



Faculty of Veterinary Medicine
Department of surgery, Anaesthesiology
and Radiology.



Cranial Cruciate Ligament Rupture Repair in Dogs (An Experimental Study)

**Thesis
Presented by**

Ahmed EL-Sayed Ashour EL-Sayed

B.V.Sc., 2009

**M.V. Sc., Faculty of Veterinary Medicine, 2013,
Cairo University**

**For
Ph. D. Degree
(Surgery, Anaesthesiology & Radiology)**

Under Supervision of

Prof. Dr. Inas Nabil El-Hosseiny

Prof. of Surgery, Anaesthesiology & Radiology.

Faculty of Veterinary Medicine

Cairo University

Prof. Dr. EL- Dessouky Mohamed

EL- Dessouky Sheta

Prof. of Surgery, Anaesthesiology &

Radiology. Faculty of Veterinary Medicine

Cairo University

Prof. Dr. Haitham Ali Mohamed Fargali

Prof. of Surgery, Anaesthesiology &

Radiology

Faculty of Veterinary Medicine

Cairo University

Cairo University 2018

Cairo university

Faculty of Veterinary Medicine

Department of Surgery, Anaesthesiology & Radiology

Name: Ahmed El-Sayed Ashour El-Sayed.

Birth date: 15/10/1986

Place of birth: Giza

Nationality: Egyptian

Scientific degree: Ph.D. of Veterinary Science

Specification: Surgery, Anesthesiology & Radiology

Thesis Title: Cranial Cruciate Ligament Rupture Repair in dogs

(An experimental Study)

Supervisors:

Prof. Dr. Inas Nabil EL-Husseiny

Prof. of Surgery, Anaesthesiology & Radiology, Faculty of Veterinary Medicine, Cairo University

Prof. Dr. El-Dessouky Mohamed Sheta

Prof. of Surgery, Anaesthesiology & Radiology, Faculty of Veterinary Medicine, Cairo University

Prof. Dr. Haitham Ali Mohamed Faragali

Prof. of Surgery, Anaesthesiology & Radiology, Faculty of Veterinary Medicine, Cairo University

Abstract

This study included twenty-one adult apparently healthy mixed breed mongrel dogs of variable sexes, ages, and weights. The present study was designed to compare between lateral fabello tibial suture technique (LFS), over- the- top and tibial plateau leveling osteotomy (TPLO) techniques to choose the best one for the management of cranial cruciate ligament rupture (CrCLR).

The results of this study showed that, TPLO technique appeared to provide better early limb function, a more rapid return to weight-bearing of dogs in comparison with LFS and over-the-top methods.

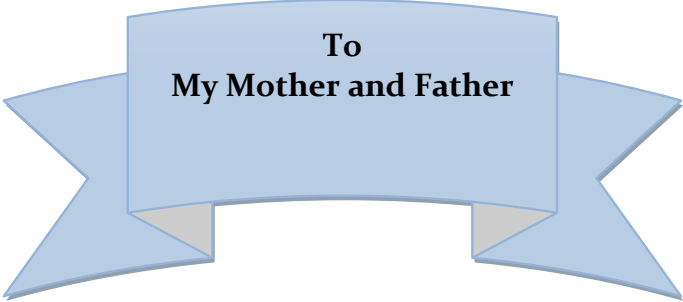
Also, it was found that, the degree of laxity of the stifle joint in dogs with CrCLR repair by LFS to some extent higher than those managed by over-the-top technique. Minimal radiographic osteoarthritic changes were observed at 3 months post-operative and still in its progression till the end of 6 months in dogs managed by LFS technique. No osteoarthritic changes were observed in other two groups managed by over-the-top and TPLO techniques.

It was identified after ultrasound scanning post-operatively, presence of joint effusion, with variable degrees according to the used technique. Concerning the used MRI in this study, it was found that MRI is an essential tool for diagnosis of the intact and ruptured CrCL.

The most common post-operative complications that have been recorded in this study were seroma, medial buttress formation and medial meniscal tears.

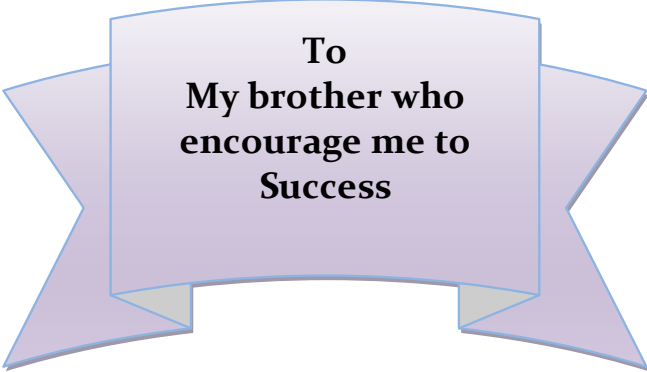
The experimental dogs in this work showed no clinical lameness at the end of the study, and at the same time, the histopathological results showed the presence of different forms of inflammatory changes in the stifle joint structures of all the experimental groups. Finally, TPLO surgical technique was currently proven as the best technique in comparison with LFS and over-the-top methods.

DEDICATION



**To
My Mother and Father**

**Who have provided never-ending support
and taught me the value of a life dedicated to
continued learning and gave me the opportunity
to pursue my love of small animal surgery**



**To
My brother who
encourage me to
Success**

CONTENTS

Item	Page
Dedication	
Acknowledgment	
List of figures	
List of diagrams & tables	
List of abbreviations	
Introduction	1
Review of Literature	3
1. Anatomy of canine stifle joint	3
2. Microanatomy of the cruciate ligament	6
2.a. Vascular supply	6
2.b. Nerve supply	7
3. cranial cruciate ligament rupture	8
3.a. Pathophysiology of cranial cruciate rupture	9
3.b. Meniscal tear and cranial cruciate ligament rupture	12
3.c. The joint capsule, synovial fluid and CrCLR	14
3.d. diagnosis of CrCLR	15
3.d.1. Radiographic diagnosis of CrCLR	18
3.d.2. Ultrasonographic diagnosis of CrCLR	19
3.d.3. Magnetic Resonance Imaging and CrCLR	21
3.e. Treatment of cranial cruciate ligament rupture	23
3.e.1. Extra-capsular repair (ECR)	24
3.e.2. Intra-capsular repair (ICR)	26
Tibial plateau leveling osteotomy (TPLO)	28
3.f. Complications of surgical treatment of CrCLR	31
4.g. Rehabilitation therapy following CrCL surgery	34
Materials and Methods	35
1. Experimental animals.	35
2. Animals preparation.	35
3. Animals groups	36
4. Anaesthetic regime.	36
5. Lateral fabello- tibial suture technique.	37
6. Over- the-top technique.	40
7. Tibial plateau leveling osteotomy "TPLO".	43
8. Radiographic determination of the tibial plateau angle "TPA".	43
9. Surgical procedure of TPLO.	44
10. Post-operative care and rehabilitation.	46
11. Lameness grading.	47
12. Radiographic assessment.	47
13. Index of laxity assessment.	48
14. Ultrasonographic evaluation.	49

15.Magnetic resonance imaging “MRI” evaluation.	50
16.Histopathological examination.	51
17.Statistical analysis of the data.	51
Results	52
1.Normal anatomical findings.	52
2.Clinical evaluation and score of lameness.	59
3.Radiographic and index of laxity evaluation.	67
4.Ultrasonographic results.	77
5.Magnetic resonance imaging “MRI” findings.	90
5.a.MRI of normal stifle joint.	91
5.b.MRI of post-operative (LFS technique).	98
5.c.MRI of operative (Over-the-top technique).	100
6.Gross and histopathological evaluation.	108
7.Histopathological findings.	114
Discussion and Conclusion	128
English Summary	143
References	146
Arabic Summary	

LIST OF TABLES & HISTOGRAM

Table No.	Legend	Page
Table (1)	Showing the scores of lameness.	47
Histogram (1)	Illustrating the degrees of lameness in relation to the three surgical techniques.	61

LIST OF FIGURES

Figure No.	Legend	Page
Fig. (1)	Intact CrCL (A-a), induced CrCL (B-a) and Infra-patellar fat (b).	37
Fig. (2)	Illustration drawing showed the lateral fabello-tibial suture technique.	39
Fig. (3)	A curvilinear skin incision (a) through the lateral aspect of the stifle joint showing tensor fascia lata (b).	41
Fig. (4)	The dissected fascia lata graft was transected at its proximal attachment (b) and arthrotomy of the stifle joint was done (c).	41
Fig. (5)	Using of Deschamp's needle (d) for placement of tensor fascia-lata strip (b) through the femoral condyles.	42
Fig. (6)	The tensor fascia-lata strip was pulled between the femoral condyles and out medially, then passed under the patellar ligament and fixed it.	42
Fig. (7)	Radiographic determination of TPA.	43
Fig. (8)	Detection of joint borders "needle" before using of bone saw.	44
Fig. (9)	Using of TPLO bone saw for creating a curved proximal tibial fragment which rotates according to the calculated TPLO angle.	45
Fig. (10)	Stabilization of the proximal tibia using cruciate plate and its cortical screws.	45
Fig. (11)	Tibial compression test "stress position "	48
Fig. (12)	Medio-lateral radiographic image of CrCLR of the stifle joint in neutral (a) and compressed (b) views	49
Fig. (13)	Showing MRI Siemens Amgneton machine	51
Fig. (14)	Lateral view of the left thigh muscles.	54
Fig. (15)	Lateral view of the left thigh muscles.	55
Fig. (16)	Medial view of the left thigh muscles.	73
Fig. (17)	Dorsal view of the menisci of the left stifle. .	56
Fig. (18)	Dorsal view of the menisci of the left stifle.	56
Fig. (19)	Cranial view of the left femoropatellar joint.	57
Fig. (20)	Cranial view of the left femoropatellar joint.	57
Fig. (21)	Dorsal view of the left tibial plateau.	58
Fig. (22)	Showing dogs managed by LFS; 2 days "non-weight bearing" (a) and one-week (b) P.O.	61
Fig. (23)	Showing dogs managed by LFS; one month "full weight bearing " (a) and two months "stress position "b" P.O.	61

Fig. (24)	Showing dogs managed by LFS; three months “full limb function in standing and stress positions” P.O.	62
Fig. (25)	Showing dogs by LFS; four months “full limb function” P.O.	63
Fig (26)	Showing a dog managed by LFS; 6 months “normal posture and limb function” P.O.	63
Fig (27)	Showing dogs treated by over-the-top technique; 2 days “hanging limb” (a) and one week “severe lameness, only touch the ground with toe” (b) post-surgery.	63
Fig. (28)	Showing dogs treated by over-the-top technique; one month (a) and three months “weight bearing on the operated limb” (b) post-operative.	64
Fig. (29)	Showing a dog managed by over-the-top technique; 6 months post-operative.	64
Fig. (30)	Showing a dog treated by TPLO technique “full limb function” 6 months post-operative	65
Fig. (31)	Showing a dog treated by TPLO “septic arthritis with incomplete weight bearing at hind limb stress position” 6 months post-operative.	65
Fig. (32)	Medio-lateral view of the normal stifle (neutral and compressed views), showing no cranial displacement of the tibia.	68
Fig. (33)	Medio-lateral view of the stifle joint with tibial compression test post-surgical induction CrCLR showing cranial displacement of the tibia because of CrCLR. Note: the abnormal position of the fabella relative to the tibial plateau.	68
Fig. (34)	Medio-lateral view of the stifle joint 6-months post-surgical repair (LFS) of CrCLR (neutral view) for determination of IL.	68
Fig. (35)	Medio-lateral view of the stifle joint 6-months post-surgical repair (LFS) of CrCLR (compression view) for determination of IL.	69
Fig. (36)	Medio-lateral view of the stifle joint post-surgical repair (LFS) of CrCLR showing no osteoarthritic changes in the stifle joint.	69
Fig. (37)	Medio-lateral and cranio-caudal views of the stifle joint 3- month post-surgical repair (LFS) of CrCLR showing minimal osteoarthritic changes in the stifle joint (arrow).	70

Fig. (38)	Medio-lateral view of the stifle joint 6-months post-surgical repair (LFS) of CrCLR showing osteoarthritic changes with joint effusion (presence of osteophytes at distal and proximal aspect of the patella, at the tibial eminence “mainly at the caudal aspect of tibial plateau” and at the medial trochlear ridge (arrows).	70
Fig. (39)	Cranio-caudal view of the stifle joint 6-months post-surgical repair (LFS) of CrCLR showing osteoarthritic changes, in the form of periarticular osteophytes formation a long lateral condyle (arrow). In addition to marginal osteophytic lipping of the tibia especially at the lateral side (arrows).	71
Fig. (40)	Medio-lateral view of the stifle 6-months post-surgical repair (over-the-top technique) of CrCLR (neutral view) for determination of IL.	71
Fig. (41)	Medio-lateral view of the stifle joint 6-month post-surgery repair (over-the-top technique) of CrCLR (compression view) for determination of IL.	72
Fig. (42)	Medio-lateral and cranio-caudal views of the stifle joint 6-months post-operative surgical repair (over-the-top technique) of CrCLR showing no evidence of osteoarthritis progression.	72
Fig. (43)	Pre-operative, medio-lateral radiograph of normal stifle joint before induction of CrCLR showing TPA is 28. Post-operative radiograph of the same stifle after fixation with TPLO decreasing the TPA to 17 degrees.	73
Fig. (44)	Cranio-caudal (a) and medio-lateral (b) radiographs of the operated limb one and six months after surgery with mild joint effusion and no signs of osteoarthritis. Also, beginning of callus formation at the osteotomy site on the tibia was observed.	73
Fig. (45)	Cranio-caudal (a) and mediolateral (b) radiographs of the operated limb, six months after surgery showing no joint effusion and no signs of osteoarthritis, with complete healing of the osteotomy site.	74
Fig. (46)	Medio-lateral views of the stifle joint with CrCLR fixed with TPLO six months after surgery, no signs of osteoarthritis, no joint effusion and no loss of infra-patellar fat pad or joint capsule distension (arrow).	74

Fig. (47)	Ultrasonographic sagittal images of the stifle joint with a repaired CrCLR using LFS technique “one-month post-operative”.	77
Fig. (48)	Ultrasonographic sagittal images of the stifle joint with a repaired CrCLR using over-the-top technique “one-month post-operative “.	78
Fig. (49)	Ultrasonographic sagittal images of the stifle joint with a repaired CrCLR using TPLO technique “one-month post-operative “.	79
Fig. (50)	Ultrasonographic sagittal images of the stifle joint with a repaired CrCLR using LFS technique “three months post-operative”.	80
Fig. (51)	Ultrasonographic sagittal images of the stifle joint with a repaired CrCLR using over-the-top technique “three months post-operative”.	81
Fig. (52)	Ultrasonographic sagittal images of the stifle joint with a repaired CrCLR using TPLO technique “three months post-operative”.	82
Fig. (53)	Ultrasonographic sagittal images of the stifle joint with a repaired CrCLR using LFS technique “six months post-operative”.	83
Fig. (54)	Ultrasonographic sagittal images of the stifle joint with a repaired CrCLR using over-the-top technique “six months post-operative “.	84
Fig. (55)	Ultrasonographic sagittal images of the stifle joint with a repaired CrCLR using TPLO technique “six months post-operative”.	85
Fig. (56)	Showing a huge joint effusion in a dog managed by TPLO technique at three months post-operative because of septic arthritis with inadequate plate and Steinman fixation.	86
Fig. (57)	MRI images of normal stifle joint.	88
Fig. (58)	MRI post-operative (LFS technique).	92
Fig. (59)	MRI post-operative (over-the-top technique).	95
Fig. (60)	Showing the PM findings of over-the-top technique at 6 months post-operative. Patella (1) and tensor fascia-lata graft (2).	99
Fig. (61)	Showing the PM findings of LFS technique at 6 months post-surgery, with normal lateral (1) and bucket handle tear of the medial meniscus (2).	99
Fig. (62)	Showing the PM findings of over-the-top technique at 6 months post-operative with radial tear of the caudal pole of the medial meniscus.	100
Fig. (63)	Showing the PM findings of TPLO technique at 6 months post-operative with normal lateral and medial menisci.	100

Fig. (64)	Showing the PM findings of TPLO technique 6 months P.O. with ulceration of the medial meniscus “septic arthritis”.	101
Fig. (65)	Showing moderate patellar ligament thickening in a dog managed by TPLO technique 6 months P.O.	101
Fig. (66)	Illustration of the upper extremity of the tibia with TPLO plate applied.	102
Fig. (67)	Showing medial buttress in cranial and medial aspects of the stifle area of both groups of LFS and TPOL techniques.	102
Fig. (68)	Band of tensor fascia lata showing focal proliferation of outer cellularity with sclerosis of vascular blood vessels of inner layer.	104
Fig. (69)	The tendinous tissue showed multiple new formed blood vessels.	105
Fig. (70)	Joint capsule showing focal inflammatory cells infiltration in peripheral zone with polyps formation.	105
Fig. (71)	Lateral meniscus showing focal few inflammatory cells infiltration in the outer collagen with intact inner tendinous portion.	106
Fig. (72)	Medial meniscus showing multiple newly formed blood capillaries in outer collagen elastic with intact inner tendinous portion.	106
Fig. (73)	Patellar ligament showing multiple newly formed capillaries in ligamentous tissue.	107
Fig. (74)	Joint capsule showing massive inflammatory cells infiltration.	104
Fig. (75)	Lateral meniscus showing edema with inflammatory cells infiltration in outer loose fibrous tissue with underlying intact collagen.	108
Fig. (76)	Medial meniscus showing severe congestion in newly formed blood capillaries with hypercellularity and polyps formation with intact underlying collagenoelastic layer.	108
Fig. (77)	Patellar ligament showing intact histological structure of elastocollagenic layer.	109
Fig. (78)	Joint capsule showing inflammatory cells infiltration in focal as well as diffuse manner.	109
Fig. (79)	Lateral meniscus showing massive number of inflammatory cells infiltration in the collagenous layer.	110
Fig. (80)	Medial meniscus: massive number of inflammatory cells infiltration was detected in the collagen and elastic fibers.	110

List of Abbreviations

Abbreviation	Meaning
CrCL	Cranial Cruciate Ligament
CaCL	Caudal Cruciate Ligament
CrCLR	Cranial Cruciate Ligament Rupture
MCL	Medial Collateral Ligament
LCL	Lateral Collateral Ligament
ECR	Extra-Capsular Repair
ICR	Intra-Capsular Repair
LFS	Lateral Fabello-tibial Suture
TPLO	Tibial Plateau Leveling Osteotomy
TLA	Tibial Long Axia
TPA	Tibial Plateau Angle
TTA	Tibial Tuberosity Advancement
CTWO	Cranial Tibial Closing Wedge Osteotomy
IL	Index of Laxity
US	UltraSonography
MRI	Magnetic Resonance Imaging
OA	Osteoarthritis
DJD	Degenerative Joint Disease
ROM	Range of Motion
UCP	Unity Cruciate Plate
P.O.	Postoperative
SE	Spine Echo
GE	Gradient Echo
PM	Post- Mortem

Acknowledgment

I would like to express my deepest gratitude to **Prof. Dr. Inas Nabil El-Hosseiny** professor of surgery, Anesthesiology and radiology, Faculty of Veterinary Medicine, Cairo University for her supervision, support, advices, valuable consultations close and sincere comments throughout the preparation and conduction of this work which helped me a lot to complete this research.

I would like to thank **Prof. Dr. EL- Dessouky Mohamed EL-Dessouky Sheta** professor of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Cairo University for valued contribution and his great help.

I would like to thank **Dr. Haitham Ali Mohamed Fargali** professor of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Cairo University for his encourage and support.

My heartfelt appreciation goes to **Prof. Dr. Fawzy Elnady** Professor of Anatomy and Embryology, Faculty of Veterinary Medicine Cairo University, who thought and shared me with a lot of his experience in the field of stifle joint anatomy. I would like to thank **Prof. Dr. Adel Bakeer, Professor** of Pathology Faculty of Veterinary medicine Cairo University, for his valued contribution and great help. Also, I would like to extend my sincere thanks to Dr. **Hani Abd El-Rhman**, the radiology consultant at Cairo scan-radiology- labs center for his work and writing reports on MRI results.

Introduction