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QUALITATIVE EVALUATION OF THE MEDIAL ROTATION OF THE PROXIMAL TIBIA AFTER HIP LUXATION ATTEMPT TO PROVE THE INFLUENCE OF THE POSITIONING OF THE COXOFEMORAL JOINT IN THE ETIOPATHOGENY OF MEDIAL PATELLAR LUXATION IN DOGS

(AVALIAÇÃO QUALITATIVA DA ROTAÇÃO MEDIAL DA TÍBIA PROXIMAL APÓS LUXAÇÃO COXOFEMORAL. UMA TENTATIVA DE PROVAR A INFLUÊNCIA DO POSICIONAMENTO DA ARTICULAÇÃO COXOFEMORAL NA ETIOPATOGENIA DE LUXAÇÕES MEDIAIS DE PATELA EM CÃES)

Diego Manoel Da Silva[1], Danielli Aparecida Lavelli[2], Fabio Rodrigo Castro Barros[1], Marjory Garcia de Oliveira[3], Guilherme Camargo Gallo[4*], Gabriela Maria Benedetti Vasques[5], Leonardo Martins Leal[6]

[1] Desenvolvedor da Pesquisa. Médico Veterinário, Centro Universitário Ingá - Uningá, Departamento de Medicina Veterinária, Maringá, Paraná, Brasil.
[2] Desenvolvedora da Pesquisa. Médica Veterinária, Centro Universitário Ingá - Uningá, Departamento de Medicina Veterinária, Maringá, Paraná, Brasil.
[3] Revisora Gramatical. Médica Veterinária com aprimoramento em Clínica Medica pelo Centro Universitário Ingá - Uningá, Departamento de Medicina Veterinária, Maringá, Paraná, Brasil.
[4] Desenvolvedor de Pesquisa. Graduando de Medicina Veterinária pelo Centro Universitário - Uningá, Departamento de Medicina Veterinária, Maringá, Paraná, Brasil.
[5] Revisora Técnica e Coorientadora do projeto que deu origem ao artigo. Docente, Centro Universitário Ingá - Uningá, Departamento de Medicina Veterinária, Maringá, Paraná, Brasil.
[6] Idealizador e Orientador do Projeto que deu origem ao artigo. Docente, Centro Universitário Ingá - Uningá, Departamento de Medicina Veterinária, Maringá, Paraná, Brasil.
*Corresponding author: gcamargogallo@gmail.comDOI:
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ABSTRACT

The objective was to evaluate the degree of medial tibial rotation after hip luxation to prove the influence of the position of the hip joint on the etiopathogenesis of medial patellar luxation in dogs. Qualitative analyzes were performed on ten dog cadavers. The observation of medial rotation and loosening of the ligament was perfomed by clinical analyzes through knee flexion and extension with slight medial rotation, mimicking the anatomical movement of the knee when the animal touches the ground. The same analyzes were performed with the luxated hip joint in the craniodorsally and caudoventrally position. There was a great difference in the looseness of the patellar ligament, especially in limb hyperextension, when there was dislocation of the hip. When compared to the normal tension of the patellar ligament, there was greater laxity of the patellar ligament when the femur was craniodorsally dislocated and slight

laxity of the patellar ligament when the femur was dislocated caudoventrally. As for the internal rotation of the tibia, during the knee flexion and extension movement, also in comparison with the preserved hip joint, there was greater medial rotation of the tibia in the craniodorsally dislocation of the femur and little medial rotation of the tibia in the caudoventrally dislocation of the femur. It is concluded that the poor conformation of the hip joint directly influences the tension of the quadriceps muscle and consequently in the patellar ligament, favoring the internal rotation of the proximal tibia, acting as a possible predisposing factor for medial patellar dislocations.
Keywords: valgus thigh; varus thigh; valgus knee; varus knee; orthopedics.

INTRODUCTION

The medial patellar luxation, characterized by the medial dislocation of the patella from the trochlear groove of the femur, is a common orthopedic injury in the surgical clinical routine, especially in small dogs, in a genetic way. Luxation degree varies from I to IV, according to the seriousness and intensity of the clinical signs and orthopedic alterations (SOUZA et al., 2009; MORAES and CRIVILLENT, 2012; FOSSUM, 2013).

The cause for the patellar luxation is not fully understood, however some studies hypothetically suggest that the varus thigh and a decreased angle of anteversion of the femoral neck could cause a dislocation of the femoral quadriceps muscle group. This muscle dislocation results in abnormal forces in the distal femoral physis, slowing down growth on the medial side, resulting in a varus distal femur and internal tibial rotation (TOBIAS and JOHNSTON, 2012). This theory, however, has been questioned, for the valgus thigh was also identified as a significant risk factor to the medial luxation of the patella in small dogs (BOUND et al., 2009).

In clinical practice, by observing dogs suffering from traumatic luxation of the hip joint, it is notorious that these patients present a medial rotational instability of the tibia; and after the repositioning of the luxation, a good indirect knee stability is immediately observed. In this manner, we strongly believe in the correlation of the bad hip joint positioning as a pre-existing factor for the patellar luxation development.

Patellar luxation treatment varies according to the degree of the dislocation, the animal's characteristics, such as race, age, weight, and musculoskeletal disorders developed. Trochleoplasty, lateral imbrication, release of the medial retinaculum, tibia crest transposition, anti-rotational suture and wedge osteotomies of the distal femur are commonly performed (FOSSUM, 2013).

To this end, for the great frequency of patella luxation in small animals routine, for the etiologic indefiniteness and due to the need for its understanding, for a better clinical surgical conduct, the objective of this report was to evaluate the degree of the tibia medial rotation after a hip joint luxation, in the attempt to prove the influence of the hip joint positioning in the etiopathogenesis of the medial patella luxation in dogs.

MATERIAL AND METHODS

The Ethics Committee in Animal Use - CEUA, of the Inga University Center – Uninga, in a meeting on February 22, 2019, approved the ethical procedures presented is this report, under protocol number: PM 63/2019.

The following dogs were used: 10 dog cadavers (five males and five females), age varying from one to 15 years old, weighing five to 25 kilograms of bodyweight; without history of locomotor diseases. The cadavers were from patients that diseased from natural causes or euthanized for different diseases. No animal was euthanized for this report. The cadavers used were from natural deaths of dogs in the routine of the Uninga Veterinary Clinic.

Initially, the animals were evaluated according to their conformation. No chondrodystrophic breeds were selected for the experiment. Two chondrodystrophic cadavers were disposed and two others were included.

Five cadavers were forwarded to the experimentation right after their death. Other five were frozen in a -20° freezer, due to the unavailability of the experiment right away. The bodies were thawed afterwards, in a tub of water, to be used later in the experiment.

The left and right knees were shaved, and a straight skin incision was made between the patella and the tibia crest with a scalpel and a 24 blade for better viewing of the medial tibial rotation during the evaluations.

A dot was made in the proximal region of the tibia crest, and another one in the central patella region with a marking pen to facilitate the identification of the degree of medial rotation of the tibia, as well as the looseness of the patellar ligament (Fig. 1).

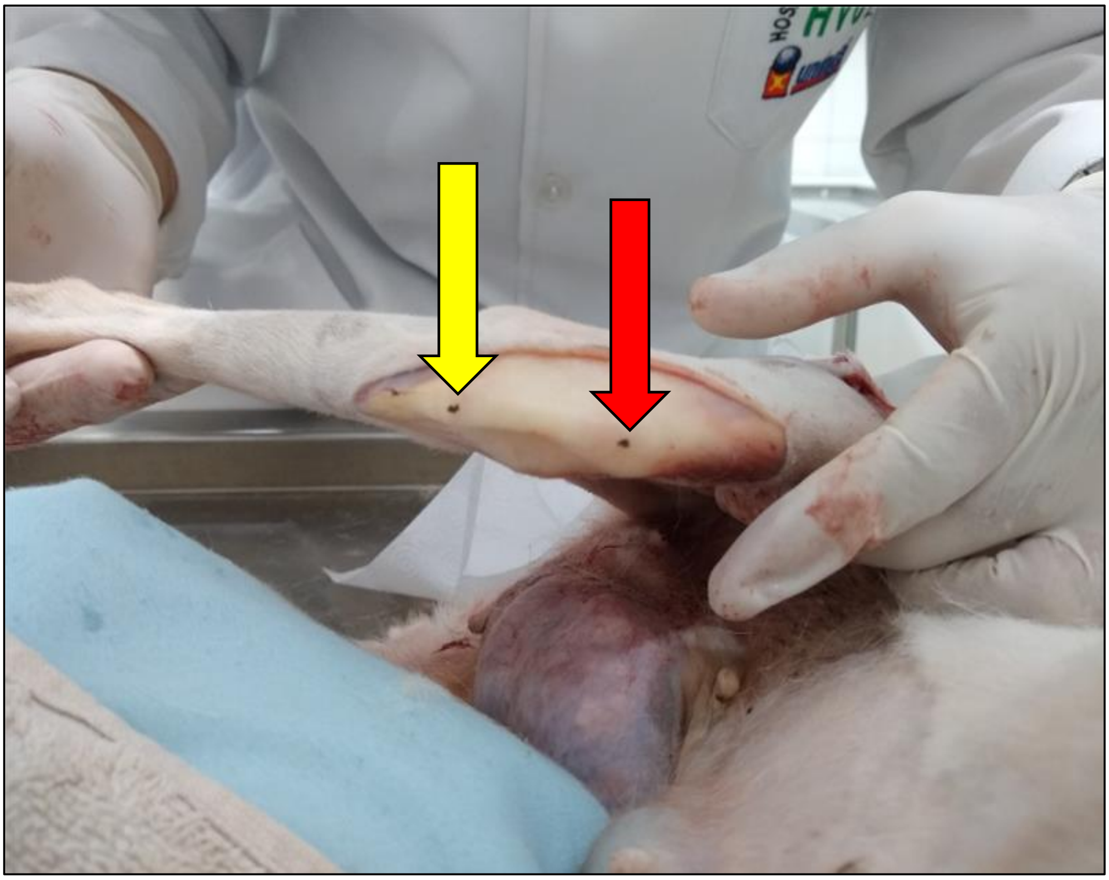

Figure 1. Photographic imaging of the skin incision at the knee region and marking of the dots on the tibial crest (yellow arrow) and on the patella (red arrow).

With the hip joint in the anatomic position, a direct observation of the medial rotation and the looseness of the ligament through the flexing and extending of the knee with a light medial rotation was performed, mimicking the anatomic movement of the knee when the animal touches the ground (Fig. 2).

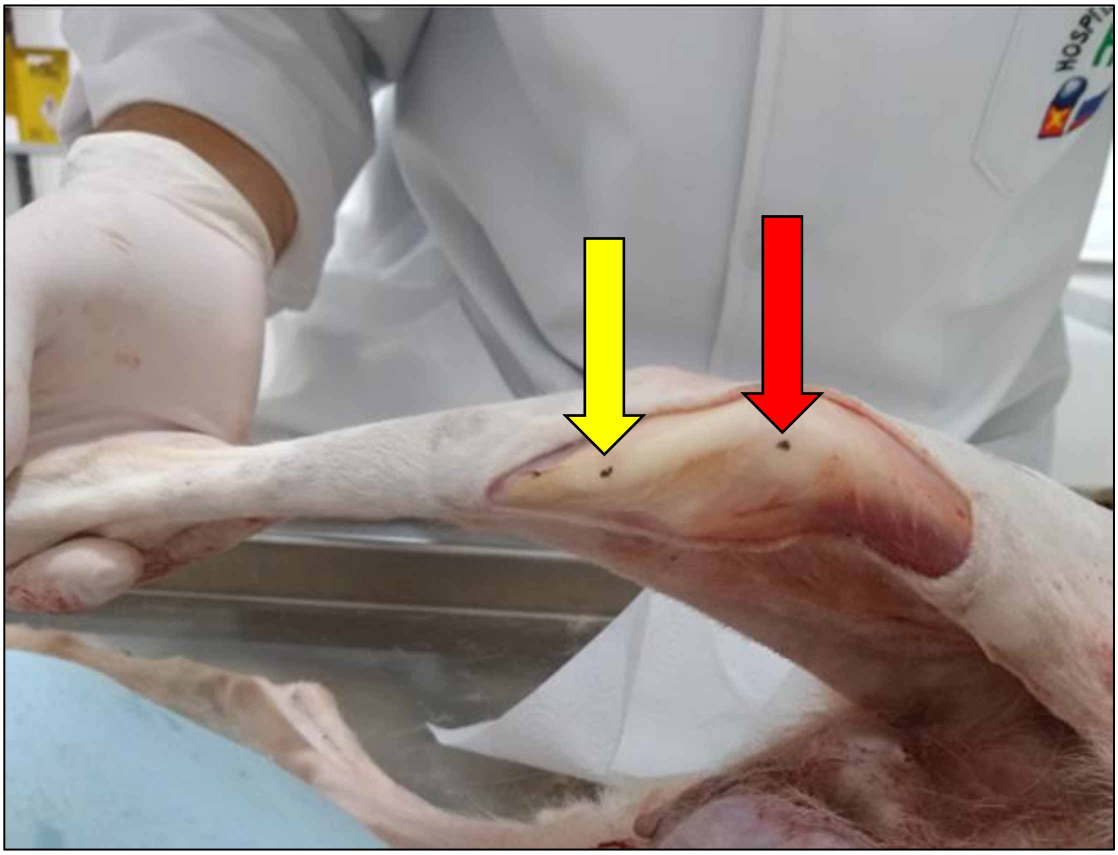

Figure 2. Photographic imaging of the flexed knee with light medial rotation of the tibia mimicking the patient support to the ground. Dots: tibia crest (yellow arrow) and the patella (red arrow)

The same analysis was performed with the luxated hip joint in the dorsocranial and tailventral positions. In order to dislocate the joint, a medial access of the hip joint was made, caudally to the pectineus muscle, in way to preserve all the muscle of the area, especially the gluteus muscles and the quadriceps femoris muscles. The entire joint capsule was cut with a scalp and 24 blade, as for the femur head ligament, it was sectioned with the blunt curved scissors. After capsule and ligament rupture, the femur was manually dislocated towards the craniodorsal and caudoventral directions, and x rays were taken to certify these positions (Fig. 3.).

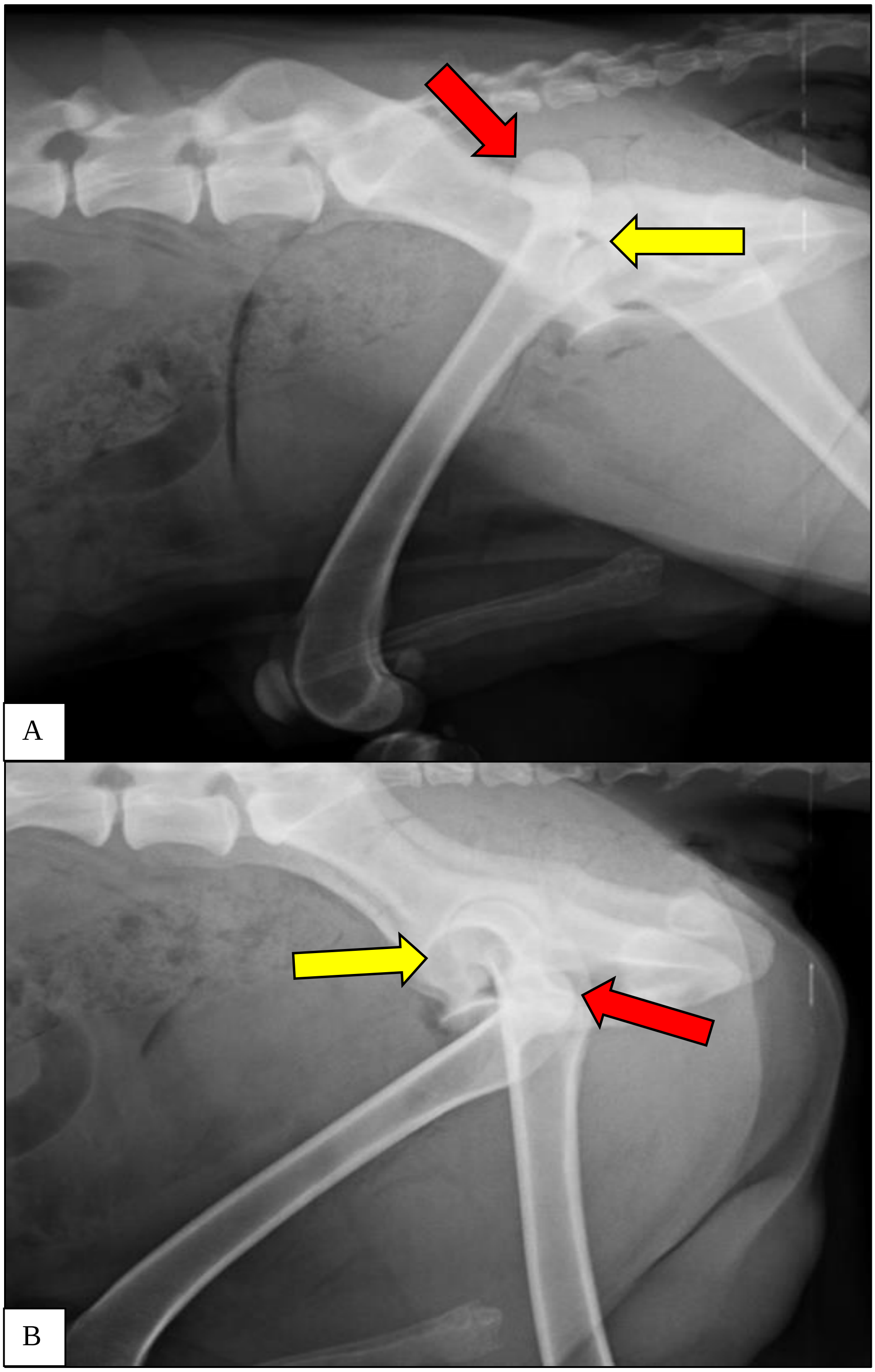

Figure 3. Radiographic images of the lateral projection of the dislocated right hip joint in the craniodorsal direction (A) and caudoventral direction (B). Notice the empty acetabulum (yellow arrow) and the dislocated femur head (red arrow).

Previously and afterwards each dislocation (dorsocranial and caudoventral), a loosening of the kneecap ligament was observed, in neutral, extended, flexed, of the limb. Moreover, an internal rotation of the tibia was observed, for the major or minor alignment of the kneecap and the tibia crest that were marked with the dots, while making flexion and extension movements of the knee.

The technique was applied to both pelvic limbs in all the 10 cadavers assessed in the experiment by the same surgeon. The same surgeon evaluated the cadavers qualitatively. Photos and videos were recorded for documentation.

RESULTS

In all cadavers researched, there were no differences in the evaluations as far as the pelvic limb, right or left, size, sex and age of the animal was considered. Regardless of the size, sex and age of the dog, all the results were similar when comparing these characteristics.

In the fresh cadavers, it is possible to observe a higher tension of the muscle when compared to the thawed ones. However, the results were proportional as the patellar ligament looseness and the internal rotation of the tibia in relation to the hip position.

In all animals studied, a great difference was observed regarding the looseness of the patellar ligament, especially in the hyperextension of the limb when the hip was dislocated. When comparing to the normal tension of the patellar ligament (non-dislocated femur), there was a greater loosening of the patellar ligament when the femur was craniodorsally luxated and a light loosening of that ligament when the femur was luxated caudoventrally in all the animals of the study.

As for the internal rotation of the tibia during the flexion and extension of the knee in contrast to the preserved hip joint, it was observed that in all animals a greater medial tibia rotation in the craniodorsal luxation, and less medial tibia rotation in the caudoventral luxation of the femur (Fig. 4).

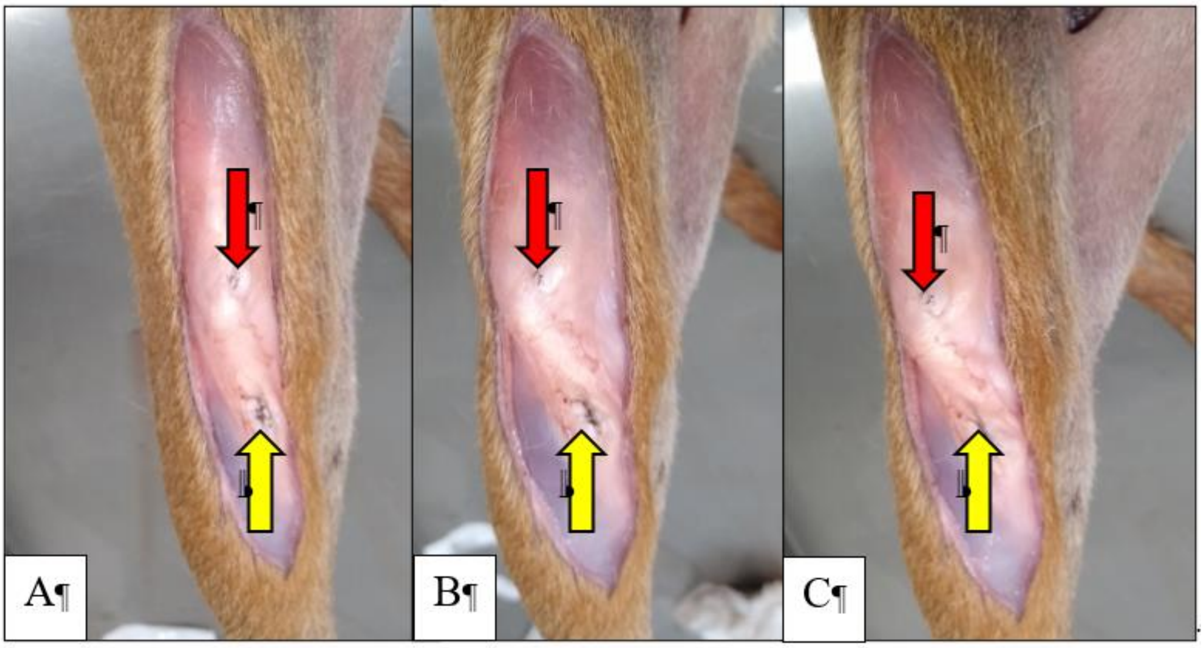

Figure 4. Photographic images of the knee in neutral position with internal rotation of the paw, mimicking the ground support, with a preserved hip joint (A), luxated caudoventrally (B) and luxated craniodorsally (C). Notice the internal rotation of the tibia crest (yellow arrow) regarding the kneecap (red arrow).

DISCUSSION

Regardless the pelvic member assessed, no differences were observed in the loosening of the patellar ligament or internal rotation of the tibia between the right and left knees. Due to the selecting of healthy subjects being a criteria to this study, there were no previous orthopedic alterations, so the anatomic conformation was similar in both legs, thus showing the same results during experimentation (ROUSH, 1992; DYCE et al., 2010; KONIG and LIEBICH, 2016).

Even though patellar luxation is a frequent disease among small dogs, and thigh-hip joint malformation is often seen on heavier dogs, as a hereditary defect (FOSSUM, 2013; TOBIAS and JOHNSTON, 2012), we believe that the animal's weight is also a factor to the origin of hip and knee diseases, as observed by other authors (SOUZA et al., 2009; FOSSUM, 2013; TOBIAS and JOHNSTON, 2012). In this "in vitro" study, regardless the weight of the animal assessed, results surrounding the loosening of the patellar ligament and internal rotation were similar; showing that damages to the knee and hip joint come with both time and repeated movements from day-to-day routine.

In larger dogs, the higher weight demands greater use of the hip joint causing forming alterations (such as valgus thigh and hip dysplasia), that may predispose the acetabular flattening and femoral head subluxation, leading to pain and possibly a degenerative articular disease (DAD) in the future (DECAMP et al., 2016). However, patella luxation is rare in large animals (SOUZA et al., 2009). On most small breeds, the opposite is true, as the hip joint is less worn due to the weight of the animal and reduced thigh muscle mass, the patellar ligament certainly stabilizes the knee less, leading to constant tibia rotations with repeated movements of flexion and extension of the knee during locomotion. In this way, even with similar results in large and small dogs in our work, we believe that the origin of the patellar luxation is related to the small size of the dogs.

Although is known that body tissues, such as muscles, change postmortem and freezing (PARDI et al., 1993), we believe that this study was not significantly affected by these alterations, for it was a comparative study in which all cadavers, frozen or fresh, were submitted to the same evaluation procedures: the knee with a dislocated and non-dislocated hip joint. The last one is considered a control group, due to the fact that the tests were also executed with the hip joint in the anatomic position, annulling the muscle tension.

None of the cadavers assessed presented patellar dislocation, even with a dislocated hip joint in craniodorsal position (which led to greater rotational knee instability). We believe that this fact occurred, due to using only adult animals without orthopedic alterations in which the patellar groove was well formed, and the femur and tibia bone axis were in perfect alignment. In pups, due to greater articular looseness and bone growing, the patellar groove flattens because of the lack of friction, causing angular and rotational alterations on the tibia and femur, dislocating the patella in different degrees (TOBIAS and JOHNSTON, 2012; PÊREZ and LAFUENTE, 2014).

We did not observe differences regarding sexual predisposition on the origin of the medial dislocations of the patella. However, literature describes a tendency to dislocation in females 1.5 times more than males (ROUSH, 1992).

The patella is an ossification of the insertion tendon of the quadriceps femoral muscle that works along with the femoral trochlea to redirect the line of action of the femoral quadriceps, which is very similar to a pulley redirecting a cable allowing a bending movement of the articulation (TOBIAS and JOHNSTON, 2012; KONIG and LIEBICH, 2016; PÊREZ and LAFUENTE, 2014). In this way, during the extension of the knee, there is naturally lesser contact between the patella and the femoral trochlea, explaining the loosening of the patellar ligament during the hyperextension of the pelvic member, regardless the hip articulation. Moreover, the hyperextended tarsus also decreases the patellar ligament tension, for it releases the tension that the gastrocnemius imposes over the cranial advancement of the tibia when the tarsus is flexed (NUNAMAKER, 1973).

In this study, it was observed that the dislocated hip joint in the cranialdorsal direction provided a form of the member similar to animals possessing a varus thigh, that is, the knee was in *genu varum* (SOUZA et al., 2009) and the tibia presented a great internal rotation during the normal knee movement simulation when compared to the tibia rotation with the hip joint in the anatomic position. As for the caudoventral dislocation, it is observable that the member acquired a valgus thigh forming, the knee was in *genu valgum* and there was a smaller rotation of the tibia when compared to the same evaluation in cadavers with cranialdorsal dislocation, although when it comes to a normal hip joint, the internal rotation was more significant.

The patella is formed by the tendon of the triceps femoris muscles. Of these muscles, the rectum femoris is the only muscle of the quadriceps femoris that origins away from the femur; its origin is in the ilium, cranially to the acetabulum (KONIG and LIEBICH, 2016). In this way, the bad positioning of the hip joint, fatally will alter the interaction of the muscles of the quadriceps, thus its insertions, that are common on the patella and posteriorly on the tibia crest (DYCE et al., 2010).

We believe that the dislocation of the hip joint in cranialdorsal way (“varus thigh”) led to a greater rotation of the tibia, for during the mimicking of the physiological movement of the member, there was an important alteration of all of the bone’s anatomic axis, causing an eccentric force on the medial side of the limb (PEREZ and LAFUENTE, 2014). The caudoventral hip joint luxation (“valgus thigh”) on the other hand, has led to a tibial mid-rotation, yet was still greater than the rotation observed in anatomic position of the hip; we suspect that this occur due to a larger tension applied on the rectum femoris muscle when distancing itself caudally from the joint, causing a medial dislocation of the quadriceps group, once the rectum femoris is originated on the ilium, staying medially to the anatomic axis of the femur.

Medial patella luxation is most commonly observed on the surgical routine than the lateral luxation. Although not fully understood, it is suggested that this fact happens due to the hypoplasia of the medial condyle of the femur (SOUZA et al., 2009; FOSSUM, 2013; TOBIAS and JOHNSTON, 2012; ROUSH, 1992; DECAMP and JOHNSTON, 2016; PÊREZ and LAFUENTE, 2014). In this paper, we agree with this information, however we suggest that this hypoplasia of the medial condyle is a consequence of the medial dislocation of the femoris quadriceps muscle. As discussed previously, regardless the varus or valgus formation of the animal, the tendency is that the femoris quadriceps muscle group dislocates medially, carrying the patella along with it thus causing a proximal rotation of the tibia through the insertion of the patella ligament along with the crest. In the same way, we believe that the flattening of the trochlear groove, that is classically considered a predisposing factor for the patella luxation (FOSSUM, 2013; TOBIAS and JOHNSTON, 2012; DECAMP and JOHNSTON, 2016), is a consequence of the lack of friction of the patella with the groove because of its medial dislocation along with the femoris quadriceps muscle, as some authors propose (PÊREZ and LAFUENTE, 2014).

Great anteversion angles promote the external rotation of the femur's head in relation to the acetabulum. The anteversion angle is positively correlated to the inclination angle, meaning that the more valgus the angle, more anteversion there is (TORRES et al., 2012; WEIGEL and WASSERMAN, 1992). However, in this study there was no such correlation. Cranialdorsal dislocation led to an external rotation of the femur, in a similar way to a hip with a great antiversion angle, but kept a varus thigh conformation (smaller inclination of the femur neck). As for the caudoventral dislocation, there was an internal rotation of the femur, similar to a smaller antiversion angle articulation, although this luxation showed a valgus thigh conformation (larger femur neck inclination angle). This lack of correlation between antiversion angle and inclination angle observed in this paper, made it difficult to interpret the results, for some studies suggest hypothetically that the positive correlation: smaller inclination angle and reduced antiversion angle, are predisposing to the medial patella dislocation (SOUZA et al., 2009; FOSSUM, 2013; TOBIAS and JOHNSTON, 2012; ROUSH, 1992; DECAMP and JOHNSTON, 2016; PÊREZ and LAFUENTE, 2014) and we saw on this occasion that regardless the positive association, the internal rotation of the tibia is present.

In this experiment, the greatest alterations of the internal tibia rotation were seen in cranialdorsal dislocations that presented a varus thigh conformation (small inclination angle) with larger antiversion angle (external rotation of the femur). According to what literature states about a varus thigh and antiversion angle being predisposing factor for the medial dislocation of the patella (SOUZA et al., 2009; FOSSUM, 2013; TOBIAS and JOHNSTON, 2012; ROUSH, 1992; DECAMP and JOHNSTON, 2016; PÊREZ and LAFUENTE, 2014), we suggest that the minor inclination angle (varus thigh) is more relevant to the etiopathogenesis of the patella dislocation than the minor antiversion angle.

Although in minor proportion, the valgus thigh was also identified as a significant risk factor for small dogs on the pathogenesis of the medial patella dislocation (BOUND et al., 2009). In our study, animals with a dislocated hip in a caudoventral way, even though presenting a similar form to the valgus thigh, presented a minor antiversion angle, unlike animals with a naturally valgus thigh, which present a minor antiversion angle. These facts make it difficult for us to affirm that the valgus thigh also acts directly on the pathogenesis of the patella luxation, for caudoventrally luxated animals (“valgus thigh”) kept a minor antiversion angle, which is a predisposing factor for medial patellar luxation, classically (TOBIAS and JOHNSTON, 2012). Nonetheless, due to the greater traction of the rectus femoris muscle when the hip takes de position of a valgus thigh, as discussed previously, we suggest that a larger inclination angle of the femoral neck also leads to the medial dislocation of the femoral quadriceps, acting on the pathogenesis of the patella dislocation. In other words, in our study, both varus and valgus thighs caused biomechanical alterations compatible with medial dislocation of the quadriceps muscle and, consequently, the patella, even though presenting opposite antiversion angles to the ones described in the literature for those hip conformations.

CONCLUSION

The present work made possible to conclude that the hip joint malformation directly influences on the tension of the quadriceps muscle, consequently on the patellar ligament, and favors an internal rotation of the proximal tibia, acting as a predisposing factor to the medial patellar dislocations.

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REFERENCES

BOUND, N.; ZAKAI, D.; BUTTERWORTH, SJ.; PEAD, M. The prevalence of canine patellar luxation in three centres: clinical features and radiographic evidence of limb deviation. **Vet Comp Orthop Traumatol**, p.22-32, 2009. <DOI: 10.3415/VCOT-08-01-0009>.

DECAMP, C.E.; JOHNSTON, S.A.; DÉJARDIN, L.M.; SCHAEFER, S.L. **Handbook of small animal orthopedics and fracture repair.** 5st ed. St. Louis: Elsevier; 2016. 877p.

DYCE, K.M.; SACK, W.O.; WENSEING, C.J.G. **Tratado de Anatomia Veterinária.** 4st ed. Rio de Janeiro: Elsevier; 2010. 856p.

FOSSUM, T.W. **Small animal surgery textbook.** 4 st ed. St Louis: Elsevier Health Sciences; 2013. 1775p.

KONIG, H.E. e LIEBICH, H. **Anatomia Dos Animais Domésticos - Textos e Atlas Colorido.** 6st ed. São Paulo: Artmed; 2016. 824p.

MORAES, P.C. e CRIVELLENTI, L.Z. Neurologia e distúrbios musculoesqueléticos. In: CRIVELLENTI, L.Z. e BORIN-CRIVELLENTI, S. **Casos de rotina em medicina veterinária de pequenos animais.** São Paulo: Medvet; 2012. p. 305-354.

NUNAMAKER, D.M.; BIERY, DN.; NEWTON, C.D. Femoral neck anteversion in the dog. It's radiographic measurement**. Journal of American Veterinary Radiology Society**, v.14, p.45-47, 1973. <DOI: 10.1111/J.1740-8261.1973.TB00647.X>.

PARDI, M.C.; DOS SANTOS, I.F.; DE SOUZA, E.R.; PARDI, H.S. **Ciência, Higiene e Tecnologia da Carne - Vol. 1.** 1st ed. Goiania: Editora Universitária (Eduff); 1993. 77p.

PÊREZ, P. e LAFUENTE, P. Management of medial patellar luxation in dogs: what you need to know. **Veterinary Ireland Journal**, v.4, p.634-640, 2014.

ROUSH, J.K. Canine patellar luxation**. Veterinary Clinics of North America: Small Animal Practice**, v.23, p.855-868, 1993. <DOI: 10.1016/S0195-5616(93)50087-6>.

SOUZA, M.M.D.; RAHAL, S.C.; OTONI, C.C.; MORTARI, A.C.; LORENA, S.E.R.S. Luxação de patela em cães: estudo retrospectivo. **Arquivo Brasileiro de Medicina Veterinária e Zootecnia**, v.61(2), p.523-526, 2009. <DOI: 10.1590/S0102-09352009000200035>.

TOBIAS, N. e JOHNSTON, S.A. **Veterinary Surgery Small Animal.** St Louis: Elsevier Health Sciences; 2012. 2777p.

TORRES, B.B.J.; MUZZI, L.A.L.; MESQUITA, L.R. Ruptura do ligamento cruzado cranial – revisão. **Clínica Veterinária**, v.17(100), p.100-112, 2012.

WEIGEL, J.P. e WASSERMAN, J.F. Biomechanics of the normal and abnormal hip joint. **Veterinary Clinics of North America: Small Animal Practice**, v.22(3), p.513-528, 1992. <DOI: 10.1016/S0195-5616(92)50052-3>.