

High tibial medial opening wedge osteotomy and ligament reconstruction for varus angulated anterior cruciate ligament deficient knee

Thesis

Submitted for fulfillment of MD degree in orthopedic surgery

By

Ahmed Mohamed Mohamed El-nokeety

M.Sc. Orthopaedic Surgery

Faculty of medicine, Cairo University

Supervised by

Prof DR.

Ahmed Amin Galal

Chairman and professor of orthopedic surgery

Faculty of medicine, Cairo University

Prof DR.

Ashraf Nehad Moharram

Professor of orthopedic surgery

Faculty of medicine, Cairo University

Dr

Waleed Reda Mohamed

Lecturer of orthopedic surgery

Faculty of medicine, Cairo University

Faculty of medicine

Cairo University

2015

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

((قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا
إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ))

الآية (32) سورة البقرة

صدق الله العظيم

Acknowledgement

ACKNOWLEDGEMENT

First and foremost, all thanks and gratitude to Allah, most gracious and most merciful.

I would like to express my deepest respect & gratitude to Prof. Dr. Ahmed Galal Chairman and Professor of Orthopaedic surgery, orthopaedic department, Cairo University for his continuous guidance and valuable advice for enriching this work.

I would like to express my highest appreciation to Prof. Dr. Ashraf N Moharram Professor of Orthopaedic surgery, orthopaedic department, Cairo University for his supervision and helpful criticism during actual conduction of this work.

I am extremely grateful to Dr. Waseed Reda lecturer of Orthopaedic surgery, orthopaedic department, Cairo University for his constant help, encouragement, meticulous constructive advice and keen supervision. Neither did he save his effort nor his time to accomplish this work.

I wish to extend my sincere gratitude to Prof. Dr. Ahmed Abdel-aziz Professor of Orthopaedic surgery, orthopaedic department, Cairo University for his kind support and help by providing his K.T-1000 arthrometer used in this work

Dedication

I dedicate this work to my family especially to my dear father who gave me support, soul of my mother and to my loving wife who always shows so much care, aid and patience.

I dedicate this work also to all members of the staff in Eltalaba hospital, Cairo University for their kind assistance to complete this work.

Lastly, my dedication and appreciation go to all the wonderful patients I treated over the past years, who, despite illness found it in their hearts to pray selflessly for my good health.

Abstract

Abstract

This prospective study was carried out from March 2012 to January 2014, included 20 patients. The patients' age ranged between 18-40 years, all were males, most injuries were sports injury and all of them suffered from chronic ACL insufficiency with varus deformity. All patients underwent simultaneous arthroscopic ACL reconstruction and medial opening wedge high tibial osteotomy (HTO) using T-locked plate and wedge bovine xenograft.

Clinical outcomes were assessed with the Subjective IKDC score, IKDC ligament standard evaluation form, Lysholm knee scoring system and KT-1000 arthrometer. Preoperatively, MRI and x-ray were used for ACL diagnosis and for measuring degree of varus, the standing hip knee ankle angle (HKA°, alignment), posterior tibial slope (PTS), lateral joint opening and degree of arthritis. Postoperative x-rays were done to evaluate deformity correction, union, fixation devices and tunnels position. All patients were followed up at 2 weeks and at 1, 3, 6, 12 and 18 months (average 12 ± 3.5 months) postoperatively. Clinical outcomes were assessed preoperatively and at 12 ± 3.5 months post-operatively.

All clinical scores improved significantly after surgery. The mean IKDC subjective score went from 42.9 points (range 34.2 to 57.7 points), preoperatively, to 79.2 points (range 72 to 95 points) at the end of follow up. Also, the final IKDC ligament evaluation showed marked improvement in both subjective and objective criteria, with 85% of patients were normal or near-normal. Moreover, 75% of patients had excellent knee function and 25% had good knee function according to Lysholm score. The anterior laxity of the patients' knee was also improved after surgery as 90% of patients were considered normal or near normal according to KT-1000 arthrometer measurement. Varus deformity was also improved after

Abstract

surgery as the mean HKA angle improved from 10.65° varus to 0.6° varus; with 60% of the patients showed normal alignment. Also, postoperatively all patients had mild lateral joint opening and the posterior tibial slope was slightly increased after surgery (from 6.06° to 6.32°). 80% of the patients returned to their preinjury level of activity at the end of the follow-up period. Postoperative complications were few and mild, and were easily managed.

It could be concluded that performing simultaneous arthroscopic ACL reconstruction and medial opening wedge high tibial osteotomy (HTO) using locked plate and wedge bovine xenograft was effective for obtaining a satisfactory correction angle, good clinical outcomes and lower complication rate.

Contents

List of tables.....I

List of figures.....V

List of graphs.....IX

List of abbreviations.....XI

Introduction.....1

Aim of the work.....3

Chapter 1: Review of literature

Anatomy of the anterior cruciate ligament.....4

Biomechanics and Kinetics of the ACL.....16

Diagnosis.....26

Treatment.....39

Chapter 2: Patients and Methods.....56

Chapter 3: Results.....93

Chapter 4: Discussion.....125

Case Presentation.....143

Summery and conclusion.....157

References.....160

Arabic summery.....176

List of tables

List of Tables

Table No.	Title	page
Table 1	Lysholm knee scoring scale.	35
Table 2	IKDC scale.	38
Table 3	<i>Hernigou</i> method for wedge size determination.	50
Table 4	Age incidence among involved patients.	57
Table 5	Frequency of involved knee among studied patients.	57
Table 6	Mode of trauma.	58
Table 7	Timing from injury.	58
Table 8	Pre injury level of activity.	59
Table 9	Primary vs. revision cases.	59
Table 10	Varus type.	60
Table 11	Lower-limb goniometry.	60
Table 12	Associated injury.	61
Table 13	Varus stress test.	61
Table 14	Knee function of studied patients.	62
Table 15	Effect of knee on activity level.	62
Table 16	Giving way of studied groups.	63
Table 17	Pain among involved patients.	63
Table 18	Swelling among studied patients.	64

List of tables

Table No.	Title	page
Table 19	Range of motion of involved patients.	64
Table 20	Lachman test score of studied patients.	64
Table 21	Anterior drawer test of studied patients.	65
Table 22	Pivot shift score among studied patients.	65
Table 23	One leg hop test scoring among studied patients.	66
Table 24	Overall IKDC evaluation of studied patients.	66
Table 25	Limp score among studied patients.	67
Table 26	Support among studied patients.	67
Table 27	Locking among studied patients.	68
Table 28	Instability score among studied patients.	68
Table 29	Pain among studied patients.	69
Table 30	Swelling among studied patients.	70
Table 31	Stairs climbing among studied patients.	70
Table 32	Squatting among studied patients.	70
Table 33	Overall Lysholm score among studied patients.	71
Table 34	KT-1000 among studied patients.	71
Table 35	Radiological findings of the involved patients (Pre vs. Post).	93
Table 36	Postoperative lower-limb goniometry.	94
Table 37	Posterior tibial slope (PTS) (Pre vs. Post).	95

List of tables

Table No.	Title	page
Table 38	Varus stress test.	96
Table 39	IKDC Subjective knee score (Pre vs. Post).	97
Table 40	Patient knee function.	98
Table 41	Effect on activity level.	99
Table 42	Giving way among studied patients.	100
Table 43	Pain scale according to activity level.	101
Table 44	Swelling according to activity level.	103
Table 45	Lachman test score of studied patients.	104
Table 46	Anterior drawer test of studied patients.	105
Table 47	Pivot shift score among studied patients.	106
Table 48	Harvest site pain.	107
Table 49	One leg hop test scoring among studied patients.	108
Table 50	Overall IKDC evaluation of studied patients.	109
Table 51	Limp score among studied patients.	110
Table 52	Support among studied patients.	111
Table 53	Locking among studied patients.	112
Table 54	Instability score among studied patients.	114
Table 55	Pain among studied patients.	115
Table 56	Swelling among studied patients.	117

List of tables

Table No.	Title	page
Table 57	Climbing stairs among studied patients.	118
Table 58	Squatting among studied patients	119
Table 59	Final evaluation according to Lysholm score.	120
Table 60	KT-1000 among studied patients.	121
Table 61	Postoperative infection.	122
Table 62	Postoperative fracture.	123
Table 63	Return to preinjury activities	124

List of figures

List of Figures

Figure No.	Title	page
Figure 1	Front view of a left knee showing the ACL in the femoral intercondylar notch.	5
Figure 2	The cross-sectional area varies in size and shape from the femur to the tibia.	5
Figure 3	2 distinct bundles, the AM and PL bundles.	5
Figure 4 (A-B)	Cadaveric model showing: (A) The AM bundle is taut in 90° of flexion; (B) the PL bundle is taut with the knee in extension.	7
Figure 5	Oval femoral attachment of the anteromedial (AM) and posterolateral (PL) bundles of the anterior cruciate ligament (ACL)	8
Figure 6	The lateral bifurcate and intercondylar (resident's) ridges were identified.	9
Figure 7	The insertion site for the ACL on the tibia.	10
Figure 8	Diagram showing the microanatomy of the cruciate ligament down to the collagen fiber level	11
Figure 9	The arterial supply to the knee	12
Figure 10 (A-B)	Varus instability of knee (A) Diagram showing a knee without bone defects but with laxity of the lateral collateral ligament, (B) Diagram showing a knee with a medial bone defect.	13
Figure 11	A P weight bearing x-ray of varus knee with elongated lateral collateral ligament.	15
Figure 12	The four bar cruciate linkage system.	16

List of figures

Figure No.	Title	page
Figure 13	The center of rotation of the knee moves posteriorly with knee flexion. ACL (AB) comes to lie horizontal when the knee is flexed to 90° while PCL become vertical (CD).	17
Figure 14	Categories of varus angulation based on cause.	21
Figure 15 (a-b)	Effect of posterior tibial slope on anterior tibial translation.	22
Figure 16	The center of rotation of angulation.	23
Figure 17	Mechanical axis and mechanical axis deviation (MAD). MAD = distance from midpoint of knee to mechanical axis of limb.	25
Figure 18	Medial proximal tibial angle defines relationship of proximal tibial joint orientation line to mechanical axis of tibia.	25
Figure 19	Representative angles for a non-deformed knee.	25
Figure 20 (A-B)	Palpation along the medial (A) and lateral (B) joint lines.	28
Figure 21	Lachman test.	30
Figure 22	Anterior drawer test in 90° flexion.	30
Figure 23	Pivot shift test.	31
Figure 24	Assessment of laxity by KT-1000 arthrometer.	32
Figure 25	Dial test.	32
Figure 26	Reverse pivot shift.	33
Figure 27	External rotation recurvatum test.	33
Figure 28	Varus stress test.	34
Figure 29 (A-B)	Cut of the bone wedge.	45

List of figures

Figure No.	Title	page
Figure 30	Anteroposterior and lateral views of the retrotubercle osteotomy.	46
Figure 31 (A-B)	(A) Maquet-type dome osteotomy.(B) True geometric correction.	47
Figure 32	An opening wedge osteotomy with an iliac bone graft.	49
Figure 33	Determination of wedge size.	50
Figure 34	<i>Slocum et al</i> determination of wedge size.	51
Figure 35	Measurement of tibial slope according to the method developed by <i>Brazier et al. 1996</i>	53
Figure 36	Preoperative planning for HTO.	72
Figure 37	Angle of correction.	73
Figure 38	Position of the patient.	74
Figure 39	Examination under anesthesia.	75
Figure 40	Empty notch (torn ACL)	75
Figure 41	Vertical skin incision on the anteromedial aspect of the tibia.	77
Figure 42	Graft preparation.	77
Figure 43	Preparation of STG graft.	78
Figure 44	Visualization of LFC through AL portal.	79
Figure 45	Visualization of LFC through AM portal.	79
Figure 46	Accessory AM portal.	79
Figure 47	Insertion of femoral guide pin.	80

List of figures

Figure No.	Title	page
Figure 48	Rosette reamer through the femoral tunnel.	81
Figure 49	Loop of vicryl No 2 through the femoral tunnel & grasper emerge the vicryl outside the skin of the thigh.	81
Figure 50	Tibial guide aimer.	82
Figure 51	tibial pin guide.	82
Figure 52	Graft passage through the tibial tunnel.	83
Figure 53	Fixation of the graft to femoral tunnel by interference screw.	83
Figure 54	Scopic assessment of ACL.	84
Figure 55	2 k-wires parallel to joint line and the other 2 k-wires directed towards the upper head of the fibula.	85
Figure 56	Oscillating saw cutting the wedge.	86
Figure 57	Gradual opening of the osteotomy with preserving the lateral cortex of the tibia.	86
Figure 58	Opening the wedge medially and posteriorly.	87
Figure 59	Graft insertion.	87
Figure 60	Checking the mechanical axis before plate fixation.	88
Figure 61	Plate fixation.	89
Figure 62	Wound closure.	89
Figure 63	Fixation by two k-wires.	123