% have been described; such complications were more frequently seen in medium to large dogs. Reluxation accounts for 30–48% of these postoperative complications (1, 8).

Medial patellar luxation is frequently associated with patella alta, a condition in which the patella is positioned proximal to

ledge Farm Specialist's Referral Center in Beit Berl, Israel, between April 2007 and December 2010. Of these procedures, patella alta was diagnosed in 17 stifles (14 dogs) and these were included in this study. The diagnosis of patella alta was made intra-operatively, based on the proximo-distal location of the patella relative to the trochlear groove following the lateral crest transposition as described below. Haematology and blood chemistry profile analyses were performed in all cases. Mediolateral and caudocranial radiographic views were obtained preoperatively, postoperatively, and at 24 weeks or more following surgery (mean 32 weeks  $\pm$  7 weeks). Dogs with other stifle abnormalities such as cranial cruciate ligament rupture, meniscal tears, trauma or previous hindlimb surgery were excluded from the study. All surgeries were performed by two surgeons (JS, US), one of whom was board certified (JS).

### Physical evaluation of the affected limb

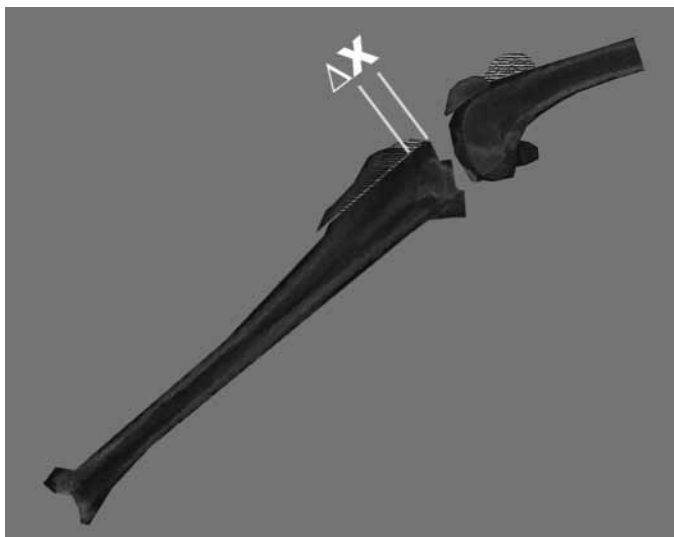
#### Lameness scoring

Lameness evaluations were performed at two occasions: prior to surgery and 24 weeks or more following surgery. Lameness

scoring forms used a numerical rating scale with five grades of lameness severity defined as: 0 = clinically sound; 1 = barely detectable lameness; 2 = mild lameness; 3 = moderate lameness; 4 = severe lameness (carries limb when trotting); and 5 = could not be more lame (13). The main distinction between scores of 4 and 5 was that, for a score of 4, the dog might be weight bearing when standing or walking, but not when trotting, whereas a score of 5 was defined as a limb that never bore weight when standing nor when moving.

#### Medial patellar luxation grading

The severity of medial patellar luxation was graded on a scale of 1 to 4 based on orthopaedic examination of the affected pelvic limb as classified by Singleton (10, 14, 15): Grade 1 – the patella can be luxated manually but returns to its normal position within the trochlear groove when released. Grade 2 – spontaneous luxation occurs, and the patella, once luxated, remains so until replaced manually. Grade 3 – the patella is permanently luxated but can be reduced manually. Grade 4 – permanent non-reducible luxation of the patella. The patella location was recorded again 24 weeks or more following surgery.



**Fig. 1** Schematic diagram of the distal transposition component within the surgical procedure. The periosteum distal to the tibial crest is fully incised and the crest is retracted further distally until the patellar ligament is stretched (the stifle being at maximum extension) and the patella is located at the mid-length of the trochlear groove. Shown is a schematic medio-lateral radiographic view of the extended stifle joint. Distal transposition is depicted by  $\Delta X$ .

#### Stifle range-of-motion evaluation

Stifle range-of-motion was documented preoperatively and postoperatively (24 weeks or more after surgery). The surgically repaired limbs were divided into three categories: 0 = normal range-of-motion; 1 = moderate decrease of range-of-motion (less than 30% decrease in flexion or extension of the stifle, as compared to the other, unaffected limb); and 2 = severe decrease of range-of-motion (more than 30% decrease in flexion or extension of the stifle). In cases where both limbs were affected, the range-of-motion classification was based on comparison with other dogs of similar weight and breed that were available in the clinic.

### Surgical procedure

#### Trochlear block recession

In all cases, the stifle joint was approached laterally and a trochlear block recession procedure was performed as previously described (10). A bone saw was used to create two parallel osteotomies in the trochlear cartilage and the bone along the widest part of the trochlear ridges. A series of parallel holes were then drilled starting from 2–3 mm proximal to the origin of the caudal cruciate ligament to the top of the trochlea. A wide osteotome was used to complete the osteotomy and to elevate the trochlear block. The block was removed and kept in a blood soaked sponge on the operating table. A bone rasp was used to deepen the subchondral bone. The block was then pressed back into this recessed femur.

#### Lateral transposition of the tibial crest and detection of medial patellar luxation with an alta composition

A lateral tibial crest transposition was carried out as described in the following paragraph. An incision in the periosteum was made medially and an osteotomy was made using an oscillating saw along the tibial crest. The most distal part of the tibial crest periosteum remained attached to the bone. Lateral transposition of the tibial crest was temporarily performed (3–10 mm laterally) until the patella was aligned with the troch-

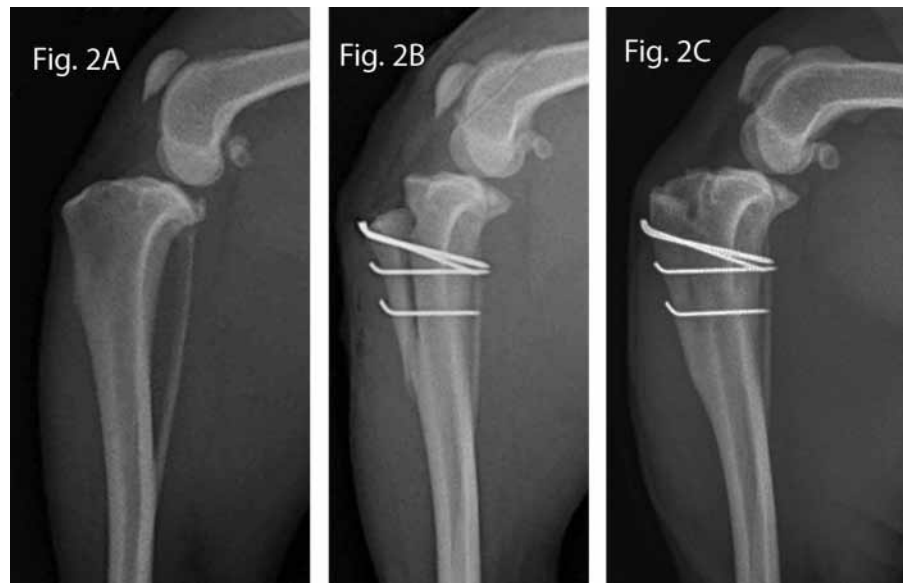
lear groove longitudinal axis. The stifle joint was then fully extended and the patella location was evaluated. In cases where the patella was within the boundaries of the trochlear groove proximally and distally, the tibial crest was fixed. However, in cases where the patella was still located proximal to the trochlear groove (defined here as medial patellar luxation with an alta composition), a distal transposition component was performed and the tibial crest was fixed.

### Distal transposition

To perform the distal transposition, the distal part of the tibial crest periosteum was fully incised allowing the entire tibial crest to be moved distally (10). The tibial crest was retracted distally until the patellar ligament was stretched (while the stifle was at maximum extension) and the patella was located between the ridges of the proximal trochlea (4–13 mm distally). A 2 mm deep notch was made 4 to 13 mm distal from the proximal end of the tibial crest osteotomy to allow easy relocation of the tibial crest (► Fig. 1). In cases where there was friction between the patellar ligament and the proximal point of tibial osteotomy, the proximal tibial osteotomy site was trimmed using a bone rongeur (about 2 mm) until no contact was observed between the patellar ligament and the proximal tibia during flexion and extension. The tibial crest was then reattached to its new position by insertion of two to four 0.9 mm Kirschner wires (in most of the dogs weighing up to 8 kg; 5 limbs) or by a combination of 1.6 mm Kirschner wires and a tension band wire (for dogs larger than 8–10 kg as well as two smaller dogs; 12 limbs). Two dogs with grade 4 luxation and marked femoral angulation had an additional distal femur osteotomy using a distal osteotomy plate as described (10).

### Postoperative care

All dogs were hospitalized for 24 hours postoperatively. The surgically repaired limb was bandaged with soft materials for three days. While hospitalized, dogs were treated with cefazolin (25 mg/kg IV). Also a constant rate infusion of lactated Ringers solution with ketamine (60 mg/L), mor-



**Fig. 2** Medio-lateral radiographic views of a stifle affected by medial patellar luxation with patella alta component. **A**) Preoperative view. **B**) Postoperative view: Distal transposition of the tibial crest is shown. The tibial crest is fixed to the tibia with four Kirschner wires. **C**) Follow-up view taken 24 weeks postoperatively. Healing of the osteotomy is observed.

phine (40 mg/L), and lidocaine (600 mg/L) was administered at 2.5 mg/kg/hr rate. The dogs were discharged with instructions to the owner to administer carprofen (2 mg/kg, orally, twice daily) for 10 days and tramadol hydrochloride (2 mg/kg, orally, twice daily) for five days. In some cases, where the surgical procedure time extended longer than usual, or where aseptic conditions were in doubt, antibiotic treatment was prescribed for an additional seven days (cefalexin 25 mg/kg). The owners were instructed to perform a 15 minute session of passive range-of-motion physiotherapy twice daily for five days until the dog was re-evaluated. Further examination, including lameness scoring, stifle range-of-motion scoring, patella location, and radiographic evaluation were performed three months or more postoperatively. In cases where owners were not available for physical evaluation, lameness scoring was performed using a telephone questionnaire.

### Calculation of radiographic parameters for patella location

Patellar ligament length and PL were measured postoperatively using medio-lat-

eral radiographic views, as described previously (12). The vertical length between the proximal pole of the patella to the transcondylar axis (A) was measured postoperatively using caudo-cranial radiographic views as described previously (12). The postoperative distal transposition distance (depicted by  $\Delta X$  in ► Fig. 1) was also measured on the postoperative radiograph.

### Statistical analysis

Correlation between weight and radiographic measurements was evaluated using Spearman's rank correlation coefficient test. Significance for Spearman's tests was evaluated using Fisher transformation yielding a z-score. Significance of change between preoperative and postoperative measurements was evaluated using paired Student's t-test. A value of  $p < 0.05$  or less was considered as significant.

### Results

Fourteen dogs (9 females, 5 males) with luxation in 17 limbs were included in this study. Body weight of treated dogs ranged

between three to 38 kg (mean 17.7 kgs  $\pm$  12.3) and ages ranged between four months to 10 years (mean 2.9 yr  $\pm$  2.4) (►Appendix Table 1 - Available online at [www.vcot-online.com](http://www.vcot-online.com)). Dog breeds represented were three mixed breeds, two Yorkshire Terriers, two King Charles Cavaliers, and one of each of the following: Pomeranian, Pinscher, Labrador, Pekingese, Akita Inu, Siberian Husky, and Boxer. Six of the dogs had left hindlimb luxation, five had right hindlimb luxation, and three had bilateral luxations.

Most of the medial patellar luxation cases had a preoperative luxation grade of 3 (9 out of 17 limbs), and of the remaining limbs, six had grade 4, and two had grade 2. All participating dogs had clinically evident lameness preoperatively. In the 17 stifles, the recorded lameness scores were 2 (n = 3),

3 (n = 8), 4 (n = 4), and 5 (n = 2). The stifle range-of-motion scores were 0 (n = 6) 1, (n = 9) and 2 (n = 2).

The mean postoperative distal transposition distance (depicted by  $\Delta X$  in ►Fig. 1) was  $6.7 \pm 2.4$  mm (range: 4 to 13 mm) distal to the original anatomical location of the tibial crest. Distal femoral osteotomy was performed in two surgically repaired stifles (►Appendix Table 1: Available online at [www.vcot-online.com](http://www.vcot-online.com)).

Outcome was physically evaluated in 13 of the 17 surgically repaired limbs. The lameness scores for these 13 dogs were improved at 24 weeks or more following the surgical procedure. The lameness scores were zero (10/13 limbs), 1 (2/13 limbs), and 2 (1/13 limbs). For the 13 limbs examined physically, there was not any decrease in range-of-motion detected in 11 stifles, and

the range-of-motion score was 1 in two stifles. In one of the dogs (case 7), the tension band wire and the Kirschner wires were removed 12 weeks postoperatively (after osteotomy healing) due to skin irritation. There were not any other complications or re-luxations recorded for the remaining dogs. In three additional cases, outcome evaluation was performed during a telephone call; in all three cases, no lameness was reported by the owner.

The preoperative A/PL ratio ranged between 1.9 and 2.53 (mean  $2.2 \pm 0.2$ ). A significant correlation ( $r = 0.57$ , Spearman's rank correlation coefficient,  $p = 0.019$ ) was detected between these A/PL ratio measurements and body weight. Preoperatively, the PLL/PL ratio ranged between 1.9 and 2.8 (mean  $2.2 \pm 0.28$ ). A weaker correlation ( $r = 0.42$ , Spearman's) was found between the PLL/PL ratios and body weight; this correlation was not significant ( $p = 0.1$ ). A significant correlation ( $r = 0.66$ , Spearman's correlation,  $p = 0.0036$ ) was found between the body weight and the postoperative distal transposition distance ( $\Delta X$ ).

In comparison to the preoperative values, the postoperative values of PLL/PL (mean  $1.8 \pm 0.2$ ; range 1.4 to 2.2;  $p = 6.9 \times 10^{-6}$ ) and A/PL (mean  $1.7 \pm 0.3$ ; range 1.1 to 2.1;  $p = 6.5 \times 10^{-7}$ ) were smaller than the preoperative values (►Appendix Table 1: Available online at [www.vcot-online.com](http://www.vcot-online.com)).

## Discussion

We have performed a previously described modified procedure for medial patellar luxation reduction, which involves a distal transposition of the tibial crest in addition to the lateral transposition, for correction of medial patellar luxation with an alta composition (10). Distal transposition of the patella in cases of medial patellar luxation with an alta composition brings the patella to the mid-length of the trochlear groove, a more normal anatomical position, and the trochlear ridges provide mechanical support to the patella, thus opposing the forces causing medial re-luxation. It was previously hypothesized that the addition of the distal transposition component makes the patella less prone to



**Fig. 3** Caudo-cranial radiographic view of a surgically reconstructed stifle (same clinical case as in Fig. 2). **A)** The patella is located medially and proximally to the patellar groove. **B)** Postoperative view: Distal transposition of the tibial crest drives the patella into the trochlear groove. **C)** Follow-up image taken 24 weeks postoperatively.

re-luxate (12). Indeed, a similar procedure, involving both medial and distal transposition of the patella, has been reported to restore normal patellar position in humans with recurrent patellar luxation (16).

Out of the 42 stifles affected by medial patellar luxation that underwent surgical correction in our practice during the period of study, 17 (40%) were defined as having medial patellar luxation with an alta composition and were treated with the distal tibial crest transposition. The decision to perform the distal transposition of the tibial crest was taken intra-operatively, based on the proximo-distal location of the patella relative to the trochlear groove following the lateral crest transposition. In most cases, a decision could not have been taken preoperatively using radiographs because the radiological evaluation does not provide information on the orientation of the patellar ligament, the quadriceps angulation, and the trochlear groove depth as these are all factors influencing the location of the patella after lateral transposition. Future radiographic studies will be needed to evaluate if other parameters might be correlated with medial patellar luxation with an alta composition.

Our postoperative evaluations show that all dogs had improved lameness scores 24 weeks or more following the surgical operation, and there was not any decrease in range-of-motion or cases of re-luxation recorded. Other studies have found that re-luxation accounts for 30–48% of postoperative complications for medial patellar luxation (1, 8). Our intra-operative subjective impression was that the patella is better positioned within the trochlea groove and this most likely provides physical support to prevent re-luxation. Our data indicate that the distal transposition may allow better anatomical alignment and improved resistance to the previously existing luxating forces.

The observation that patella alta may play a role in medial luxation was previously established, and it was shown that medial patellar luxation is associated with a relatively long patellar ligament and patella alta in medium to giant breed dogs (9, 11, 12). Our definition of medial patellar luxation with an alta composition is not directly parallel to Johnson's definition of patella alta, since the

alta composition in our study refers to the patella position in luxated condition, while Johnson's definition of alta refers to the patella in normal conditions (9, 11). It is nevertheless possible that there is a correlation between patella alta in normal conditions and luxated conditions.

In most of the stifles where distal transposition was performed (13/17, 76%), the postoperative radiographic measures showed values of A:PL <1.92, which is consistent with a condition of patella baja (12). In contrast to patella alta, which was associated with medial luxation, patella baja was correlated with increased frequency of lateral patellar luxation events (12). Since it is likely that the forces driving the patella into lateral patellar luxation oppose those that drive it into medial patellar luxation, the baja position of the patella might be beneficial for preventing re-luxation medially immediately after the operation.

One of the limitations of our study was a relatively small number of cases that underwent this modified surgical procedure. Future studies aimed at evaluating this modified procedure should include a larger number of cases in order to provide stronger statistical evaluation of factors such as body weight. Furthermore, our study was not double blinded and did not include a control group of limbs with medial patellar luxation with an alta composition that did not undergo the distal transposition procedure. Further investigations which include these controls are needed to establish the benefits of our procedure before it can be strongly recommended.

Nevertheless, the improved clinical outcome, zero recurrence rate, and low overall rate of complications may be suggestive of a better clinical outcome as compared with the commonly performed procedure that involves lateral transposition only. This modified surgical procedure, which reduces patella alta into a more normal proximo-distal anatomical position, is relatively simple to perform and warrants further evaluation for surgical treatment of medial patellar luxation concurrent with alta.

#### Conflict of interest

None declared.

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