

Change of Quadriceps Angle after Tibial Tuberosity Transposition in Dogs with Medical Patellar Luxation

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(Accepted: March 27, 2014)

Abstract : We evaluated the change of quadriceps angle (QA) after tibial tuberosity transposition. Twenty-nine animals and 37 limbs of the total 62 case possibilities qualified for this study. The preoperative QA was 24.02 ± 4.02 in grade 2, 26.08 ± 5.66 in grade 3 and 30.25 ± 7.41 in grade 4. The postoperative QA was 21.25 ± 3.24 in grade 2, 19.16 ± 3.92 in grade 3 and 19.72 ± 7.30 in grade 4. The postoperative QA for all grades significantly decreased when compared with the preoperative QA ($P < 0.05$). However, the postoperative QA values were not within the normal range, although the dogs' prognosis remained good during the 4-month follow-up period. These results suggest that postoperative QA outside of the normal range may be allowed clinically.

Key words : patellar luxation, quadriceps angle, tibial tuberosity transposition, dog.

Introduction

Medial patellar luxation (MPL) is a common condition that affects dogs (10), occurring in 7.2% of immature animals (12). Toy and small breed dogs such as Boston terriers, Chihuahuas, Pomeranians, poodles and Yorkshire terriers are more likely to experience MPL than other breeds (2,3,11).

Various surgical techniques such as soft tissue reconstruction, trochleoplasty, tibial tuberosity transposition and femoral and/or tibial corrective osteotomy have been used for MPL correction. However, reluxation occurs in up to 48% of cases (15), and specific factors that contribute to recurrence have not yet been established.

The quadriceps muscles, patellar trochlear groove, patellar tendon and tibial tuberosity are linearly aligned and show patellofemoral joint movement. When one or more of these structures' positions are altered, patellar luxation can occur. These alterations can be complex, likely because of a combination of anatomic deformities in the hindlimb that result in malalignment of the quadriceps. Many researchers have investigated various parameters to quantify the related skeletal deformation and the discrepancies between skeletal and quadriceps/patellar alignments.

The quadriceps angle (QA) is a measurement used in human orthopedics; it describes the alignment of the quadriceps mechanism and quantifies the deviation of patellar tracking from the sagittal axis of the femur (1,4,8). The QA can

change, which correlates with femoropatellar pressures and cartilage lesions (5). A study reported that the QA increased following a patellar luxation grade increase (7).

In this study, we evaluated the QA change after transposition of the tibial tuberosity, which is a landmark of QA measurement.

Materials and Methods

Animals

The object of this study was to examine cases which were diagnosed with MPL and treated with tibial tuberosity transposition (TTT), trochleoplasty and soft tissue reconstruction in the Royal Medical Center from January to December 2011. Physical examination, complete blood count, serum biochemistry and thorax radiogram were performed prior to anesthesia preparation. Cases which had systemic or other orthopedic disease or incorrect position in the radiograph which did not allow appropriate QA measurements were excluded from this study. The age, weight and sex of the dogs were also recorded.

Patellar luxation grade

The stifles were evaluated with palpation and stifle radiogram and categorized into grades 1-4 based on Piermattesi's (10) classification guidelines. For grade 1, the patella was in the trochlear groove, and was easily luxated manually, but returned to the groove. In grade 2, the patella could be luxated manually, but returned spontaneously. In grade 3, the patella was luxated the majority of the time, but could be returned to position manually. For grade 4, the patella was in the luxated position at all times and could not be returned manually.

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Surgical procedures

All surgical treatments were performed by the 4th author (Jang, S-U). After general anesthesia was induced, the stifle was exposed after an incision through the craniolateral skin, subcutaneous tissue and joint capsule. For TTT, the tibial tuberosity was resected. The resected tibia tuberosity was transposed laterally to the patella until it was in the groove and stabilized with 1-2 Kirschner wires. Additionally, lateral retinacular overlapping and trochleoplasty were performed. An antibiotic (cephalexin 20 mg/kg IV BID) and analgesic (carprofen, 2.2 mg/kg PO BID) were administered for 3 days postoperatively. All patients were followed for 4 months after the surgery to evaluate prognosis.

Quadriceps angle measurement

Anteroposterior radiographs of the stifle were obtained before and after the surgery for QA evaluation. The method of QA measurement is described in Towle’s report (14). A line was drawn from the origin of the rectus femoris muscle to the middle of the femoral trochlea, and another line was drawn from the middle of the femoral trochela to the tibial tuberosity (14). The acute angle formed between the two lines was defined as the QA (14).

Statistical analysis

Preoperative and postoperative QA were expressed as the mean ± standard deviation. Preoperative and postoperative QA were compared using a paired sample t-test. The preoperative QA was analyzed, taking into account breed, sex, age, weight and patellar luxation grade. One-way analysis of variance was performed followed by a Tukey test using SPSS software (version 18.0; SPSS Institute, Cary, NC, USA). P values under 0.05 were considered statistically significant.

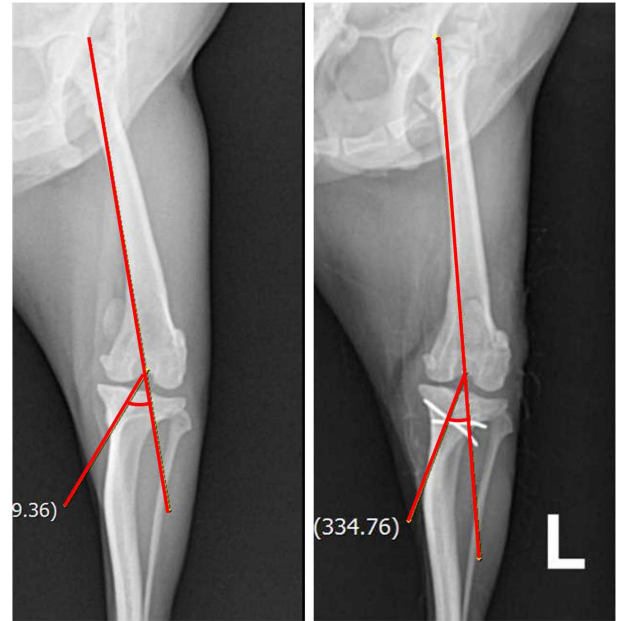


Fig 1. Quadriceps angle (QA) measurement (Left: preoperative, Right: postoperative).

Results

Twenty-nine animals and 37 limbs of the total 62 case possibilities qualified for this study. The breeds included Yorkshire terriers (n = 6), Maltese (n = 11), poodles (n = 4), Chihuahuas (n = 2), Pekinese (n = 3), Pomeranians (n = 1), Miniature pinschers (n = 1) and Golden retrievers (n = 1). There were 15 males and 14 females, and 8 dogs were under 1 year of age, 14 dogs were over 1 year and 7 dogs were over 7 years. The body weight of 25 dogs was less than 5 kg and 4 dogs were over 5 kg.

Table 1. Pre- and postoperative Quadriceps angle (QA) results.

	Preoperative QA			Postoperative QA		
	mean ± SD	min	max	mean ± SD	min	max
Grade 2 (n = 5)	24.02 ± 4.02	17.68	29.44	21.25 ± 3.24*	17.45	25.06
Grade 3 (n = 27)	26.08 ± 5.66	13.87	37.29	19.16 ± 3.92**	11.42	25.73
Grade 4 (n = 5)	30.25 ± 7.41	21.92	40.64	19.72 ± 7.30**	8.77	25.24

*: P < 0.05 between pre- and postoperative QA
 **: P < 0.01 between pre- and postoperative QA

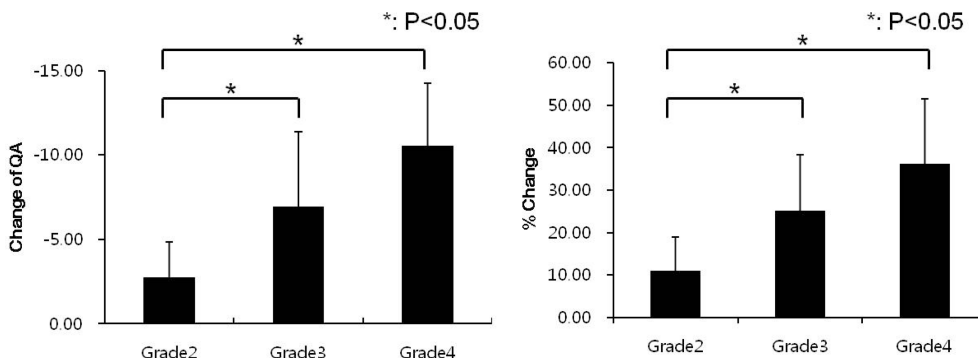


Fig 2. Quadriceps angle (QA) change (Left) and percent change (Right) results.

The patellar luxation grade analysis determined that there were 0 grade 1 cases, 5 grade 2 cases, 27 grade 3 cases and 5 grade 4 cases. All patients had a good prognosis without lameness and recurrence during the follow-up period.

The mean \pm standard deviation, minimum and maximum values of the QA, preoperatively and postoperatively, with patellar luxation grade are displayed in Table 1. All postoperative QA grades were significantly lower than the preoperative QA (Grade 2: $P < 0.05$, Grade 3-4: $P < 0.01$). There were no significant changes between preoperative and postoperative grades, respectively.

The QA changes were -2.77 ± 2.07 in grade 2, -6.92 ± 4.48 in grade 3 and -10.52 ± 3.71 in grade 4 (Fig 2A). The rates of QA change were $10.90 \pm 8.02\%$ in grade 2, $25.18 \pm 13.07\%$ in grade 3 and $36.23 \pm 15.22\%$ in grade 4 (Fig 2B). The change and percent change of QA in grade 2 were significantly lower than in grades 3 and 4 ($P < 0.05$), and there were no significant differences between the changes in grades 3 and 4.

Discussion

Patellar axis deformation induces patellar luxation. In the present study, quadriceps angle was evaluated to determine patellar deformation. In human medicine, QA is thought to correlate with patellar instability and chondromalacia of the patella (1,4,6,13). In veterinary medicine, the QA of dogs is measured using magnetic resonance imaging, computed tomography and radiography (7,14). The QA in dogs with patellar luxation was significantly higher when compared with dogs without patellar luxation (7,14).

In this study, the postoperative QA was significantly lower than the preoperative QA. These results may be induced by transposed tibial tuberosity, which is a landmark for QA measurement. However, postoperative changes of the QA remain controversial. Mortari *et al* reported that the QA did not significantly change between pre- and postoperative grade 1-3 values (9). Specifically, the postoperative QA in grade 1 increased slightly in the study (9). Towle *et al* also reported that the postoperative QA in patellar luxation grades 2-3 decreased 33% on radiography, although the results were not significant (14). We excluded the cases which were treated without TTT in this study. The differences in the results are regarded as that of surgical treatment and subject inclusion criteria.

Preoperative QA values were not significantly different when patellar luxation grades were compared. Kaiser *et al* reported that the QA of patellar luxation grade 3 was significantly higher than that of grade 1, but not in other grade groups (7). The significance could not be confirmed in this study because the cases with patellar luxation grade 1, which did not require TTT, were excluded. However, preoperative QA values in grades 2-3 were higher than those in normal limbs without patellar luxation (7), and increased following grade increases, although these results were not significant.

When TTT is performed, the positioning of the tibial tuberosity is not determined exactly. Generally, the surgeon subjectively decides the position of the tibial tuberosity after patellar reduction, and confirms the axis from the quadriceps

muscle to the tibial tuberosity. QA in normal limbs are known 10.5 ± 5.6 ranged from -2 to 24.9 due to medial deviation of tibial tuberosity (7,10). We expected that the postoperative QA of all grades would be within the normal range. However, all of the postoperative QA values were higher than the normal range, although all cases showed good prognosis without recurrence and lameness for 4 months after surgery. These results suggest the possibility that high postoperative QA may be clinically viable. However, additional studies should be conducted to investigate QA change with a longer follow-up period.

Cases in this study underwent TTT as well as trochleoplasty and soft tissue reconstruction. These surgical processes can also affect the postoperative QA measurement, which was not considered when QA was evaluated in this study. Further study should investigate the change of QA associated with each surgical technique using experimental models.

In conclusion, TTT significantly decreased QA in all patellar luxation grades. However, postoperative QA values were not within the normal range, although the prognosis of all dogs was good for the duration of the 4-month follow-up period.

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내측 무릎골 탈구를 나타낸 개에서 경골결절 전위술 후 대퇴사두근각의 변화

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요 약 : 내측 무릎골 탈구를 나타낸 개에서 경골결절 전위술 실시후 대퇴사두근각(QA)의 변화를 평가하였다. 내측 무릎골 탈구를 나타낸 전체 62 증례 중 실험조건에 맞는 37개의 다리를 조사대상으로 선정하였다. 술전 QA는 각각 grade 2에서 $24.02 \pm 4.02^\circ$, grade 3에서 $26.08 \pm 5.66^\circ$ 그리고 grade 4에서 $30.25 \pm 7.41^\circ$ 로 나타났다. 술후 QA는 grade 2에서 21.25 ± 3.24 , grade 3에서 19.16 ± 3.92 그리고 grade 4에서 19.72 ± 7.30 로 나타났으며, 모든 등급에서 술후 QA는 술전 QA에 비해 유의성 있게 감소되었다($P < 0.05$). 4개월간 추적관찰한 결과 모든 증례는 술후 양호한 예후를 나타냈었으나, 술후 QA는 정상보다 높게 나타났다. 이러한 결과는 정상범위보다 큰 술후 QA는 임상적 예후와 관련성이 적을 것으로 생각된다.

주요어 : 무릎골 탈구, 대퇴사두근각, 경골결절 전위술, 개