Single Stage Anterior Cruciate Ligament Reconstruction and High Tibial Osteotomy

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Abstract

Background: An essential part of the knee joint is the ACL, anterior cruciate (ACL), which guards against pressures on the anterior tibia. It is one of the structures that is most often hurt during high-impact or sports activity. The aim of the study was to assess the effectiveness of single stage ACL surgery combined with osteotomy of the upper tibia in genu varum patients with ACL-deficient knees.

Methods: In a prospective case series randomized study, 20 patients with symptomatic combined ACL and varus knee deformity were assessed. These patients were treated surgically by simultaneous HTO and ACL reconstruction.

Results: Lyshom score preoperative and postoperative outcomes were compared, and the latter's findings were statistically significantly different (p 0.001). According to the Subjective Knee International Knee Documentation Committee (ICKD), the postoperative findings were significantly better than the preoperative ones (p0.001, p=0.01, p0.001 and p0.002, respectively) for effusion, pivot shift, lachman, and lack of extension.

Conclusions: Treatment of ACL injury in genu varum knees with combined ACL restoration and osteotomy of the upper tibia seems promising.

Keywords: *ACL, anterior cruciate, Tibial Osteotomy, sporting activities.*

INTRODUCTION

An essential part of the knee joint is the anterior cruciate ligament (ACL), which guards against pressures on the anterior tibia during translation and rotation. It is one of the structures that is harmed the most commonly during high impact or sports activity(1).

In order to halt further degenerative changes, anterior cruciate ligament repair is a common surgical treatment to restore knee stability in active adults after acute ACL injuries or in patients with chronic anterior knee instability (2, 3).

Varus misalignment increases ligament strain, which might have a detrimental impact on how well the ACL rehabilitation goes(4). osteotomy of the upper tibia is a commonly used treatment that can produce great outcomes with the right patient selection and attentive surgical technique. In every situation, it is essential to carefully assess both sagittal alignment and coronal alignment (i.e., varus and valgus) (i.e., tibial slope). For HTO, a number of methods have been described. (5) Combining HTO and ACL repair is usually advised in varus-angulated knees and ACL deficiency without severe cartilage deterioration. On how to treat persons with symptomatic varus and chronic ACL deficit, however, there is debate (5).

Knee stability may improve in those with varus deformity and ACL replacement, but medial compartmental OA cannot be stopped (6). Moreover, walking patients have an adduction moment due to varus alignment. This moment of adduction during the heel strike results in a varus push on the knee joint. (7) This might put stress on the graft used to reconstruct the ACL, which could cause it to fail sooner. Some authors suggest using a tier system, starting with an isolated HTO and only transitioning to an ACLR if the instability persists. A single-stage treatment prevents the need for a second operation and subsequent recovery period. (6)

This article offers a thorough treatment strategy for a individual with an errant Varus and an anterior cruciate ligament dysfunction. The therapy plan is developed using an evaluation of the lower extremities' discomfort, instability, and alignment. The purpose of the work is to assess the functional outcomes of single stage HTO-assisted ACL restoration in genu varum patients with ACL-deficient knees based on clinical and radiological findings.

Patients and Methods:

Twenty patients with symptomatic combined ACL and varus knee deformity, lateral thrust osteoarthritis, and medial compartment osteoarthritis were evaluated in a prospective case series randomised study at the school of medicine hospital at Cairo University (kasr Al Aini) and at al Haram hospital. These patients were treated surgically by simultaneous ACL repair and HTO.

Patients with revision reconstructed ACL, multi ligamentous knee injury, patients with inflammatory arthritis, age more than 40 years, young patients with open physis, medically unfit patient and severe varus deformity that required bone graft were excluded.

Each patient was checked out as soon as they arrived at the hospital, immediately following surgery, and six months later. Each patient underwent preoperative evaluation to determine their suitability for anaesthesia, which included clinical, radiological, and other preoperative laboratory examinations. Taking history: Following a full explanation of the injury's aetiology and a thorough history of the symptoms, the knee was subjected to a clinical examination. Recurrent swelling, recurrent bouts of instability (letting go), experienced with daily activities as reported by all patients, and medial side knee joint soreness were the most typical signs of an ACL insufficiency. Using functional scoring techniques as the Lysholm score and the International Knee Documentation Committee Subjective Knee, we gathered data from our patients.

The clinical evaluation included a look at both involved and unrelated knees. Each patient's We evaluated the active and passive range of motion as well as the efficiency of the extensor mechanism.

The radiological evaluation process comprised standing X-rays, MRIs, and Scanograms. A plain radiograph can provide insight into the type of deformity present since a scanogram can pinpoint the position and degree of coronal plane misalignment. Measurement of the posterior slope and preoperative patient discussion of possible outcomes.

Our examination was built around evaluation of the lower limb's stance position and gait pattern. A varus push established which side was involved. Patients were asked to stand with their ankles together while being observed at the knees to check the alignment. The knee was examined while the patient was supine for scars, apparent effusion, ecchymosis, wasting of the thigh, or joint position.

The knee's anatomical structures were palpated to determine whether they were tender to direct pressure. They included the femur, tibia, and tibial joint surfaces as well as the muscles and tendons that surround the knee. Passive medial and lateral movement was used to measure patellar mobility. A joint Moreover, the degree of any effusion was palpated if it was found.

The active and passive ranges of motion in each patient's knee were measured. While the patient is lying down, it is simple to examine the knee's range of motion. The results of particular testing for ACL impairment revealed knee instability.

Preoperative imaging

Plain X-Ray: Anteroposterior standing and lateral radiographs of both knees are helpful in diagnosis of ACL avulsion and associated fractures. By measuring the proximal medial tibial angle (PMTA) in long-exposure film, the involved knee's varus deformity was evaluated at the knee's joint level. The medial joint space was found to be smaller on anteroposterior X-rays of the knee.

Surgical procedures

In each case, a single prophylactic injection of a third-generation cephalosporin antibiotic weighing one gramme was given before the tourniquet was applied. Spinal anaesthetic was used to put all of the patients to sleep. A radiolucent table that allowed for intraoperative imaging of the hip, knee, and ankle was used to put the patients supine. The affected limb was drape-free and sanitised from the mid-thigh to the toes to allow for easy access and manipulation. While receiving spinal anaesthesia, each patient had a clinical examination, the Lachman's exam, among others. The anterior drawer test and pivot shifting test are difficult to conduct without anaesthesia. A 7-8 cm medial incision was made between the tibial tubercle and the tibial posteromedial cortex. The superficial medial collateral ligament's distal insertion is only partly connected because the periosteum was elevated. Freehand technique and a C-arm 2.5-mm were used to introduce a guidewire parallel to the joint line in the subchondral bone. To determine the posterior slope of the tibia, a guide wire is placed under fluoroscopic guidance from medial to lateral and from distal to proximal, commencing about 4 cm below the medial joint line and aiming at the top of the proximal tibia-fibular joint. (about 1 centimetre below the lateral joint line) A second osteotomy guide wire was inserted after the firstSubcutaneous tissue was dissected to locate the gracilis and semitendinosus tendons, and sartorial fascia was found and incised. The gracilis is cord-like and commonly palpable prior to skin incision in individuals with little subcutaneous fat. Avoid at all costs the IPBSN (saphenous nerve's infra-patellar branch), which superficially branches to the sartorius tendon on the knee's medial side. Deep within the sartorius, one may feel the STG as discrete structures. Above the gracilis and parallel to the semitendinosus, a precise incision is made for the sartorius tendon. For the autografting a hamstring and ACL repair, the semitendinosus and gracilis tendons were removed from the field.. A transplant procedure was used to prepare the tendons. Using a periosteal stripper, the muscle fibres on the proximal end of the tendons were gently released. A double-procedure was used to prepare the ST with GS tendons. The tendons were first double-looped folded. graft was joined to endbutton. The tendons were then quadrupled as this doubled loop was refolded once more.

After that, the graft was tensioned using a graft tensioner, and Ethibond No. 2 was used to suture the graft's end for around 3 cm. To tug on the graft, two Ethibond No. 2 wires were inserted through the graft. During arthroscopy, the traditional anterolateral and anteromedial gateways were used to look at the condylar notch, pouch above the patella, femoral head joint, the lateral and medial compartments, as well as lateral and medial gutters. The micro-fracture method was used to treat individuals with modest chondral lesions; patients with large chondral lesions were excluded from this investigation. The three-portal approach was used. Along the margins of the patellar tendon, the main anteromedial (AM) and anterolateral (AL) portals were formed.

A cannulated reamer was used to create the tunnel. The graft harvest incision was where the tibial tunnel entry was located. It was 1.5 cm medial to the tuberosity and around 4 cm distal to the tibial articular surface. The knee was then left hanging loose in 90o flexion as the scope was subsequently inserted into the AL portal. The guide aimer was passed through the AM portal with the guide set at a 55o angle. The guide arm's stylet tip was then positioned in the foot print's centre, halfway between the centres of both bundles of The notch-debridement method preserved 1 to 2 mm of ACL fibres at the tibial plateau. On the anatomic tibial footprint of the ACL, a tibial guide will be positioned. The distal tibial aperture of the tunnel should be somewhat anterior when a guide wire is drilled into the proximal tibia to minimise interference between the tibial tunnel and the proximal anterior cancellous screws. An annular guide arm that was transmitted to this location had a hole drilled through it for a guide pin. The tibial tunnel was reamed in accordance with the size of the graft after the guide had entered the joint.

Femoral tunnel placement

The scope was first made available through the primary AM portal for direct femoral footprint imaging. There is an AAM portal used for instrument operation and tunnel drilling. By bending the knee 120 degrees, the resident's ridge was brought into alignment with the femoral shaft and rendered horizontal. Using a 4.5-mm cannulated reamer and this method, a full tunnel through guiding wire was created to be able to prepare for the EndoButton femoral fixation. A depth gauge was used to gauge the femoral tunnel's length to be able to establish the right length for the EndoButton loop. Then the tunnel was made using a cannulated reamer. according according to the graft's size. Under arthroscopic supervision, that tube in the femur was resized with a rosette reamer in line with the graft's dimensions. A no. 2 Vicryl suture was threaded through the tunnel with the aid of a looped point of the guiding pin remaining inside the knee. The subchondral bone was next punctured with a 2.5-mm C-arm guidewire in a line with the joint line. to determine the tibia's posterior slope. The osteotomy was first performed anteriorly by chopping the medial, anterior, and posteromedial cortices distally to a guide wire so as to isolate the tibial tuberosity.

Statistical analysis

The statistical analysis application SPSS v26 was utilised (IBM Inc., Chicago, IL, USA). Quantitative elements were presented using the means and the average deviation. Frequency and percentages were used to show the qualitative metrics.

Results:

The patients' average age was 25, with a range of 18 to 28 years, All of the patients (100 %) were male (Table 1).

Table 1: number of patients according to age& duration of follow up and sex

Descriptive Statistics	
	Mean± SD
Age	21.800±3.005
Duration of follow up	10.867±3.925
Sex	**N (%)**
Male	15 (100.00)
Total	15 (100.00)

The affected side were the right in 13(86.67%) of the participants, and the dominant side were the right limb in 12(80%) of the patients, At enrollment six participants reported that they were smokers. 3 (20%) of 15 patients suffered contact trauma, The average time from operation to complete bone union was 3.5 months , 9 patient(60%) have complete union in less than 3 months (Table 2).

Table 2: number of particpants according to affected & dominant side, smoking, occupation , type of trauma, patients with medial & lateral meniscus injur and Duration of unin

Affected side		
	N	**%**
Right	13	86.67
Left	2	13.33
Total	15	100.00
Dominant side		
Right	12	80.00
Left	3	20.00
Total	15	100.00
Smoking		
Not amoking	9	60.00
Smoking	6	40.00
Total	15	100.00
Employee	6	0.004
Farmer	7	66.64
Banker	1	66.6
Officer	1	6.66
TYPE OF TRAUMA		
Pivoting non contact	12	80.00
Contact	3	20.00
Total	15	100.00
MEDIA MENISCAL INJURY		
Intact	5	33.33
MEDIAL Meniscal tear	5	33.33
Repaired	2	40.00
Menesctomy	3	60.00
LATERAL MENISCAL INJURY		
INTACT	5	33.33
Lateral meniscus tear	5	33.33
Repaired	3	60.00
Menectomy	2	40.00
Duration of unin		
Less than 3 Months	9	60.00
Post 3-6 Months	6	40.00
Total	15	100.00

Data was presented as frequency and percentage.

Comparing preoperative and postoperative results for Lyshom score revealed a statistically substantial variation in the latter's favour. ($p<0.001$) (Table 3)

Table 3: lysholm score comparing patients pre& post operative

Time	Lyshom score			Differences	Paired Test	
	Mean	±	SD	Mean ±SD	t	P-value
Pre-operative	39.800	±	9.518	-48.467 ±8.509	-22.059	<0.001*
Post-operative	88.267	±	5.483			

Data was presented as Mean± SD, P< 0.05.

By contrasting preoperative and postoperative data for ICDK, there was statistically substantial variation favouring post-operative results (p 0.001). Moreover, there was statistically more postoperative effusion than preoperative effusion (p = 0.01). With Pivot Shift and Lachman, there was a statistically substantial variation favouring postoperative results in comparison preoperative and postoperative results (p 0.001). Then there a statistically substantial variation favouring post-operative results in terms of absence of extension when preoperative and postoperative observations were compared (p = 0.002). (Table 4)

Table 4: ICDK score, Effusion, Pivot shift, Lachman test, Lack of extension comparing patients pre& post operative, Lack of flexion

ICDK	Pre-operative		Post-operative		Chi-Square	
	N	%	N	%	X^2	P-value
Normal A	0	0.00	10	66.67	30.000	<0.001*
Nearly normal B	0	0.00	5	33.33		
Abnormal C	10	66.67	0	0.00		
Severely abnormal D	5	33.33	0	0.00		
Total	15	100.00	15	100.00		
Effusion	**Pre-operative**		**Post-operative**		**Chi-Square**	
	N	%	N	%	X^2	P-value
Normal A	8	53.33	10	66.67	6.508	0.039*
Nearly normal B	2	13.33	5	33.33		
Abnormal C	5	33.33	0	0.00		
Severely abnormal D	0	0.00	0	0.00		
Total	15	100.00	15	100.00		
Pivot shift	**Pre-operative**		**Post-operative**		**Chi-Square**	
	N	%	N	%	X^2	P-value
Normal A	0	0.00	12	80.00	30.000	<0.001*
Nearly normal B	0	0.00	3	20.00		
Abnormal C	12	80.00	0	0		
Severely abnormal D	3	20.00	0	0.00		
Total	15	100.00	15	100.00		
Lachman	**Pre-operative**		**Post-operative**		**Chi-Square**	
	N	%	N	%	X^2	P-value
Normal A	0	0.00	15	100.00	30.000	<0.001*
Nearly normal B	4	26.67	0	0.00		
Abnormal C	9	60.00	0	0.00		
Severely abnormal D	2	13.33	0	0.00		
Total	15	100.00	15	100.00		

Lack of extension	Pre-operative		Post-operative		Chi-Square	
	N	%	N	%	X^2	P-value
Normal A	6	40.00	15	100.00	12.857	0.002*
Nearly normal B	5	33.33	0	0.00		
Abnormal C	4	26.67	0	0.00		
Severely abnormal D	0	0.00	0	0.00		
Total	15	100.00	15	100.00		
Lack of flexion	**Pre-operative**		**Post-operative**		**Chi-Square**	
	N	%	N	%	X^2	P-value
Normal A	10	66.67	12	80.00	0.170	0.680
Nearly normal B	5	33.33	3	20.00		
Abnormal C	0	0.00	0	0.00		
Severely abnormal D	0	0.00	0	0.00		
Total	15	100.00	15	100.00		

Degrees of varus improved postoperatively compared to preoperative (p<0.001). posterior tibial slope degree was improved significantly postoperative contrasted to preoperative (p<0.001*) (Table 5)

Table 5: Degree of varus and posterior tibial slope in patients pre& post operative

Time	Degree of varus	Paired Test	
	Mean ± SD	T	P-value
Pre-operative	8.467±1.846	14.623	<0.001*
Post-operative	0.933±0.799		
Time	**Posterior tibial slope**	**Paired Test**	
	Mean ± SD	T	P-value
Pre-operative	9.200± 1.373	-6.325	<0.001*
Post-operative	10.533 ± 1.356		

Data was presented as mean ± SD, * P< 0.05 is significant

Discussion

We looked at combination osteotomy of the upper tibia and ACL replacement in without a medial compartment, main varus knees osteoarthritis and just varus thrust in our sample of patients.

the knee's position in the sagittal plane should be taken into consideration while performing a valgus high tibial osteotomy and concurrent ACL restoration. Positive correlation exists between tibial translation and posterior tibial slope, with translation of the anterior tibia rising as the posterior tibial slope rises and falling with the posterior tibial slope is decreasing (99). Every 10o the posterior tibial slope rising causes a 6 mm the anterior tibial translation increasing (11). De day et al. (12) advocated lowering the tibial slope in knees with a torn ACL. if it was more than 10°. Increased posterior A higher risk has been linked to tibial slope. of re-injuring the ACL after ACL surgery, according to Webb et al. (13). The most vulnerable individuals are those having a less than 12-degree posterior tibial slope. Nevertheless, different studies disagree on how variations in posterior tibial slope impact ACL tensioning. In a study employing human cadavers, Stephen et al. (14), came to the conclusion that there is no increased risk of greater ACL loading when the posterior tibial slope is unintentionally changed. Griffin et al. (8) discovered that changes in the cruciate ligaments' in situ state is unaffected by the tibial slope. forces or antero-posterior translations. The postoperative posterior tibial slope angle reduced in our study.

James and O'Neill (10) analysed the performance of 10 patients, an average age of 32, during a 3 years later. experiences of each patient bracing and physical therapy, an effort is made to address the symptoms and indicators of symptomatic genu varum and chronic anterior knee instability were unsuccessful. Even though both the subjective functional score and the objective IKDC score increased following about 30% of these individuals were able to resume their sports after surgery. The authors conclude that combined high tibial osteotomy and ACL repair is effective based on these findings. should be considered for young, active individuals with medial joint degeneration as a salvage therapy and loose ACL. Neuschwander et al. claim that five patients, 27 years old on average underwent high tibial osteotomy and ACL replacement surgeries simultaneously (15).

The need for surgery was indicated by a number of symptoms, including difficulty moving about, instability during everyday activities, A constructive pivot shift is the varus alignment., soreness along the radiographic evidence of medial compartment arthrosis and the medial joint line. Patients were assessed over an average follow-up of 2.5 years using the Hospital for Special Surgery Knee Ligament Rating Questionnaire and the Tegner Activity Scale and the Lysholm scale. The results for four patients that ranged from good to extraordinary based on the aforementioned criteria. A reasonable result for the fifth patient was seen, which was attributed under correction at the location of the osteotomy. Also, Every period of turmoil was entirely gone, the pain along the joint lines had greatly lessened, and all patients had some degree of success getting back into sports. According to the authors, the combined HTO/ACL repair was carried out to provide operational stability for regular life activities and may decrease how degenerative arthritis develops. Even so, they emphasised In this patient population, increased levels of activity shouldn't be anticipated.

Two studies examined the distinction between patients with complaints of instability and those with pain sensations in young or middle-aged patients with medial compartment OA and chronic ACL insufficiency (16). Williams et al (17) 's advice treating individuals with the combined surgery while taking instability, pain, and alignment into account. These patients were said to have a persistent ACL dysfunction, OA in the middle chamber, and Varus malformation with a considerable instability complaint.

Because simultaneous surgery takes up less of the length of the operation, is safer, does not conflict with the positioning of the tibial tunnel does not affect the ACL's postoperative rehabilitation program, it is preferred to staged surgery.

Conclusions:

Combining ACL repair with high tibial osteotomy is one possible method of treating

ACL injuries in varus knees that are weak in the ligament. The efficacy and security of this approach have been demonstrated in short- and medium-term monitoring.

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