CLINICAL REPORT

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Leveling osteotomy of the tibial plateau at an inverted angle in a dog

Osteotomia de nivelamento do platô tibial em ângulo invertido em um cachorro

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ABSTRACT: One dog, Golden Retriever, 5 months old, was seen complaining of lameness and pain in the left pelvic limb. Avulsion of the tibial crest was diagnosed by radiographic means, which was corrected with a tension band. The absence of postoperative radiographic monitoring and the non-removal of the apparatus led to the early closure of the cranial tibial physis with continuous flow growth, resulting in pain, functional loss of the limb after one year and at a 13.2º tibial plateau angle negative. The biomechanical alteration of the limb was corrected using the inverted TPLO technique, converting the angle of the tibial plateau to 5.3 positive, without a rockback evidenced in 30, 60, 90 days up to four months after the operation. The objective of this case report is to describe the surgical correction with the inverted TPLO technique in a case of angle of the negative tibial plateau secondary to not removing the tension band applied in avulsion of the growing tibial crest. After 120 days, the dog was presented fully recovery and weight-bearing without any complication.

KEYWORDS: tibial plateau angle negative; avulsion; stifle joint; osteotomy.

RESUMO: Um cão, Golden Retriever, de 5 meses de idade, foi atendido com queixa de claudicação e dor em membro pélvico esquerdo. Diagnosticou-se por meio radiográfico a avulsão da crista da tíbia, a qual foi corrigida com banda de tensão. A ausência de acompanhamento radiográfico pós-operatório e a não retirada do aparato levou ao fechamento precoce da fise tibial cranial com crescimento contínuo da caudal, resultando em dor, perda funcional do membro após um ano e em um ângulo de platô tibial de 13,2º negativos. A alteração biomecânica do membro foi corrigida por meio da técnica de TPLO invertida, convertendo o ângulo do platô tibial em 5,3º positivos, sem rockback evidenciado em 30, 60, 90 dias até quatro meses de pós-operatório. O objetivo desse relato de caso é descrever a correção cirúrgica com a técnica de TPLO invertida em um caso de ângulo do platô tibial negativo secundário a não retirada de banda de tensão aplicada em avulsão da crista da tíbia em crescimento. Após 120 dias, o paciente apresentou recuperação total com adequado suporte do peso no membro, sem qualquer complicação.

PALAVRAS-CHAVE: ângulo do platô tibial negativo; avulsão; joelho, osteotomia.

INTRODUCTION

Avulsion fractures of the tibial tuberosity occur in dogs with an immature skeleton independently or in association with a fracture of the proximal tibial epiphysis (BROWN et al., 2013; GOWER; BOUND; MOORES, 2008). It is known that the closure of growth plates in medium-sized dogs occurs until approximately one year of age, and in animals of larger breeds up to 18 to 20 months. The fracture along the bone growth plate of the tibial tuberosity leads to its proximal avulsion by the patellar tendon. This occurs due to the relative weakness of this zone when compared to the tendon insertion zone (BRADEN, 1981; GOLDSMID; JOHNSON, 1991; VON PFEIL, 2009).

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Complications can happen after surgical repair and include dislocation of the patella, implant failure and deformity of the proximal tibial plateau with consequent inclination of the articular surface (GOLDSMID, 1991). In general, the late removal of the implant can lead to premature closure of the growth line, which occurs first for the tibial plateau and second for the tibial axis, leading to bone deformity and distal migration of the tibial tuberosity, which results in alteration of the tibial plateau (GOLDSMID, 1991; PIRAS et al, 2001; PRATT, 2001).

The angle of the tibial plateau (APT) varies between 18 and 26º, taking into account breed, size, sex and age (MORRIS; LIPOWITZ, 2001; REIF; PROBST, 2003; SEO et al. 2020; SU; TOWNSEND; WITTUM, 2015; WILKE et al, 2002). Rotations below 5º can lead to excessive stress on the caudal cruciate ligament and predispose to injuries (WARZEE, 2001).

Aiming at this problem, techniques have been developed in recent decades that lead to dynamic stability of the knee through the alteration of bone geometry and active containment of the joint, among which is the osteotomy for leveling the tibial plateau (TPLO) (WARZEE et al, 2001). This technique achieves dynamic stability through radial osteotomy of the proximal tibia with rotation and fixation of the proximal fragment in an APT of approximately 5º (SLOCUM; SLOCUM, 1993; WARZEE et al., 2001; ZANN et al., 2020).

Case reports of dogs with APT lower than the normal value are rare and the risk of rupture of the caudal cruciate ligament increases exponentially due to its consequent tension (SLOCUM; SLOCUM. 1993; VINCENTI; KNELL; POZZI, 2017; WARZEE et al., 2001).

This report aims to describe the technique of inverted TPLO in a canine to correct negative APT and functional impotence of the left pelvic limb due to failure to remove an implant for osteosynthesis of avulsion of the tibial crest when growing, leading to bone deformity of the limb . The inverted TPLO technique proved to be effective for the rare case presented.

CASE REPORT

A five-month-old Golden Retriever male dog, 18 kg, was seen at the orthopedics and veterinary traumatology service with the main complaint of acute lameness in the left pelvic limb. No evident trauma was reported by the tutor.

The general physical examination showed no change in physiological parameters. During the orthopedic examination, the patient presented na abnormal gait with lameness in the left pelvic limb. On palpation, exacerbation of pain in the region of the tibial crest and crackling was evident.

Radiography of the femorotibiopatellar joint in orthogonal projections, shows an avulsion fracture of the tibial crest, and surgical treatment was indicated.

Pre-anesthetic medication was performed with methadone (0.3mg / kg, IM), in addition to sodium ampicillin (20mg / kg, IV) for antimicrobial prophylaxis. Induction was achieved with dose-effect propofol (IV). After orotracheal intubation, maintenance was performed inhaled with isofluorane in a mixture of gases with 60% in 100% oxygen and 40% compressed air.

With the patient in an adequate anesthetic plane, the avulsion of the tibial crest was corrected using the tension band technique. For this, after a standard surgical approach, two 2mm Steinmann pins were inserted into the bone fragment, in the caudal skull and parallel to the tibial plateau. The stabilization of the pins was performed using a 1mm cerclage wire in pattern eight and the surgery was completed with dermorraphy. For postoperative medication, tramadol (3mg / kg, BID, VO, five days), dipyrone (25mg / kg, BID, VO, five days) and meloxicam (0.05mg / kg, SID, VO, three days were prescribed). The tutor was instructed to return to control radiographs periodically in order to determine the exact moment of removal of the tension band, however, this guidance was not complied with.

Consequently, after one year, the patient returned for care due to functional impotence of the left pelvic limb. In the anamnesis, the tutor reported that the post-operative period of osteosynthesis due to avulsion of the tibial crest would have been satisfactory and, therefore, did not perform the scheduled returns. However, in one year, the patient presented lameness in the operated limb. She opted for specialized care in physiotherapy, where there was no resolution of the condition, not preventing the worsening of clinical signs and with that, the patient was referred for further care at the orthopedics and traumatology service.

In the general physical examination, the patient did not show changes in physiological parameters. Orthopedic examination revealed non weight-bearing of the left pelvic limb and exacerbated pain on palpation. The patient underwent radiography, where bone deformity was diagnosed in tibial epiphysis due to normal bone growth in the caudal portion of the tibia, but with growth atrophy in the cranial portion due to the non-removal of the tension band, causing the inverted tibial plateau (Fig. 1).

Surgical treatment was necessary to correct this condition. The technique of choice was TPLO in an inverted form. The planning carried out by the Horos Project® application, where the APT was measured in negative 13.6º (Fig. 2 - A) and the use of a 21mm TPLO blade for radial osteotomy was indicated (Fig. 2 - B). Afterwards, with the vPOP PRO® application, an inverted turn (caudocranial direction) of 18.5º, converted to 6.8mm, was predicted, to reach the tibial plateau at 5º (Fig. 3 - A). The plate chosen for fixation of the osteotomy was 3.5 mm (Fig. 3 - B).

The anesthetic protocol was the same used in surgery for osteosynthesis of avulsion of the tibial tuberosity. Additionally, epidural block was performed with bupivacaine (0.4mg / kg) and morphine (0.1mg / kg).

After the patient reached an adequate anesthetic plan, surgery was started through an incision in the medial side at the level of the femorotibiopatellar joint, exposing the proximal tibial shaft. The cerclage band was removed to access the inverted TPLO. Afterwards, circular osteotomy was performed in the proximal tibia with a 21mm TPLO saw, and then the fragment was rotated 6.8mm in the caudacranial direction, according to the surgical planning. The resulting tibial plateau was fixed with a 3.5mm TPLO plate (Intrauma Fixin V3063 plate) applied to the medial

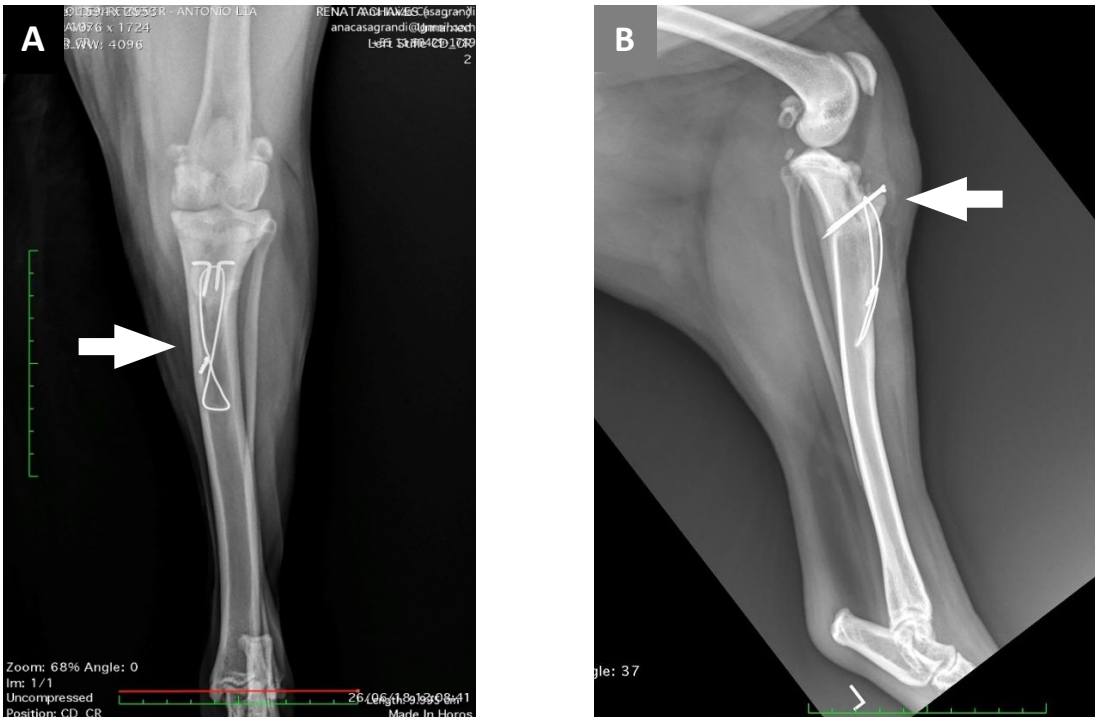

Figure 1. Radiographs of the femorotibiopatellar joint of a dog, showing bone deformity in tibial proximal epiphysis as a result of not removing the patient's tension band (white arrow). A - Cranio-caudal projection; B - Mid-lateral projection.

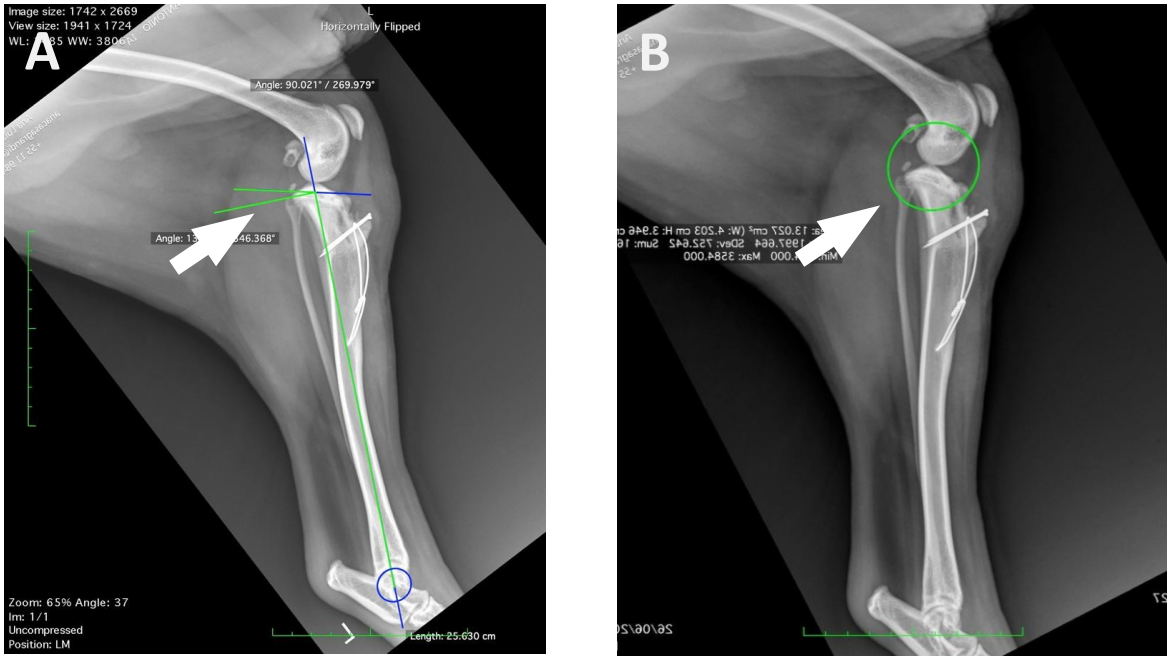

Figure 2. Radiograph of the left femorotibiopatellar joint of a dog in mediolateral projection for surgical planning using the Horos Project®. A - Indicated by the white arrow, the measurement of the angle of the tibial plateau is negative 13.6º; B - Indicated by the white arrow, it is possible to view the tool for choosing the 21mm TPLO blade.

surface of the tibia, ending the procedure with the suture in three planes.

On the immediate postoperative radiography, adequate apposition, alignment and application of the apparatus was observed. The final tibial angle obtained was 5.2º, considered satisfactory and compatible with the surgical planning.

The patient was discharged with a Robert Jones splint, recommended for five days. For postoperative analgesia, tramadol (4mg / kg, BID, VO, five days), dipyrone (24mg / kg, BID, VO, five days) and the anti-inflammatory meloxicam (0.1 mg / kg, SID, VO three days) have been prescribed. In addition, physiotherapy was recommended from five days after the procedure, until three months were completed.

Radiographic control took place at 30, 60 and 90 days and finally, at four months, with absence of rockback, keeping the APT at 5.2º (Fig. 4 A, B, C and D).

The patient presented functional recovery of the limb and absence of pain during the entire postoperative follow-up period, showing the effectiveness of applying the inverted TPLO technique to correct the inverted tibial plateau.

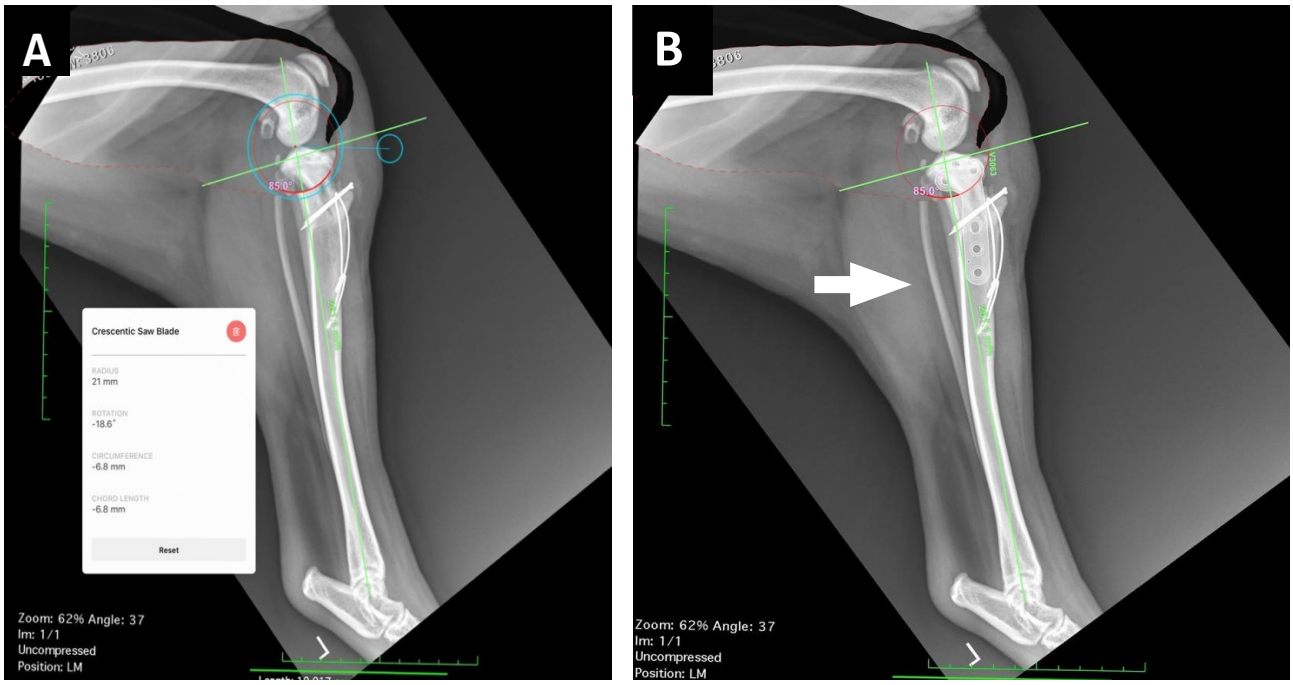

Figure 3. Radiograph of the left femorotibiopatellar joint in mediolateral projection. A - surgical planning using the vPOP PRO® application. In the lower left corner it is possible to observe the rotation indication of 18.5º or 6.8mm to reach the APT of 5º. B - surgical planning using the vPOP PRO® application. Indicated by the white arrow, it is possible to observe the projection of the TPLO V3063 plate.

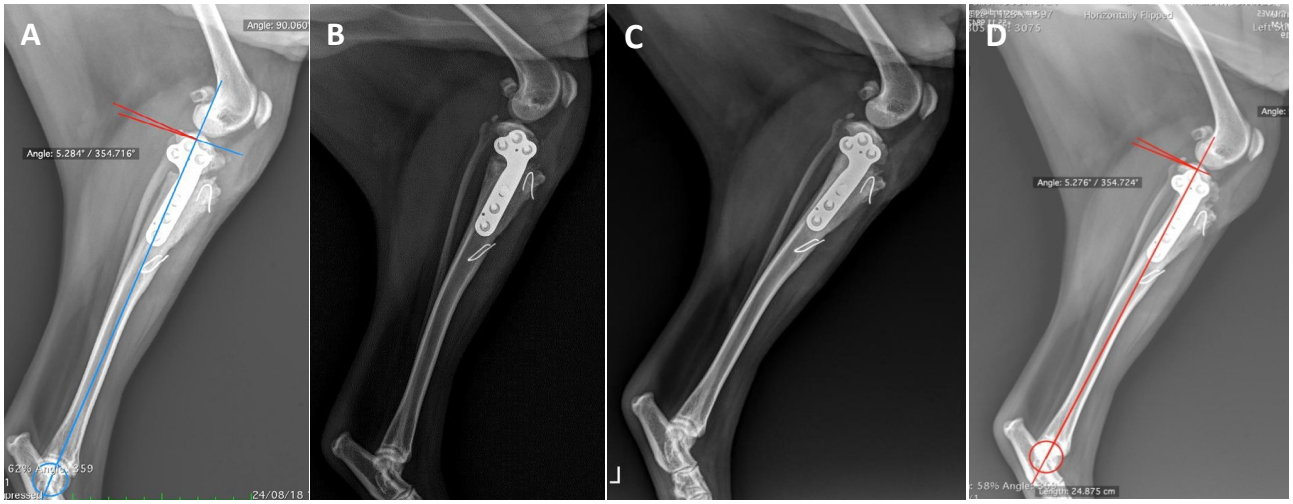

Figure 4. Control radiographs of the left femorotibiopatellar joint of a dog in mediolateral projection. A - 30 days postoperatively; B - 60 days postoperatively with evidence of adequate bone healing; C - 90 days postoperatively with consolidated fragment; D - 4 months postoperatively with maintenance of the APT of 5.2º.

DISCUSSION

In the reported case, we describe a tibial deformity characterized by negative APT in a dog corrected by de technique of inverted TPLO. The origin of the condition was the avulsion of the patient's tibial crest at 5 months, surgically corrected by the tension band technique. It is described that this type of fracture occurs due to the weakness of this cartilaginous zone in relation to the bone, and in cases of avulsion of the tibial crest, the fragility of the physis compared to the traction exerted by the patellar tendon. This information is reinforced by the fact that the tibial tuberosity is a traction apophysis that undergoes continuous distracting forces applied by the quadriceps muscle during contraction (BRADEN, 1981; PRATT, 2001), which explains the underlying cause of the fracture presented by the patient in the report.

The technique used to correct the initial fractures may seem controversial because the literature provides clear guidance that growing epiphysis must not be compressed (PITAS et al., 2011), but it is also emphasized that, if the use of compressive techniques is unavoidable, the implant must be removed as soon as signs of consolidation are seen on radiography (GOLDSMID, 1991; PRATT, 2001).

In the present report, the interruption of the growth of the cranial proximal epiphysis of the tibia with continuous growth on the caudal portion, resulted in an APT cranially inclined, or inverted. This finding is similar to the case reported by Demianiuk and Guiot (DEMIANIUK; GUIOT, 2014). However, in a study by Gower et al. (2008), of 24 patients aged three to 10 months with avulsion of the tibial crest treated with the tension band technique, none presented inverted APT. We believe that the difference in the result is due to the fact that the removal of the tension band occurred at the appropriate time in those 24 patients, differently from the case presented here.

While the APT usually ranges from 16º to 26º (MORRIS; LIPOWITZ, 2001; REIF; PROBST, 2003; SU; TOWNSEND; WITTUM, 2015; WILKE et al, 2002), reaching 29.2º according to the size of the dog (SU; TOWNSEND; WITTUM, 2015), the patient in question had a negative 13.6º angle. Studies show that the angulation of the tibial plateau below 6.5º induces a caudal tibial displacement, similarly, angulations greater than the normal value lead to a cranial displacement, resulting in damage (APELT et al, 2010; DEMIANIU; GUIOT, 2014; FOX et al., 2020; SLOCUM; SLOCUM, 1993; WARZEE, 2001). Despite the translation taking place in the caudal direction, there were no changes in the caudal cruciate ligament due to the displacement, however this is a considerable risk and must be evaluated.

There is a spread knowledgemente about TPLO technique for correction of cranial cruciate ligament rupture (BEER; BOCKSTAHLER; SCHNABL-FEICHTER, 2018; COSENZA; REIF; MARTINI, 2015; DUER et al., 2014), however, there is just one reported dog previously treated with inverted TPLO for correction of negative APT secondary to asymmetric bone consolidation. due to avulsion of the tibial crest. Similar to the conventional TPLO, the inverted TPLO is performed by rotating the tibial plateau in order to increase the APT instead of decreasing it, reaching approximately 5º (DEMIANIUK; GUIOT, 2014). As it was described in the literature previously referenced and based on the Slocum and Slocum (SLOCUM; SLOCUM, 1993) tests, the technique applied to our patient was the inverted TPLO, providing the mechanical stability of the knee.

The TPLO technique requires systematic planning based on correct radiographic measurements to achieve the desired angulation and thus obtain a satisfactory postoperative result (BARNES et al., 2016; FUJINO; HONNAMI; MOCHIZUKI, 2020; MINDNER et al., 2016). Currently, computer software is commonly used by veterinarians in specialized centers and allows the planning of osteotomy via modeling the size of the radial saw blade and indicates points of reference to better centralize osteotomy in the tibial intercondylar eminence. Although the risk of complications cannot be completely eliminated from any procedure, the advanced knowledge of the surgical technique and execution, combined with implant improvements, in addition to precise planning, makes the procedure safe (NANDA; HANS, 2019). Thus, in order to refine the technique and avoid intra and postoperative complications, we opted for operative planning via the Horos Projetc® and vPOP PRO® application.

The planning method carried out by the Horos Project® application allowed the choice of the right TPLO blade for the patient with greater precision. The planning performed by the vPOP PRO® mimicked the necessary rotation of the distal bone fragment that would be obtained after the dome osteotomy, providing the surgeon with both the angle measurement of the rotation to be performed and the distance in millimeters. In addition, it was possible to choose the plate to be used in the fragment fixation so that the APT remained stable. We planned an approximate ATP of 5º, which was obtained with confirmation on postoperative radiography of 30, 60, 90 days and after four months (Figures 4 – A, B, C and D, respectively), which shows us an APT of 5,2º.

It is known that when converting the ATP to a value between 5 and 7º, the caudal cruciate ligament starts to act, together with the local musculature, as a joint stabilizer (WARZEE et al, 2001). Thus, the maintenance of the integrity of the caudal cruciate ligament of our patient, as well as the role of physiotherapy for muscle strengthening, became important in the postoperative period for functional recovery of the limb and success of the technique employed.

CONCLUSION

It is concluded that negative tibial plateau could be corrected by means of the inverted TPLO technique, promoting fully recovery of limb function in the dog of the presente report.

REFERENCES

APELT, D. et al. Effect of cranial tibial closing wedge angle on tibial subluxation: an ex vivo study. **Veterinary Surgery**, v. 39, n. 4, p. 454-459, 2010.

BARNES, D. C. et al. Short-term outcome and complications of TPLO using anatomically contoured locking compression plates in small/medium-breed dogs with "excessive" tibial plateau angle. **Journal of Small Animal Practice**, v. 57, n. 6, p. 305-310, 2016.

BEER, P.; BOCKSTAHLER, B.; SCHNABL-FEICHTER, E. Tibial plateau leveling osteotomy and tibial tuberosity advancement–a systematic review. **Tierärztliche Praxis Ausgabe K: Kleintiere/Heimtiere**, v. 46, n. 04, p. 223-235, 2018.

BRANDEN, T. D. Epiphyseal Injuries. In: Borjab MJ, editor. **Pathophysiology in Small Animal Surgery**. 1st ed. Philadelphia: Lea & Febiger. p. 791-800, 1981.

BROWN, G. W. et al. Avulsion fragmentation of the tibial tuberosity apophysis and associated patellar tendon enthesopathy in a skeletally immature dog. **Veterinary and Comparative Orthopaedics and Traumatology**, v. 26, n. 03, p. 242-247, 2013.

COSENZA, G.; REIF, U.; MARTINI, F. M. Tibial plateau levelling osteotomy in 69 small breed dogs using conically coupled 1.9/2.5 mm locking plates. **Vet Comp Orthop Traumatol**, v. 28, n. 05, p. 347-354, 2015.

DEMIANIUK, R. M.; GUIOT, L. P. Reverse TPLO for asymmetrical-premature closure of the proximal tibial physis in a dog. **Journal of Small Animal Practice**, v. 55, n. 11, p. 589-592, 2014.

DUERR, Felix M. et al. Treatment of canine cranial cruciate ligament disease. **Veterinary and Comparative Orthopaedics and Traumatology**, v. 27, n. 06, p. 478-483, 2014.

FOX, Elisabeth A. et al. Average tibial plateau angle of 3,922 stifles undergoing surgical stabilization for cranial cruciate ligament rupture. **Veterinary and Comparative Orthopaedics and Traumatology**, v. 33, n. 03, p. 167-173, 2020.

FUJINO, Hiroko; HONNAMI, Muneki; MOCHIZUKI, Manabu. Preoperative planning for tibial plateau leveling osteotomy based on proximal tibial width. **Journal of Veterinary Medical Science**, p. 19-0501, 2020.

GOLDSMID, S.; JOHNSON, K. A. Complications of canine tibial tuberosity avulsion fractures. **Veterinary and Comparative Orthopaedics and Traumatology**, v. 4, n. 02, p. 54-58, 1991.

GOWER, J. A.; BOUND, N. J.; MOORES, A. P. Tibial tuberosity avulsion fracture in dogs: a review of 59 dogs. **Journal of Small Animal Practice**, v. 49, n. 7, p. 340-343, 2008.

MINDNER, Julia K. et al. Tibial plateau levelling osteotomy in eleven cats with cranial cruciate ligament rupture. **Veterinary and Comparative Orthopaedics and Traumatology**, v. 29, n. 06, p. 528-535, 2016.

MORRIS, Ethan; LIPOWITZ, Alan J. Comparison of tibial plateau angles in dogs with and without cranial cruciate ligament injuries. **Journal of the American Veterinary Medical Association**, v. 218, n. 3, p. 363-366, 2001.

NANDA, Andy; HANS, Eric C. Tibial Plateau Leveling Osteotomy for Cranial Cruciate Ligament Rupture in Canines: Patient Selection and Reported Outcomes. **Veterinary Medicine: Research and Reports**, v. 10, p. 249, 2019.

PIRAS, L. et al. Treatment of fractures of the distal radius and ulna in toy breed dogs with circular external skeletal fixation: a retrospective study. **Veterinary and comparative orthopaedics and traumatology**, v. 24, n. 3, p. 228, 2011.

PRATT, J. N. J. Avulsion of the tibial tuberosity with separation of the proximal tibial physis in seven dogs. **Veterinary Record**, v. 149, n. 12, p. 352-356, 2001.

REIF, Ullrich; PROBST, Curtis W. Comparison of tibial plateau angles in normal and cranial cruciate deficient stifles of Labrador retrievers. **Veterinary surgery**, v. 32, n. 4, p. 385-389, 2003.

SEO, Beom Seok et al. Measurement of the tibial plateau angle of normal small-breed dogs and the application of the tibial plateau angle in cranial cruciate ligament rupture. **Journal of Advanced Veterinary and Animal Research**, v. 7, n. 2, p. 220, 2020.

SLOCUM, B.; SLOCUM, T. D. Tibial plateau leveling osteotomy for repair of cranial cruciate ligament rupture in the canine. **Veterinary Clinics of North America: Small Animal Practice**, v. 23, n. 4, p. 777-795, 1993.

SU, L. et al. Comparison of tibial plateau angles in small and large breed dogs. **The Canadian Veterinary Journal**, v. 56, n. 6, p. 610, 2015.

VINCENTI, S.; KNELL, S. C.; POZZI, A. Surgical treatment of a proximal diaphyseal tibial deformity associated with partial caudal and cranial cruciate ligament deficiency and patella baja. **Schweizer Archiv für Tierheilkunde**, v. 159, n. 4, p. 237-242, 2017.

VON PFEIL, D. J. F. Orthopedic problems in the immature dog. **VeterinarySpecialistsof Alaska**, v. 1, p. 1-10, 2009.

WARZEE, C. C. et al. Effect of tibial plateau leveling on cranial and caudal tibial thrusts in canine cranial cruciate–deficient stifles: An in vitro experimental study. **Veterinary Surgery**, v. 30, n. 3, p. 278-286, 2001.

WILKE, Vicki L. et al. Comparison of tibial plateau angle between clinically normal Greyhounds and Labrador Retrievers with and without rupture of the cranial cruciate ligament. **Journal of the American Veterinary Medical Association**, v. 221, n. 10, p. 1426-1429, 2002.

ZANN, Geoffrey J. et al. The effect of tibial plateau leveling osteotomy on patellofemoral kinematics in dogs: An in vivo study. **Veterinary Surgery**, v. 49, n. 1, p. 207-213, 2020.