Prospective clinical assessment of tibial tuberosity advancement for the treatment of cranial cruciate ligament rupture in dogs[1]

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Abstract

Purpose: To evaluate clinically dogs that underwent tibial tuberosity advancement (TTA) six months previously.
Methods: Dogs of various breeds, gender, weight, and age that had CCL rupture and underwent TTA for treatment were included in this study. Parapatellar arthrotomy was performed in all patients to assess the joint for a ruptured ligament and meniscal injury before the TTA. The appropriate cage for the TTA was chosen with planning surgery. The surgical procedure was performed according to the literature, using a modified Maquet technique. Six months after surgery, lameness during walking; muscular atrophy; crepitation, cranial drawer and tibial compression tests and quality of life based on owner's evaluation were assessed.
Results: Postoperative complications were observed in only one knee (4.76%), with a surgical site seroma. The mean lameness score at walking was 0.29 (± 0.64). The mean score regarding muscular atrophy was 0.95 (± 1.56). The mean score of the cranial drawer test, in a range from 0 to 5, was 1.52 (± 1.54). The owners rated the dog's quality of life as excellent in 44%, good in 30%, and moderate in 17%.
Conclusion: This clinical study supports the affirmation that patients who undergo TTA for treatment of CCL rupture have an acceptable response.
Key words: Orthopedics. Osteotomy. Veterinary. Dogs.

DOI: http://dx.doi.org/10.1590/s0102-865020180080000004

■ Introduction

The role of the cranial cruciate ligament (CCL) is to prevent cranial movement of the tibia relative to the femur, internal rotation of the tibia, and hyperextension of the knee[1]. In dogs, CCL rupture has multiple causes, involving genetics, conformation, and inflammatory changes, that combine to promote an imbalance between biomechanics applied to the CCL and its capacity to support the load. Thus, degeneration and rupture of the ligament can occur leading to instability of the stifle joint[2,3].

Multiple surgical techniques have been described to treat CCL rupture, although none are ideal, because they all allow for progression of stifle osteoarthritis (OA)[4-6]. OA occurs due to the inaccuracy of the techniques, which allow for movement of the joint[7].

Among the techniques, proximal tibial osteotomies alter the stifle geometry and cause dynamic stability that nullifies the force of cranial translation of the tibia, which decreases the progression of OA[1,8-10].

Tepic *et al*.[1] presented a biomechanical theory describing the results when the force on the stifle joint is parallel to the patellar ligament. Thus, the tibial cranial translation is performed in reference to the angle between the tibial plateau and the patellar ligament. When the patellar ligament is perpendicular to the tibial plateau, the resulting force on the joint is minimal. This can be achieved with a tibial tuberosity advancement (TTA)[5,11].

The aim of the present study was to clinically assess dogs that underwent TTA six months previously. Orthopedic examination, including lameness score (range 0-4)[16], muscle atrophy, crepitation on manipulation, cranial drawer, and tibial compression test, were assessed.

■ Methods

This work was submitted and approval by Animal Ethic and Use Committee, Universidade Estadual Paulista, protocol number 008038/18.

Dogs of various breeds, gender, weight, and age admitted at veterinary hospital of Universidade Católica Dom Bosco, Campo Grande-MS, Brazil, that had CCL rupture and underwent TTA for treatment were included in this study. The diagnosis was made by cranial drawer and tibial compression tests. Complete orthopedic examination and radiography were performed to evaluate for the presence of joint effusion or OA. Dogs with contralateral CCL rupture were not excluded from the study.

Fasting of solids and liquids were started at 8 and 2 h prior to surgery, respectively. A combination of acepromazine (0.03 mg/kg) and tramadol (1 mg/kg) was injected intramuscularly as a pre-anesthetic, and anesthesia was induced with propofol (5 mg/kg IV). Animals were intubated with an endotracheal tube, and anesthesia was maintained with 0.5% isoflurane vaporized in 100% oxygen in a closed circuit. Furthermore, epidural anesthesia with morphine (0.1 mg/kg) and lidocaine (0.5 mg/kg) was performed.

Parapatellar arthrotomy was performed in all patients to assess the joint for a ruptured ligament and meniscal injury before the TTA. The ruptured ligament and injured meniscus were removed. Meniscal release was not performed if the meniscus was normal.

The appropriate cage for the TTA was chosen with planning surgery, using software and a mediolateral radiograph with the knee angled at 135º. The surgical procedure was performed according to the literature with titanium cage[12-14], using a modified Maquet technique[15].

Oral cephalexin (30 mg/kg, every 12 h, for 10 days), tramadol (2 mg/kg, every 12 h, for 7 days), and meloxicam (0.1 mg/kg, every 24 h, for 5 days), in addition, movement restriction for 4 to 8 weeks, were prescribed.

Six months after surgery, assessment was performed regarding the following criteria: lameness during walking; muscular atrophy; crepitation, ranging from 0-4, as described by Hudson *et al*.[16]; cranial drawer and tibial compression tests, ranging from 0-5, as described by Hudson *et al*.[16]; and quality of life based on owner's evaluation, ranging from 9 to 36, with 9 to 15= terrible, 16 to 22= bad, 23 to 29= moderate, 30 to 33= good, and 34 to 36= excellent.

■ Results

Eighteen dogs (eight males and ten females) were included in the study, and three of the dogs had contralateral rupture. Therefore, a total of 21 operated knees (11 left and 10 right) were evaluated. Mean age of the patients was 7.4 years (± 3.5), and mean weight was 20.39 kg (± 13.5).

Postoperative complications were observed in only one knee (4.76%), with a surgical site seroma. The knee was treated with draining of the fluid, daily cleaning, and bandaging.

Six months postoperatively, no lameness at running was observed in 81% of the dogs. The mean lameness score at walking was 0.29 (± 0.64). Muscular atrophy was not observed in 62% (13/21), while mild atrophy was observed in 19% (4/21), and moderate in 19% (4/21). The mean score and standard deviation regarding muscular atrophy were 0.95 (± 1.56).

No crepitation was palpated on eight (38%) of the knees, while four (29%) had mild crepitation, seven (33%) moderate, and two (10%) high. The mean score and standard deviation, in a range from 0 to 4, were 1.14 (± 1.06).

Regarding the tibial compression test, 57% (12/21) were negative, 38% (8/21) partially positive, and 5% (1/21) positive. For the cranial drawer test, 43% were negative, 38% partially positive, and 19% positive. The mean score and standard deviation of the cranial drawer test, in a range from 0 to 5, was 1.52 (± 1.54).

The quality of life evaluation was performed by all owners. In dogs that had both knees operated on, the questionnaire was completed after the second surgery, and they had the same answers for both knees. The results of the questionnaire are shown in Table 1. Regarding lameness, 52.3% of dogs had no signs six months postoperatively. The owners rated the dog's quality of life as excellent (score from 34 to 36) in 44%, good (score from 30 to 33) in 30%, and moderate (score from 23 to 29) in 17%. No patient's quality of life was classified as bad or terrible.

Table 1 - Questions regarding quality of life of the dogs, evaluated by the owners.

Question	Bad	Good	Excellent
1. Did the surgery disturb the dog's life?	0%	5%	95%
2. Does the dog show lameness on the operated limb?	0%	48%	52%
3. Is he/she eating?	0%	5%	95%
4. Is he/she unusually tired?	38%	10%	50%
5. Is he/she still playing as before?	0%	14%	86%
6. How is he sleeping?	5%	24%	71%
7. Can your dog position to urinate and defecate normally?	0%	0%	100%
8. How is his/her behavior?	0%	5%	95%
9. Is he/she licking the operated limb?	10%	0%	90%

■ Discussion

Approximately 48% of dogs with CCL rupture will experience rupture in the contralateral limb[17]. However, in the present study, only three (16.7%) of the dogs had CCL rupture in the other limb. This could be due to the evaluation time of only six months after surgery. More patients may have developed contralateral rupture after the follow-up evaluation. Medeiros *et al*.[5], who evaluated dogs four months postoperatively, found CCL rupture in the contralateral limb in 7 (20%) out of 35 dogs, similar to the percentage found in this study.

The low rate of postoperative complications observed in this study was different from others that have reported rates of 11 to 59% for minor and major complications, such as meniscal injury, tibial fracture, infection, granuloma, fracture or loosening of the screws, implant rejection, septic arthritis, and patellar luxation[5,13,14]. In the present study, all of the surgeries were performed with aseptic technique by an expert surgeon, which could decrease complications.

The lameness rates at gait analysis after TTA in literature are divergent; one study showed that 68% of all patients had no lameness four months after surgery[14]. In another study using Ricinus communis polyurethane polymer as the cage in a modified TTA, Medeiros *et al*.[5] had an excellent result, with 95% of dogs showing minimal or no lameness at four months postoperatively. In our study, the recovery rate was 81%, similar to that showed by Lafaver *et al*.[13] (74.5%). The difference among these results can be explained by the difference in clinic observers, since it is a subjective analysis. Thus, the assessment duration is important, as affirmed by Mölsä *et al*.[18] since in veterinary medicine follow-up is often limited to one reassessment.

In this study, 62% of the dogs had no muscular atrophy. This is different from the results of a study that promoted iatrogenic rupture of the CCL and early treatment, which showed evident muscular atrophy at two weeks and progression until five weeks postoperatively, and few recovered the muscular mass after ten weeks[19].

In this study, 38% of patients had no crepitation on palpation, 29% had mild crepitation, 33% moderate, and 10% high. Crepitation occurs due to the presence of osteophytes in the joint from OA. Medeiros *et al*.[7], observed radiographic signs of OA mainly at five years after modified TTA.

Other techniques used to treat CCL rupture also allow some movement in the knee. Therefore, there is no technique that completely nullifies the joint instability observed after CCL rupture and prevents OA development, as well as the resultant joint crepitation, pain, and lameness[4,20-22].

Bruce *et al*.[23] observed that 89% (57/64) of stifles were positive on the tibial compression test 6 to 12 weeks after triple tibial osteotomy, and this rate increased to 91% (50/55) after 11 to 26 weeks. Similarly, Medeiros *et al*.[7] affirmed that all of the operated knees were positive after modified TTA. However in our study, only 5% of patients were positive on the tibial compression test, 38% partially positive, and 57% were negative, and no dogs showed pain.

Osteotomies for treatment of CCL rupture promote dynamic stability; thus, cranial compression test, which mimics stepping, should be negative after surgery. However, our hypothesis was that because of the inaccuracy of all techniques, they allow instability. Au *et al*.[4], corroborated this hypothesis in an ex vivo biomechanics study in dogs, as they observed that after tibial plateau leveling osteotomy (TPLO), there was cranial tibial translation. Additionally, Bruce *et al*.[23] affirmed that the cranial tibial test is not similar to forces in the knee during walking, because once load is applied on the joint through loading mechanism of the calcaneus tendon, the dynamic stability of the knee depends on

various muscle contractions.

The results obtained in the questionnaire (Table 1) were similar to those observed by other authors, who showed that more than 90% of owners classified their dog's gait as good or excellent after surgery[7,18].

Bruce *et al*.[23] established that 100% of owners reported an increase in quality of life of patients 12 months after triple tibial osteotomy, and Dymond *et al*.[24] affirmed that 87% of owners reported good recovering 13 months postoperatively after TTA. All owners in both studies said that they would opt for the same procedure in similar cases. In another study, Hoffman *et al*.[12] showed that 75% of owners classified their dog's quality of life as excellent 24 months after TTA.

Despite the fact that we noted lameness, crepitation, and positive cranial compression test in various dogs, most of the owners reported being satisfied after TTA treatment of CCL rupture. This is likely because the owners do not see the changes observed by trained veterinarians, and the dog's quality of life increases after surgery.

■ Conclusion

Patients who undergo tibial tuberosity advancement for treatment of cranial cruciate ligament rupture have an acceptable response regarding gait, muscular atrophy, crepitation, cranial drawer, and tibial compression tests.

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Received: Apr 12, 2018
Review: June 13, 2018
Accepted: July 15, 2018

Conflict of interest: none
Financial source: none

[1]Research performed at Veterinary Hospital, Universidade Católica Dom Bosco (UCDB), Campo Grande-MS, Brazil.