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**COMPARAÇÃO DE TRÊS MÉTODOS DE FIXAÇÃO DA  
TUBEROSIDADE TIBIAL EM CÃES SUBMETIDOS À CIRURGIA  
PARA REDUÇÃO DA LUXAÇÃO PATELAR MEDIAL**

Santa Maria, RS  
2019

**Renan Bonotto de Oliveira**

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EM CÃES SUBMETIDOS À CIRURGIA PARA REDUÇÃO DA LUXAÇÃO  
PATELAR MEDIAL**

Dissertação apresentada ao Programa de Pós-Graduação em Medicina Veterinária, Área de Concentração em Clínica e Cirurgia Veterinária, da Universidade Federal de Santa Maria (UFSM, RS), como requisito parcial para obtenção do título de **Mestre em Medicina Veterinária**.

Orientador: Prof. Dr. Daniel Curvello de Mendonça Müller

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## RESUMO

### COMPARAÇÃO DE TRÊS MÉTODOS DE FIXAÇÃO DA TUBEROSIDADE TIBIAL EM CÃES SUBMETIDOS À CIRURGIA PARA REDUÇÃO DA LUXAÇÃO PATELAR MEDIAL

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O presente estudo busca comparar três métodos diferentes para a execução da técnica de transposição da tuberosidade tibial (TTT) em pacientes com luxação medial de patela. Para tal, 19 cães da rotina cirúrgica foram selecionados e agrupados aleatoriamente em três grupos, sendo os pacientes do grupo “A” (n=7) submetidos à fixação da tuberosidade tibial por dois pinos de Kirschner 1,2mm, os do grupo “B” (n=9) submetidos à fixação da tuberosidade osteotomizada por um parafuso cortical 2mm e os cães do grupo “C” (n=7) pela fixação da tuberosidade tibial com a técnica de cerclagem por fio de aço n°2. O número amostral compreendeu 23 transposições ao todo, sendo os procedimentos cirúrgicos e as avaliações executadas pelo mesmo cirurgião por até 90 dias após o procedimento. O grau de luxação nos membros operados foi maior no grupo “C”, sendo que a tendência se manteve e luxação residual foi encontrada com maior frequência nessa população. O escore de claudicação inicial foi maior nos grupos “C” e “A” em relação aos cães do grupo “B”, porém no 10º dia, o grupo “A” se destacou como pior claudicação. O tempo cirúrgico foi diferente entre os métodos testados, sendo o grupo “B”, 13,46 minutos mais rápido que os demais. A amplitude articular nos grupos não foi influenciada pelos dias avaliados onde as médias oscilaram entre  $138,76^\circ \pm 2,32^\circ$ , ainda que os pacientes do grupo “C” tivessem uma amplitude maior em comparação com os demais. As três técnicas apresentaram resultados semelhantes para os parâmetros avaliados, exceto luxação residual aos 90 dias onde “C” > ”B” > ”A”, e não ocorreram complicações maiores que justificassem nova intervenção cirúrgica.

**Palavras-chave:** Amplitude articular. Canino. Cirurgia ortopédica. Claudicação. Joelho.

## ABSTRACT

### COMPARISON AMONG THREE TIBIAL TUBEROSITY FIXATION METHODS IN DOGS THAT UNDERWENT SURGERY TO REDUCE MEDIAL PATELLAR LUXATION

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The current study compared three different methods to perform the tibial tuberosity transposition technique (TTT) in patients with medial patellar luxation observing the luxation degree, lameness degree, the surgery time, articular amplitude and trans-operative and post-operative complications. 19 dogs from the surgical routine were selected and randomly divided in three groups. Patients in group “A” (n=7) were submitted to the tibial tuberosity fixation with two 1,2mm K- wire. In group “B” (n=9) the animals were submitted to fixation of osteotomized tuberosity with a 2mm cortical screw and the dogs in group “C” (n=7) were submitted to the cerclage by n°2 steel surgical wire technique. The sample number had 23 transpositions and the same researcher carried out the surgical procedures and evaluations until 90 days after the interventions. The luxation degree in the operated limbs was bigger in “C” keeping the trend and the residual luxation presented a higher frequency in this group. The initial lameness scoring was bigger in groups “C” and “A” in comparison to group “B”; however, on day 10, the scores were bigger in “A” than in “C” and “B” had an intermediate score. Surgical time was different among the groups, lasting 13min46sec more to the animals in “C” in comparison to “B”. Joint amplitude in the groups was not influenced by the evaluation days where the means oscillated between  $138,76^{\circ} \pm 2,32^{\circ}$ , though the patients in “C” had a bigger amplitude regarding the others. The three techniques presented similar results considering the evaluated parameters, except for the residual luxation on the 90 day where “C” > “B” > “A”, and no bigger complications happened to justify a new surgical intervention.

**Keywords:** Articular amplitude. Canine. Orthopedic Surgery. Lameness. Knee.

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## 1 INTRODUÇÃO

Luxação medial de patela é uma condição bastante comum na rotina clínico-cirúrgica de cães, afetando particularmente os de pequeno porte, e causando desde pequeno desconforto durante a deambulação até graves alterações no alinhamento dos membros pélvicos, impedindo o suporte de peso (PETAZZONI et al., 2018; ROSSANESE et al., 2019). Dentre as diversas técnicas para redução da luxação patelar, a transposição da tuberosidade tibial (TTT) está entre as mais difundidas e que alcançam maior efetividade quando se busca o alinhamento do aparelho extensor (ALAM et al., 2007).

A evolução na engenharia de materiais, o refinamento das técnicas e a disponibilidade de meios mais modernos de diagnóstico por imagem em tempo real possibilitou o avanço no uso de novos implantes em ortopedia veterinária, tornando as técnicas mais seguras, rápidas e menos invasivas (GUERRERO e MONTAVON, 2009; HALL et al., 2018). Paralelo a isso, a possibilidade de usar outros implantes para fixar a tuberosidade tibial osteotomizada no novo leito exige atualização do cirurgião e investimento em novos materiais, sempre na busca de um método mais seguro e que resulte em menos complicações (NURMI et al., 2017).

Para a execução da TTT em cães, o acesso cirúrgico pode ser realizado através de abordagem lateral ao tendão patelar, e é recomendada sempre que há luxação patelar medial por possibilitar o acesso articular, preparação do leito de implantação da tuberosidade, imbricação da cápsula e retináculo lateral, inspeção dos ligamentos e dos meniscos (DREW, 2018). A osteotomia da tuberosidade tibial pode ser executada por serra óssea oscilatória, que permite cortes precisos em pouco tempo ou com auxílio de osteótomo delicado, com capacidade de controle do instrumental e sem risco de necrose óssea associada à alta temperatura da lâmina (KOWALESKY et al., 2017).

Dentre os métodos de fixação da tuberosidade tibial, o uso de pinos de Kirschner são os mais comumente descritos, associados ou não a fio de aço em banda de tensão. O índice de complicações relacionadas ao método é variado dentro da literatura, oscilando entre 13% e 45%, sendo que as principais complicações, das que requerem reintervenção, são a quebra do implante e fratura óssea da tíbia (ROSSANESE et al., 2019). A utilização desse método permite o uso de instrumentais ortopédicos básicos e baratos, além do próprio implante ter o custo reduzido (FAURON e PERRY, 2016).

O uso de parafuso cortical para fixar a tuberosidade tibial é descrito, porém os dados relacionados a recuperação plena dos pacientes ou mesmo fatores de risco e falhas na técnica são conflitantes. As complicações maiores associadas são a fratura do fragmento

osteotomizado durante a fixação e casos de relaxação (STANKE et al.,2014; FILLIQUIST et al.,2019), mas são escassas as pesquisas que trazem estudos com número suficiente de indivíduos. A compressão do fragmento durante a fixação por parafuso permite fechar a cunha da osteotomia, podendo acelerar o processo de consolidação. Outra vantagem é a capacidade de suportar grandes tensões no tendão patelar sem ocorrência de avulsão do implante (DAVIS et al.,2000).

A busca por um método de execução a baixo custo, capaz de promover compressão do fragmento osteotomizado e que não ocorresse a migração pós operatória do implante levou a estudos para a proposição da técnica de TTT em cães usando cerclagem com fio de aço<sup>1</sup>. O método consiste em transfixar dois orifícios na tuberosidade tibial e dois orifícios na crista da tibia, e passar através destes orifícios um fio de aço cirúrgico maleável- cerclagem, formando uma figura semelhante a um ponto de colchoeiro horizontal, ao passo que as duas pernas do fio são unidas por torção (BELLO, 2018). Um estudo de resistência mecânica mostrou que a força necessária para a avulsão da porção submetida a osteotomia é incrementada ao associar mais de uma cerclagem, mas sua viabilidade depende de estoque ósseo considerável na tuberosidade tibial (DAVIS et al., 2000), o que é dificultado quando a população compreende cães muito pequenos. Os dados relacionados a este método, no que diz respeito às complicações a longo prazo, são ainda incipientes e necessitam de mais investigação (BELLO, 2018).

A graduação do escore de claudicação se faz necessária para avaliar a resposta precoce ao tratamento nos pacientes, detectar potenciais complicações e ter um ponto de partida para a comparação nos grupos e entre eles, ainda que seja um julgamento subjetivo e dependente da experiência do examinador (RAMÍREZ-FLORES et al., 2017). Variadas são as escalas para classificar os graus de claudicação, e não há uma que seja padrão ouro para estimar o uso do membro ao apoiar, visto que claudicação é qualquer alteração no apoio normal do membro ao solo (ROUSH, 2001). A necessidade de escala que mostrasse com clareza os intervalos para cada grau de claudicação e fácil de aplicar, levou à modificação da tabela de claudicação de Tudury e Raiser (1985) e consequente adoção da nova escala (anexo A).

Os graus de luxação patelar medial estão associados com alterações na marcha e deformidades anatômicas relacionadas às estruturas que compõem o joelho, em seus variados níveis. Paralelo a isso, a invasividade do método ou associação de técnicas para redução da

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<sup>1</sup> Técnica de fixação executada na UFSM a partir de adaptação e demonstração pelo Prof. João E. W. Schossler

luxação aumenta conforme há um agravamento no escore de luxação inicial. Por outro lado, o prognóstico piora nos graus mais elevados (ROSSANESE, 2019). Por propiciar um julgamento claro dos graus de luxação e ser amplamente difundida, optou-se nesse estudo pela adoção da tabela descrita por Singleton (1969)- Anexo B.

A amplitude articular ao nível do joelho pode ser mensurada com o auxílio de goniômetro e serve como dado objetivo para a investigação de alterações biomecânicas nos aparelhos extensor e flexor. Luxações, distrofias, aderências e outras alterações podem modificar a amplitude normal de movimento da articulação femorotibiopatelar, que em cães é em torno de 140° (RENBERG,2001).

O estudo foi conduzido com o objetivo de comparar três métodos de fixação da tuberosidade tibial em cães submetidos a TTT. Dentre as variáveis avaliadas, coletou-se dados de tempo cirúrgico, amplitude articular, claudicação e luxação por até 90 dias após o procedimento. Tal necessidade se deve ao fato de serem escassas as publicações que incluem caninos tratados e avaliados pelo mesmo cirurgião, e que foram portanto submetidos às mesmas condições cirúrgicas e manejo pós operatório. Outrossim, ainda não há na literatura disponível a comparação entre o método de fixação por cerclagem com fio de aço como único implante com outros métodos amplamente testados e descritos para TTT em cães.

## 2 MANUSCRITO

Os resultados deste trabalho encontram-se na forma de manuscrito que será submetido ao periódico “Journal of Veterinary Science”. As normas para submissão ao periódico estão disponíveis no site: <https://vetsci.org>.

### **COMPARISON AMONG THREE TIBIAL TUBEROSITY FIXATION METHODS IN DOGS THAT UNDERWENT SURGERY TO REDUCE MEDIAL PATELLAR LUXATION**

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## ABSTRACT

The current study compared three different methods to perform the tibial tuberosity transposition technique (TTT) in patients with medial patellar luxation observing the luxation degree, lameness degree, the surgery time, articular amplitude and trans-operative and post-operative complications. 19 dogs from the surgical routine were selected and randomly divided in three groups. Patients in group A (n=7) were submitted to the tibial tuberosity fixation with two 1,2mm K- wires. The animals in B (n=9) were submitted to fixation of osteotomized tuberosity with a 2mm cortical screw and the dogs in C (n=7) were submitted to the cerclage by number 2 steel wire technique. The sample number consisted of 23 interventions and the same researcher performed evaluations and surgical procedures until the 90th day. Group B had the best results for surgical time, articular amplitude and lameness degree. Group A was the only one that did not present luxation in the operated limbs on day 90. Pain and lameness did not differ among the groups during the analyzed days; therefore, they presented positive correlation.

**Keywords:** Canine. Orthopedic Surgery. Lameness. Knee.

## INTRODUCTION

Regarding orthopedics, studies to reduce the failures related to implants and to refine operative techniques should be a constant search for the evolution of this area. Medial patellar luxation (MPL) in dogs is a relatively common alteration responsible for 95% to 98% of all luxation in small breeds, where 50 to 90% of the individuals have bilateral involvement [1, 2]. The complication rates after surgery to reduce MPL in dogs vary from 15 to 45%, without considering the degrees of luxation or techniques employed. The main complications reported are: recurrent patellar luxation, implant failure or migration, fracture and tibial tuberosity avulsion, rupture of the patellar ligament and fractures in the femur or tibia [2, 3].

Minor complications such as subclinical patellar luxation, patellar malalignment and skin irritation caused by implant pressure are even more common and usually do not require further surgical intervention [4].

Considering the techniques to reduce patellar dislocation in dogs, the transposition of the tibial tuberosity is effective, since it allows the alignment of the quadriceps femoris extensor mechanism [2, 5] and is less invasive than the corrective femoral osteotomy to treat the coxa vara [6].

TTT-associated procedures are required in more severe degrees of luxation, such as medial soft tissue release, femoral trochleoplasty and capsula and lateral retinaculum imbrication, allowing the patella to accommodate in the trochlear groove, improving the joint stability [7, 8].

Despite the scarcity of works comparing populations with MPL that underwent a TTT procedure with different methods for fixation of the tibial tuberosity by the same surgical team, the obtained results are variable and become conflicting in questions concerning trans and post-operative complications, viability of methods and functional recovery of the operated limb. Considering this, the present study aimed to compare the degrees of luxation, pain, lameness score, articular amplitude, complications and time of surgery in a population of dogs submitted to TTT and divided in three different groups. The animals were treated for the tibial tuberosity fixation according to the type of implant used, and they were operated and evaluated by the same surgeon.

## **MATERIAL AND METHODS**

This prospective study had 19 dogs presenting medial patellar luxation, aging from 10 months to 13 years old (media 5.5 years;  $p=0,02$ ) and weighing from 1,2 kg to 9,6 kg (media 4.56kg;  $p= 0,09$ ). The most prevalent breeds were Yorkshire Terrier ( $n=5$ ), Shih Tzu ( $n=3$ ), Poodle ( $n=1$ ), Pug ( $n=1$ ) and mixed breed ( $n= 9$ ). The tutors sign a consent term and the study followed the ethical standards of the research institution (1486100719). It was carried out the clinical exam, blood test and x-ray of the pelvic limbs. Dogs with chronic diseases or under treatment, with orthopedic diseases or concomitant neurologic diseases were excluded. The patients were admitted on the day of surgery and placed in individual boxes. They followed 12 hours of fasting for solid food and 8 hours for water. The surgical procedure was performed under general anesthesia (Morphine 0.3mg/kg IM; Propofol 4mg/kg IV; Diazepam 0.3 mg/kg IV; Isoflurane 1.5 CAM vaporized in 100% oxygen in a circuit with partial rebreathing) associated to epidural block (Lidocaine 5mg/kg plus morphine 0.1mg/kg). The



division in three groups was randomly made: Group A (n=7) animals were submitted to the tibial tuberosity fixation with two 1,2mm K- wires; group B (n=9) the animals were submitted to fixation of osteotomized tuberosity with a 2mm cortical screw and the dogs in group C (n=7) were submitted to the cerclage by n° 2 steel wire technique, a total of 23 luxation cases treated. The exclusion criteria observed in this study were dogs with cruciate ligament tear (n=2), absence of postoperative revisions (n=2) and concomitant neurological disorder (n=1).

### **Surgical Procedures**

The patients were placed in dorsal recumbency and the limb was disinfected with 4% chlorhexidine gluconate and 0.5% chlorhexidine alcoholic solution. Distal structures to the tibia were protected with sterile bandage. All surgical procedures were performed by the same surgeon. Through lateral parapatellar incision it was exposed the subcutaneous tissue, *fascia lata* and the knee articular capsule (Fig.1A). The arthrotomy was performed through incision, which was expanded with the use of scissors. It was checked the articular surfaces, cranial and caudal cruciate ligament and menisci of the stifle joint. With osteotome and cone-shaped rasp, the femur trochlear groove was deepened to rightly accommodate the patella. The patients with luxation of degree IV had their retinaculum and medial articular capsule released. In sequence, it was performed the tibial tuberosity osteotomy until the third distal with 8mm osteotome followed by the lateral transposition of the same (Fig. 1B). The lateral transposition of the tibial tuberosity was considered enough to reduce the luxation of degree I with aligned limb, which was carried out by the surgeon visually checking (Fig. 1C).

Regarding the tibial tuberosity fixation method in group A, using two 1,2mm K-wire, the implants were introduced in the craniocaudal direction until the trocar-point broke out the cortical caudal. In all cases, it was searched for the insertion of the first K-wire to the level of the tibial tuberosity and perpendicular to the tibia anatomical axis, and the second distally to the first K-wire in horizontal plan and lateromedial in frontal plan. In the end, it was incurved the pin's cranial extremity to avoid implant migration (Figure 2A).

In group B, it was made just one craniocaudal hole in the tibial tuberosity with a 1,5mm K-wire and electric drill, and then it was measured the deepness of the bone tunnel and a 2mm cortical leg screw was inserted to compress the tibial tuberosity in its new place(Figure 2B).

The fixation method in C was through two tunnels in the tibial osteotomized portion with a 1.2mm K-wire, being the proximal in the tibial tuberosity and the other 5 to 7 mm

distal to the first. Two coincident tunnels in tibial caniolateral part was drilled. Through them, it was inserted a surgical steel wire (316-L number 2) and the extremities were twisted until the necessary tension to compress the fragment was reached (Figure 2C).

After fixing the tibial tuberosity through the implants selected to each group, it was performed the articular washing with 0.9% sterile physiological solution under pressure and lateral imbrication of the joint capsule and retinaculum with polyglactin 2-0 in isolated horizontal mattress. Subcutaneous tissue was reduced with polyglactin 3-0 in simple isolated pattern and the dermorrhaphy with nylon 4-0 in simple isolated pattern. Post-operative x-rays in orthogonal positioning were obtained to verify the positioning of the implants.

### **Post-operative evaluations**

The dogs were pre and post-operative revised where it was checked their march to classify the lameness score and the orthopedic exam to assess the degree of luxation according to the Singleton system. The articular amplitude was measured at femorotibiopatellar joint level applying a goniometer. Evaluations were carried out on days 0 (before the surgery), 10, 45 and 90 after the TTT surgery. X-rays were made on lateral and craniocaudal incidences, projecting the coxofemoral joint to tarsal and with the collimator centralized on the knee on days 0, 45 and 90. After the procedure and anesthetic recovery, the patients were released and received a drug prescription (Carprofen 4 mg/kg PO, Tramadol 4 mg/kg PO, Cephalexin 25 mg/kg PO and Dipyron 25 mg/kg PO according to frequency and duration of usual treatment) and surgical wound cares. On day 10, the skin sutures were removed. After verifying and judging all aspects, the researcher registered the data in a table.

### **Statistical analysis**

After normality test (*Shapiro-Wilk*), data was submitted to analysis of variance. Regarding the time of surgery, the statistical analysis, using the SAS® MIXED procedure, version 9.4., considered the groups (A, B, C) as a fixed effect, the patients and the residue as random effects. To other variables, the statistical analysis considered the groups, the evaluation days (0, 10, 45 and 90) and the interaction, group x days, as fixed effects and patients and residue as random effects using the SAS® MIXED procedure, version 9.4.

The dogs' age in the beginning of the study was included as a co-variable. For the variables in repeated measure according to time, the structure selection test using the *Bayesian information criterion* (BIC) was performed.

When differences were observed, the means were compared using the *lsmeans* resource and the interactions were deployed when significant at 5% of probability.

Frequency analysis (FREQ procedure) and the probability of occurrence (GLIMMIX procedure) were performed to the variables of class (claudication score, pain and degree of luxation). It was adopted the probability limit values of 5% to significance and 10% to tendency.

## RESULTS

Time for surgery was different ( $P=0.04$ ) among the groups, group C took 24% more time in comparison to group B. Group A had an intermediate time, not differing from the other groups (Table 1).

The interaction groups x days was not significant to the variables weight ( $P=0.09$ ), articular amplitude ( $P=0.05$ ) and degree of luxation ( $P=0.08$ ) in the operated limbs. There was a higher articular amplitude trend ( $0.05 < P < 0.10$ ) considering the dogs in group C in comparison to the ones in group A, and the patients in group B presented an intermediate amplitude. A reduction in the articular amplitude was noticed in all groups, when the means on day 0 and 90 were compared. The degree of luxation in the operated limbs was bigger ( $0.05 < P < 0.10$ ) in group C in relation to other tested groups and was different on the evaluation days, being 6 times higher on day 0 in comparison to other evaluation days. Such trend was kept; despite the decreasing in the score over the days, group B had the highest score on day 90 (Table 2). Group A was the only one that did not present luxation in the end of the evaluation period.

There was an interaction among the groups and evaluation days regarding the variable lameness score in the operated limbs ( $P=0.04$ ). On day 0, the animals in A and C presented a higher lameness score in the operated limbs in comparison to the animals in B. On day 10, the score was higher in group A than in C. On day 90, the patients in B presented a better score (Fig. 3).

Considering the evaluations of non-operated limbs, the animals in C presented the highest scores of luxation and pain, but they had the lowest lameness scores. The lameness, pain and luxation scores of non-operated limbs were not influenced by the evaluation days; however, they increased on days 10 and 45 when compared to day 0. On the 90-evaluation day, the scores decreased again. Tibial tuberosity fracture was observed in one case in group

B (11.1%). Patellar desmitis was observed in one case in group B (11,1%) and other in C (14,29%). There was no need for a new surgery in any case.

## DISCUSSION

The results show that TTT is an effective procedure to reduce the medial patellar luxation in small dogs being in agreement with previous studies [2, 4, 9]. The occurrence of major complications justifying a new surgical procedure, reported in previous publications concerning the TTT technique, was not observed in this population during the evaluation time in our study. [2, 5, 10]. The time of surgery ranged from 55min43sec to 68min76sec (media 61min; P= 0,04) showing no difference from other studies in which this variable was included [4, 9]. The method of fixation by cerclage with steel wire (group C) was longer because of the number of required surgical procedures when compared to the other two methods.

The articular amplitude in the operated limbs presented, in an overview, a reduction of  $4.65^\circ$  between the pre-surgery evaluation and day 10. The biggest difference was observed in group B ( $10.7^\circ$ ). The reduction of patellar luxation and soft tissue procedures contribute to the joint amplitude reduction, making the limb flexion arch smaller because of the previous contracture in the extensor muscles and the joint healing, respectively[11, 12]. There were no significant changes in groups A and C when the amplitudes were compared on day 0 and 90. Regarding B, the evaluations showed an amplitude of  $140^\circ$  for the operated limbs and  $139.75^\circ$  for the non-operated limbs on day 90, representing the closest values for the species physiology [13] what can be associated to lower degrees of luxation on day 0 in B when compared to A and C.

Patients demonstrated a gradual reduction in pain scores throughout the assessments. Although the AINEs post-operative prescription is able to reduce the undesirable effects of orthopedic surgery such as inflammation and local pain [14], the joint stabilization associated to the procedure contributes to nociceptive stimuli reduction [15, 16] what can be observed after 10 days of surgery. The pain scores similarity among the groups allows us to infer that none of the tested method was much more aggressive than the others to the tissues. The pain evaluation was performed by the same researcher who knew the TTT method used.

Causes for the occurrence of patellar re-luxation following TTT may be linked to insufficient lateral translation of the osteotomized fragment, severe angular deformities in the

femur and tibia or deficiencies related to associated procedures such as insufficient trocheoplasty and the non-release of the medial retinaculum [17]. The need for sufficient bone stock in the tibial tuberosity for steel wire positioning, together with the worst degrees of luxation on day 0, may have contributed to the fact that 57% of the patients in group C presented medial luxation of degree I on day 90. It is currently recommended to treat subclinical luxation (degree I) conservatively [9, 12], representing a smaller surgical complication.

The lameness score in group B decreased in a constant way from day 10 on, while groups A and C showed oscillations. When the experiment finished, C and A had the worst scores considering this variable. The capacity to compress the tibial tuberosity in the new place increases the fragment stability and the avulsion resistance [18] what may have contributed to better results in B. Considering the non-operated and operated limbs, on day 90 the lameness score was smaller in the limbs submitted to TTT than in the non-operated ones (in patients with bilateral patellar luxation). This reassures the recovery of limbs under treatment, differing from the non-operated limbs that in most cases had different MPL degrees. The best lameness score was observed in operated members on day 90 because of the necessary time for healing and regeneration of articular and bone structures [16, 19].

The patellar desmitis is a complication associated to the positioning of the osteotomy fixation implant, on or adjacent, to the patellar ligament and may need to be removed in cases that do not respond to conservative treatment [7, 9]. In this study, the patellar desmitis was diagnosed from the 45 day through patellar ligament ultrasound exam. The chance for a tibial tuberosity fracture or fragmentation is bigger in cases where the dimensions of the osteotomized portion are small due to the excessive compression or the use of multiple implants with reduced diameter [12] and because of the reduced bone density as it happens in puppies [10].

The three fixation methods proved to be safe and feasible without major complications. The fixation with the 2mm cortical compressive screw showed to be the fastest method, able to promote the joint amplitude recovering to great levels in a period of 90 days and it had the best lameness scores as well, becoming the recommended method for adult patients.

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### CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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## TABLES

**Table 1** – Means for surgical time according to the tested groups.

Variables	Group			EPM	P
	A	B	C		
Time of surgery (min)	60.30ab	55.43b	68.76a	3.49	0.04

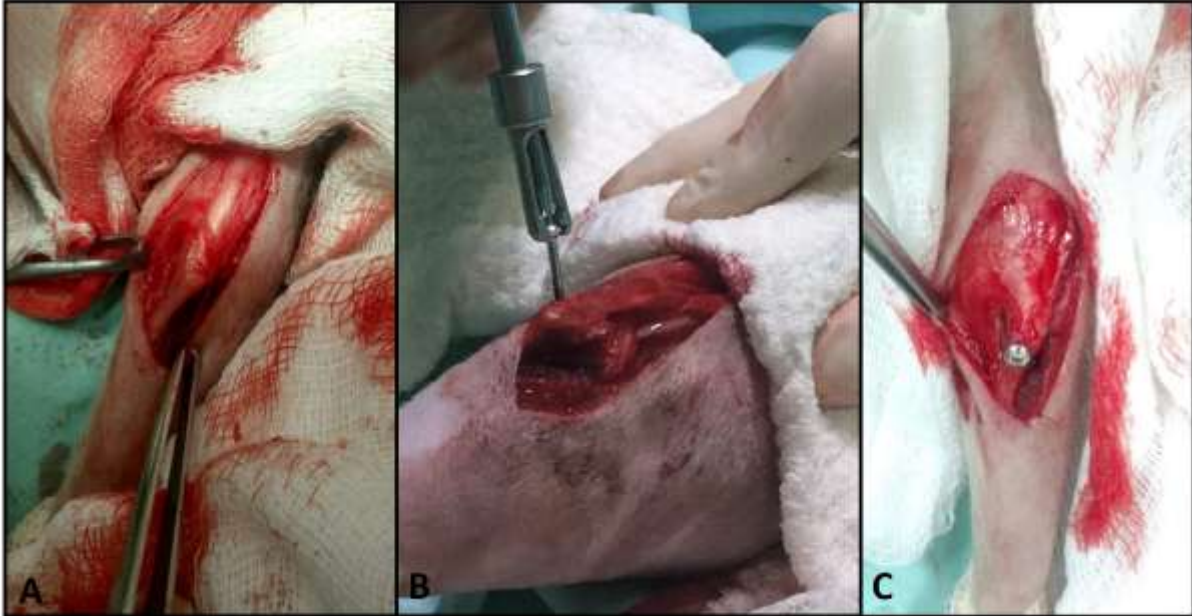
EPM = Mean pattern error; P = Probability.

**Table** – Means for variables of limbs operated according to groups and days tested.

Variables	Group			Days				EPM	Probabilities		
	A	B	C	0	10	45	90		Group	Days	G*D
Weight (kg)	4.32a	4.97a	2.59b	4.04	3.8	3.9	4.09	0.63	<0.01	0.94	0.99
Articular											
amplitude	135.84b	138.26ab	141.01a	140.69	136.04	137.84	138.93	1.57	0.06	0.25	0.52
Lameness	2.17	1.88	2.25	3.16	2.81	1.79	0.63	0.17	0.09	<0.01	0.04
Degree of											
luxation	0.81b	0.89b	1.1a	3.21 <sup>a</sup>	0.04b	0.26b	0.22b	0.1	0.05	<0.01	0.82

EPM = Mean pattern error; G\*D = interaction group versus days.

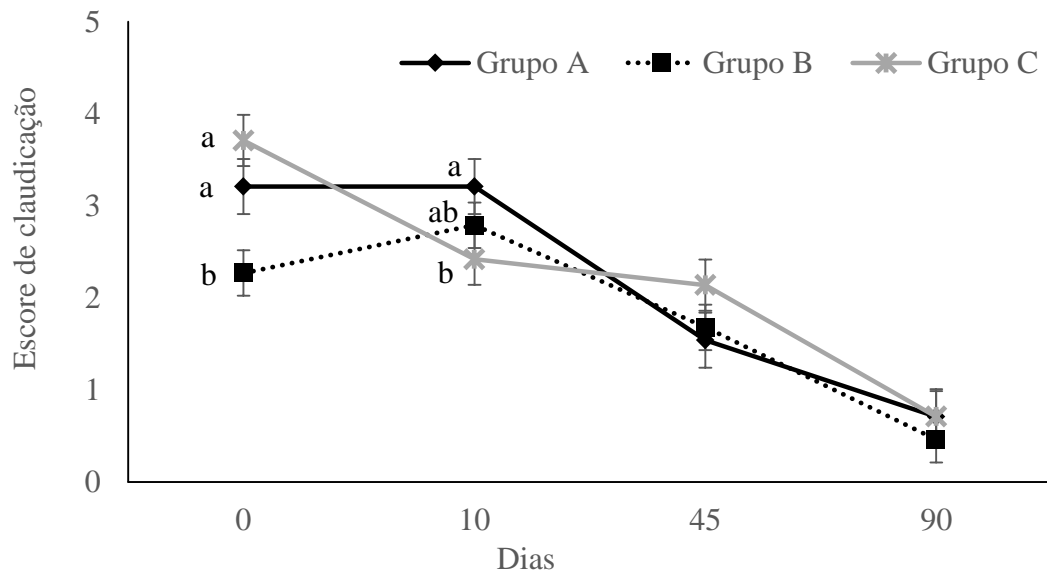
## FIGURES



**Fig.1.** Transoperative view of the TTT surgery. A- parapatellar approach and patellar ligament exposure. B- insertion of a screw through the tibial tuberosity for attachment to the new place. C- Appearance at the end of surgical fixation.



**Fig.2.** 45 days after surgery appearance of tibial tuberosity fixation. A- fixation with two K-wires method. B- fixation with 2mm cortical compressive screw. Partial consolidation of tibial tuberosity fracture (arrow). C- fixation with surgical steel wire.



**Fig.3.** Lameness score of operated limbs according to the groups and days evaluated. Patients in group B presented linear regression for the measured variable after the 10th day. □

### **3 CONCLUSÃO**

A transposição da tuberosidade tibial é uma técnica efetiva para redução da luxação patelar medial em cães pequenos. A evolução positiva nos escores de claudicação sugere que membros operados, independente do método de fixação da tuberosidade tibial, experimentam melhora no uso funcional e apoio. Pacientes com luxação patelar bilateral apresentam piora nos escores de luxação e claudicação do membro não operado até 45 dias após o procedimento. Sugere-se a utilização de um parafuso cortical 2 mm como único implante para a fixação da TTT em cães adultos por ser método de execução mais rápida, cursar com melhor amplitude articular e menor grau de claudicação aos 90 dias. São necessários mais estudos e avaliação a longo prazo para determinar o método de fixação mais seguro e que curse com menos complicações.

## ANEXOS

**Anexo A:** Tabela modificada a partir da original de Tudury e Raiser (1985), em que consta a graduação dos escores de claudicação em caninos a partir da inspeção visual da marcha.

Grau 1	Inconsistente, pode passar despercebida, se torna moderada se o examinador estender/flexionar o membro imediatamente antes do exame;
Grau 2	Difícil de observar ao passo, mas pode ser exacerbada ao aumentar a velocidade da marcha ou conduzir em círculos;
Grau 3	Claudicação consistente, em círculos e também em linha reta, porém ainda há apoio do membro;
Grau 4	Claudicação óbvia, geralmente faz apoio do membro, balança a cabeça verticalmente, diferença de tempos nas fases de apoio/ suspensão;
Grau 5	Não tolera apoio de peso sobre o membro.

**Anexo B:** Escala adaptada de Singleton WB (1969) para graduação de luxação patelar medial em cães. Tabela amplamente utilizada e difundida para caracterizar a luxação ao exame clínico dentro de cada intervalo.

Grau 1	Patela pode ser luxada medialmente aplicando pressão lateral e com o membro completamente estendido, patela retorna ao sulco troclear ao cessar a pressão;
Grau 2	Luxação e redução espontâneas, claudicação esporádica e pequena rotação interna da tíbia;
Grau 3	Patela permanentemente luxada mas pode ser reduzida manualmente, severa rotação interna da tíbia e <i>genu varum</i> na porção distal do fêmur;
Grau 4	Luxação patelar permanente e não redutível, rotação interna da tíbia de 60° a 90° em relação ao plano sagital.

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