

*Research article*

## CLINICAL OUTCOMES AND STIFLE OSTEOARTHRITIS ASSESSMENT OF NINE CATS BEFORE AND AFTER TIBIAL PLATEAU LEVELLING OSTEOTOMY

TAMBURRO Roberto\*, COLLIVIGNARELLI Francesco, FALERNO Ilaria, CERASOLI Ilaria, VIGNOLI Massimo

University of Teramo, Faculty of Veterinary Medicine, 64100 Piano D'Accio, Teramo, Italy

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This study aimed to evaluate the clinical and radio graphical outcome of cats following TPLO surgery for cranial cruciate ligament deficiency. Each cat underwent orthopedic assessment, pre-operative radio graphical evaluation, surgical procedure, postoperative management and clinical re-examination 1, 2, and 12 months following surgery. Age, body weights, TPAs, meniscal tears, implants and osteoarthritis progression were recorded. Postoperative OA score was compared with that obtained 1 year after surgery using a paired t-test with commercially available software. Radio graphical evaluation performed 1 year after surgery showed no significant OA progression ( $P$ -value > 0.1). Minor complications occurred in one case (#7) in which a mild to moderate seroma was observed ten days after surgery. No major complications were recorded. Although TPLO surgery in cats remains controversial, this study suggests that it was a suitable option for surgical treatment of feline cranial cruciate ligament rupture, but considering the *ex vivo* outcomes recently published, further *in vivo* evaluation is strongly recommended.

**Key words:** cranial cruciate ligament, TPLO, cat, osteoarthritis

### INTRODUCTION

Cranial cruciate ligament deficiency (CCLd) is the most common cause of hindlimb lameness in dogs leading to stifling joint instability, inflammation, pain, lameness and osteoarthritis development [1-5].

In the last decade, different surgical procedures have been described for treating CCLd in dogs [3,5-7].

Tibial plateau levelling osteotomy (TPLO) is one of the most common surgical techniques in use, which aims to neutralize the cranial tibial thrust, achieving a caudal displacement of the tibial plateau, levelling the slope up to get a perpendicular angle

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\*Corresponding author: e-mail: rtamburro@unite.it

between the tibial plateau and the patellar tendon, without restoring the cranial cruciate ligament [1,3,4,8-11].

Cranial cruciate ligament deficiency in cats is usually treated by performing extracapsular procedures [12-17]. A single case of TPLO associated with cranial closing wedge ostectomy was described with an excellent outcome in 2005 [18] whilst in 2016, Mindner *et al* (2016) published a primary paper regarding TPLO application in eleven cats with CCLd. TPLO outcomes were very positive and further evaluations including longer-term clinical re-examination were encouraged by the authors [19].

For these reasons, this study was aimed to evaluate the clinical outcomes and the radiographic osteoarthritic changes of nine cats following TPLO for cranial cruciate ligament deficiency one year after surgery.

## MATERIAL AND METHODS

Inclusion criteria were cats referred with a diagnosis of cranial cruciate ligament deficiency between 2016/2018.

The study protocol was under institutional guidelines for research on animals; owners were fully informed of the procedures and written informed consent was obtained.

Each cat underwent the same protocol including orthopedic assessment, preoperative radiographical evaluation, surgical procedure, postoperative management and clinical re-examination 1 month, 2 months and 1 year after surgery.

Age, body weights, TPAs, meniscal tears, implants and osteoarthritis progression were recorded.

Stifle radiographical assessment was performed under general anesthesia during the preoperative evaluation.

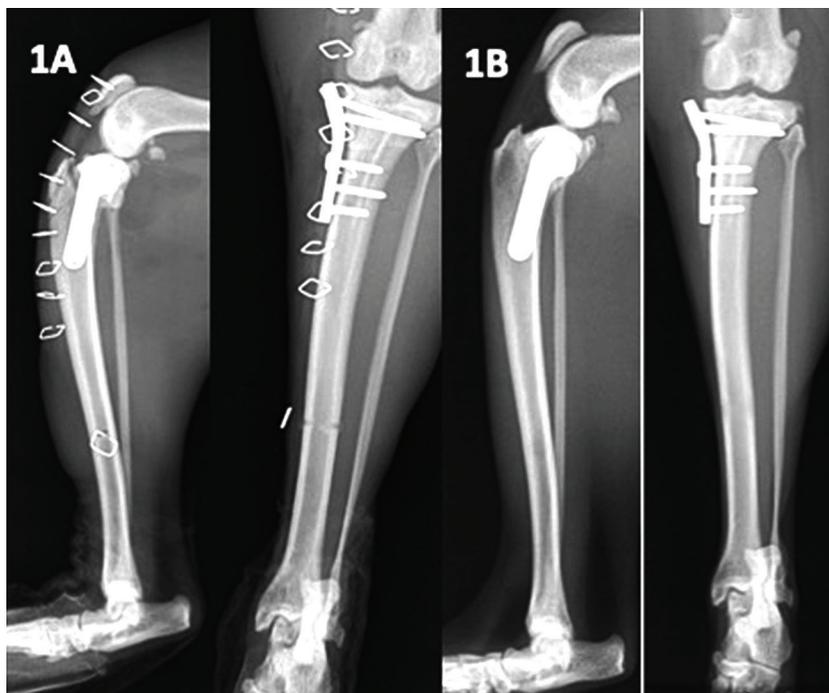
Medio/lateral tibial thrust view was achieved to evaluate potential tibial displacement, OA development, and TPA/D1/D2 evaluation and a caudocranial view aimed to assess potential tibial deformity [20]. Each radiograph was evaluated by a European Diplomat in Veterinary Diagnostic Imaging (MV). Osteoarthritis was subjectively assessed by the authors according to Freire *et al.* [21]. Macroscopic changes included joint mineralization, cartilage damage and osteophytes. Radiographic changes indicative of DJD were graded as follows: absent = 0, slight = 1-3, mild = 4-6, moderate = 7-9, severe = 10.

Complications were classified as major in cases of additional surgery, and minor in cases of conservative management.

### Surgical technique

Each cat was placed in dorsal recumbency. A craniomedial parapatellar incision was used to approach the stifle joint. Partial meniscectomy was performed in the case

of axial tears. All tibial osteotomies were performed using #12 TPLO radial blade (Colibri 2, Depuy Synthes, Raynham, Massachusetts, US) and always fixed using 2.0 mm LCP TPLO system (Mini Fragment 2.0 mm Sistem, Depuy Synthes Raynham, Massachusetts, US) [1,19].



**Figure 1A-B.** 2-year-old dsh (domestic shorthair) female cat. Medio-lateral and caudo-cranial radiographic views of the stifle joint performed postoperatively (**A**) and compared with that obtained one year after TPLO surgery (**B**). In A a soft tissue/fluid increasing intra-articular opacity is visible, with compression of the fat pad, compatible with joint effusion and/or synovial thickening in the mediolateral view. The caudocranial view shows minimal mineralization of the medial meniscus and in the area of the CCL. In B the mineralization of the medial meniscus and in the area of the CCL is more visible in the caudocranial view. In the mediolateral view, the joint opacity appears normal, and only a minimal osteophyte formation at the proximal border of the femoral trochlea is present, suggesting very minimal arthritic changes.

### Postoperative management

Each cat was hospitalized and discharged 24 hours after surgery. Postoperative mediolateral and caudocranial radiographic views were performed to inspect implant position and measure the tibial plateau. A soft bandage was applied for 48 hours.

Post-operative medications included Amoxicilline/Clavulanic acid (Synulox® Zoetis Italia srl, Rome, Italy) 20 mg/kg and Metacam (Metacam® Boehringer Ingelheim Animal Health Italia SpA, Noventana, PD, Italy) 0.1 mg/kg q24.

Antibiotic and anti-inflammatory treatments were extended for the following two weeks.

Cage rest was requested for 4 weeks.

The clinical and radiographical re-examination was performed one month, two months and one-year post-surgery to check the weight-bearing and the bone healing of the operated stifle joint.

### Statistical analysis

All OA scores were tested with the Shapiro Wilk test to evaluate a normal distribution. Postoperative scores were compared with those obtained one year after surgery using a paired t-test design with commercially available software (Prism 7, © 2018 GraphPad Prism®, La Jolla, California, USA)

Mean and standard deviations were calculated, and  $P < 0.01$  was considered significant.

## RESULTS

Nine cats matched the inclusion criteria. Individual information on body weight (in kg) at the date of presentation, sex, pre-operative TPA, pre-operative OA/1 year post-operative OA are provided in Table 1.

**Table 1.** Medical records include breed, sex, age, bodyweight, pre-operative TPA, post-operative TPA, preoperative OA score and one year follow up OA score

	Breed	Sex	Age (y)	Weight (kg)	Preop TPA	Post op TPA	Post op OA	1 yr post op OA
1	Dsh	nM	7	5.4	27	7	4	4
2	Dsh	nM	12	7.1	29	6	6	6
3	Main Coon	M	7	7.5	28	4	2	4
4	Dsh	nF	5	6.3	30	5	2	3
5	Dsh	nF	12	6.9	26	7	5	5
6	Carthusian	M	5	5.8	31	3	7	7
7	Dsh	nF	6	4.8	28	5	6	6
8	Dsh	nC	8	5.6	29	6	4	4
9	Dsh	nC	9	6.0	28	7	6	7
Mean			8	6,16	28,44	6	4,67	5,5
SD			1,41	0,42	0,70	1,42	1,41	2,12

Dsh = domestic short air; nM = neutered male; nF = neutered female; yo = year old, preop TPA = preoperative tibial plateau angle value; postop OA = postoperative osteoarthritis score; 1 yr postop OA = 1 year follow up osteoarthritis score; SD = standard deviation

Axial meniscal tears were observed and treated in four cases. Median postoperative TPA was  $6^\circ \pm 1.42$ .

Pre-operative OA score was  $4.66 \pm 1.41$ . Post-operative score was  $5.5 \pm 2.12$ .

Minor complications occurred in one case (#7) in which a mild to moderate seroma was observed ten days after surgery.

No major complications were recorded.

A comparison between the immediate postoperative radiographic OA scores with that obtained one year after surgery showed no statistical differences between the two groups ( $P\text{-value} > 0.5$ ).

## DISCUSSION

Extracapsular procedures are usually performed to treat cranial cruciate ligament deficiency in cats [12-17]. Biceps femoris transposition was recently proposed for stifle stabilization in 2019 [17]. Biceps femoris transposition has been firstly described in small breed dogs in 2010 and was found useful in eight cats with cranial cruciate ligament rupture [7,17].

Tibial plateau levelling osteotomy has become very popular for the surgical treatment of cranial cruciate ligament deficiency in dogs [22].

The application of TPLO in cats is a controversial subject. In 2018 an *ex vivo* study was published whose outcomes failed to demonstrate the stabilizing effects of tibial plateau levelling osteotomy on cranial tibial subluxation and tibial rotation angle in a feline model [23].

The author concluded that according to the model they proposed, the standard tibial plateau levelling osteotomy technique applied to stabilize the canine stifle may not be appropriate in cats [21]. This is contradictory to the results obtained with a similar canine model [9].

It is also contradictory to the good clinical results reported in a recent study in 11 cats, although the stability of the stifle joint obtained with this technique was not assessed [19].

Cadaveric studies have severe limitations, still we believe they may provide very useful information in understanding and comparing varying surgical procedures in different joints [9,24-29].

Our clinical outcomes were coherent with those obtained with another clinical study published in 2016 in which eleven cats underwent TPLO for cranial cruciate deficiency [19].

Contradictory results from cadaveric to *in vivo* studies suggest that the biomechanical stifle evaluation of cats require more assessment. Osteoarthritis changes in feline stifle commonly include osteophytes, joint-associated mineralization, and cartilage damage. In particular, Voss reported that small mineralizations were usually confined to the medial meniscus while larger mineralizations tended to be located cranially to the

menisci potentially associated with osteoarthritis and cranial cruciate ligament disease [30]. In this study, even cats had no history of major trauma and five of them had large mineralization located cranially to the meniscus. In particular, significant OA progression was not observed one year after TPLO surgery. We then speculate joint stability was achieved following TPLO procedure [31-34]. Further evaluations for better understanding of muscle activation are strongly recommended. Tibial plateau levelling osteotomy surgery was performed without major complications; mean body weight of 6.1 kg suggesting that overweight may be significant in the development of the stifle instability.

In 2011 Ruthrauff *et al* observed 67% (65/98) of medial meniscal injuries in a study population of 98 cats affected by CCLd while Mindner *et al* reported 18% of meniscal damages (2/11) [19, 35]. In this study, the medial meniscus incidence was 44% (4/9). The axial meniscal tears were always positioned in the caudal horn of the medial meniscus; a large arthrotomy was required for a proper meniscal assessment.

Within this study, only one minor postoperative complication was observed, but a larger study is encouraged to assess all possible complications.

In our experience, TPLO is a suitable option for surgical treatment of cranial cruciate ligament rupture in cats. However, considering the *ex vivo* outcomes recently published, further *in vivo* evaluation is strongly encouraged.

### **Authors' contributions**

TR and CF performed the surgical procedures as first and second operator respectively. VM and FI were involved in the radiological evaluations. CI performed the anaesthesia and postoperative protocol. TR, CF and VM mainly wrote the paper. CI and FI participated in the design of the study and data collection. All authors helped to draft the manuscript, read and approved the final manuscript.

### **Declaration of conflicting interests**

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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## **KLINIČKI ISHODI I PROCENA OSTEOARTRITISA I UKOČENOSTI ZGLOBA KOD DEVET MAČAKA POSLE OSTEOTOMIJE TIBIJALNOG PLATO**

TAMBURRO Roberto, COLLIVIGNARELLI Francesco, FALERNO Ilaria, CERASOLI Ilaria, VIGNOLI Massimo

Studija je obavljena radi evaluacije kliničkih i radiografskih posledica kod mačaka kod kojih je urađena TPLO operacija usled deficijencije kranijalnog krucijalnog ligamenta. Kod svakog pacijenta, urađena je ortopedijska procena, pre-operativna radiografska evaluacija, hirurška procedura, posleoperativna procedura i kliničko posmatranje jedan, 2 i 12 meseci posle operacije. Za svaku mačku, beleženi su podaci u vezi starosti, telesne mase, TPA, rascepa meniskusa, kao i napredak u odnosu na implant i osteoartritis. Posle operativni OA skor je, upotrebom parnog t-testa (komercijalno dostupan softver), upoređivan sa onim koji je dobijen godinu dana posle operacije. Radiografska evaluacija koja je obavljena godinu dana posle operacije, nije pokazala statistički značajan napredak u OP skoru ( $p > 0,1$ ). U jednom slučaju (pacijent broj 7), deset dana posle operacije, uočene su blage komplikacije u smislu pojave seroma blagog do srednjeg intenziteta. Uopšteno, nisu uočene bilo kakve komplikacije. Iako se smatra da je TPLO hirurška intervencija kod mačaka kontroverzan zahvat, ova studija ukazuje da se ipak radi o prihvatljivoj opciji za hirurški tretman ruptуре kranijalnog krucijalnog ligamenta kod mačaka. Međutim, imajući u vidu ex vivo posledice koje su nedavno opisane, ipak je neophodno da se obavi dalja evaluacija ove procedure.