

## Arthroscopically Assisted Anterior Cruciate Ligament Anatomic Reconstruction Using Quadruple Semitendinosus and Gracilis Graft

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**Abstract: Background:** If complete anterior cruciate tear is diagnosed, surgical treatment mandatory to reconstruct ACL after a period of rehabilitation to regain muscular activity and to avoid its atrophy, this facilitates early return to work after surgery. **Object:** To reconstruct the torn ACL by Semitendinosus and Gracilis tendons using Arthroscopically assisted Anatomic Quadruple Bundle Technique. **Methodology:** The study comprises 30 patients who underwent single bundle anterior cruciate ligament reconstruction using quadrupled hamstring graft in Al-Azhar university hospital Damietta, followed up for average period of 12 month. All patients were operated for anterior cruciate ligament reconstruction using endobutton on the femoral side using trans-portal technique (accessory antero-medial) and interference screw on the tibial side. **Results:** In surgical management of cases which had chronic anterior cruciate ligament tear, we had the choice to do arthroscopically assisted anatomic ACL reconstruction using quadrupled Gracilis and semitendinosus tendon graft, fixing it through bony tunnels, from above in femoral tunnel by endobutton and from below in tibial tunnel by biodegradable interference screw, this unique technique offered us good results as it allow early incorporation of the graft in the bones, as well as it done through small incision to attain long powerful tendon graft had great intensity, this lower risk of joint stiffness or other complications, while increases the strength and stability of the knee, following this method we had attained good satisfactory results. **Conclusion:** The goals of ACL reconstruction are to restore stability of the knee, allow the patient to return to normal activities, including sports, and to delay the onset of osteoarthritis with associated recurrent injuries to the articular cartilage and loss of meniscal functions. During the past decades arthroscopically assisted techniques have been an accepted method of reconstructing the ACL.

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**Keywords:** ACL, Quadruple Semitendinosus, Gracilis

### 1. Introduction

The anterior cruciate ligament (ACL) consists of 2 functional bundles the anteromedial (AM) and posterolateral (PL) bundles named for their position on the tibia, Recent research has indicated that 2 distinct bundles, separated by a septum of vascularized connective tissue, are already in existence in a fetus after approximately 20 weeks of development, which leads one to assume that the 2-bundle anatomy of the ACL is hereditary<sup>(1)</sup>.

For the femoral insertion site, the prominent landmark is the resident's ridge (lateral intercondylar ridge), which serves as the anterior limit of the ACL in the anatomical position. It is located on the medial wall of the lateral femoral condyle and, in the arthroscopic view of the orthopedic surgeon with the knee at 90° of flexion, marks the upper border of the ACL<sup>(2)</sup>.

Rupture of ACL is a common and severe injury during sports and leisure time activities. The treatment alternatives are surgical or non-surgical. There is a definite place for non-surgical treatment. But it is extremely difficult exactly to determine the role of

non-surgical treatment and for whom it should be used. An almost universally accepted indication for ACL reconstruction is heavy demand on knee function during work or leisure time and or repeated episodes of giving way in spite of complaint rehabilitation training<sup>(3)</sup>.

Chronic ACL insufficiency is associated with recurrent giving way, several studies had reported that, in addition to increased anterior posterior laxity (A-P laxity), these knees suffer from a change in kinematics<sup>(4,5)</sup>.

An ACL injury predisposes the knee to subsequent injuries to the menisci and cartilage and finally the early onset of osteoarthritis<sup>(6,7)</sup>.

A goal of anatomic ACL reconstruction should be to create a femoral tunnel aperture that resembles the native attachment site in terms of size and orientation.<sup>(8,9)</sup>

### Aim of the Work

To reconstruct the torn ACL by Semitendinosus and Gracilis tendons using arthroscopically assisted anatomic quadruple bundle technique.

## 2. Patient and Methods

The material of this study consisted of thirty patients with chronic anterior cruciate ligament deficient knees, patients had initial injury to their knees while engaged in sports activities mostly football, or involved in other injuries as working and road accidents. All patients were admitted from out-patient clinic, and operated by arthroscopic unit team, orthopedic department, Al-Azhar university hospital, Damietta. Study was started from January 2015 till December 2017, over a period of 3 years. Average follow up period was 12 months.

### Inclusion and exclusion criteria

#### Inclusion criteria

1. All cases were diagnosed to have chronic complete ACL tear clinically and radiologically.
2. All cases were males.
3. Age group from 18 up to 40 years.
3. Examined and reconstructed by the same surgery team.
4. Radiological ACL deficient knee confirmed by MRI.
5. Associated Meniscal injury or not.

#### Exclusion Criteria

1. Observed chondral lesions that could modify the post op rehabilitation protocol.
2. Collaterals and /or PCL injuries.
3. Acute ACL tear within 3 month from injury time.
4. Partial ACL tear, one bundle injury.
5. Chronic ACL insufficiency with osteoarthritis.
6. Infection whether superficial or septic arthritis.
7. Bilateral knee injuries.
8. Associated tibial plateau fractures or any implant in proximal tibia.
9. Age above 40 yrs.
10. Previously operated knee.
11. Spontaneous rupture caused by chronic illness.
12. Stiff knee and arthrofibrosis.

Patients were followed-up over a period of 12 months, (ranging from 10-14 months). Follow-up visits had done every 2 weeks for 3 months, then every month all-over follow-up period.

The diagnosis of chronic ACL tear had been made on the basis of history, clinical examination, and MRI finding of complete ACL tear. All patients were examined by pivot shift test, anterior drawer test and Lachman test before arthroscopy under anaesthesia.

### Methods

#### Management Protocol

Patient had physiotherapy program for quadriceps and hamstring strengthening preoperatively. The patient was admitted one day before surgery.

All patients had arthroscopic ACL reconstruction using quadrupled gracilis and Semi-tendinosus autograft fixed through suspensory fixation by endobutton in the femoral tunnel and bioabsorbable interference screw in the tibial tunnel.

### Operative Technique

Tourniquet wrapped around upper thigh as high as possible, over a cotton pad to protect sciatic nerve from compression, then leg elevated for 3 minutes, then the pressure was elevated within the pneumatic tourniquet up to range 300-350 mm hg according to patient's musculature.

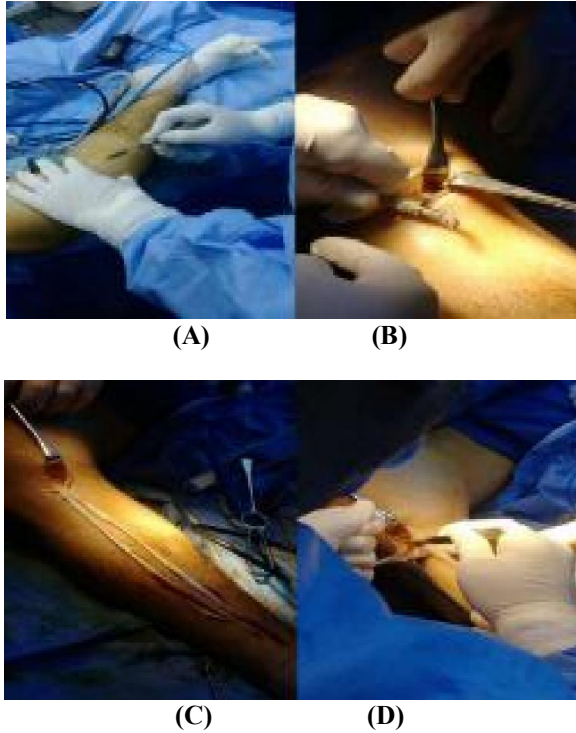
Using povidone iodine foot, leg, knee as sterilized from foot down to tourniquet and surgical sheets applied, leg was wrapped to its middle by a separate sheet. With hip flexed to 45 and knee to 90 degrees, we used anterolateral and a portal slightly medial to the standard anteromedial portal to assist in better viewing of the femoral foot print and femoral tunnel positioning. (Figure1).



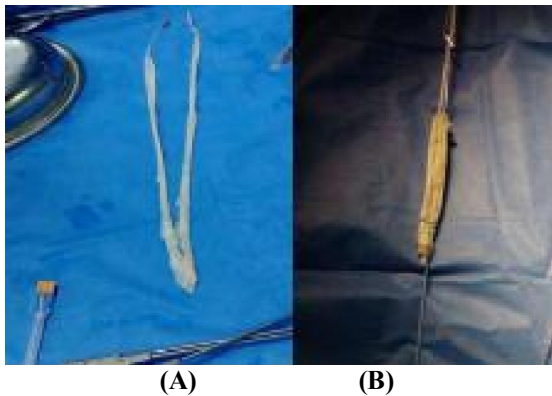
**Figure 1:** Incision and portals of entry

For graft harvesting, a 2 cm incision was made midway between the tibial tuberosity and the posteromedial border of the tibia. The pes anserinus was exposed. The sartorial fascia was opened to reveal the gracilis and the semitendinosus tendons. The tendons were carefully dissected and detached from their connections to medial head of gastrocnemius muscle then harvested using a tendon stripper directed towards ischial tuberosity, then freeing the tendons with their periosteal attachment to the tibia (Figure 2).

After tightening the graft by tensioner, it was quadrupled over an endobutton of appropriate size and sutured together as a single unit, and then tensioned again (figure 3).



**Figure 2:** Graft harvesting (A) Site of skin incision. (B) Dissection and tendon identification. (C) Stripping of Gracilis and Semi T tendons. (D) Separation of tendons from its periosteal connection.

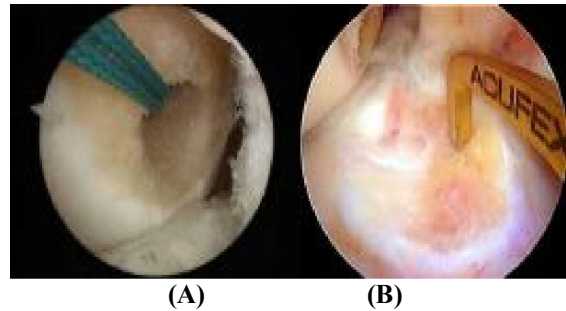


**Figure 3:** Graft Preparation (A) Gracilis and Semi T tendons were prepared and become clean (B) Tendons were Quadrupled over the endobutton with tibial side sutured and prepared.

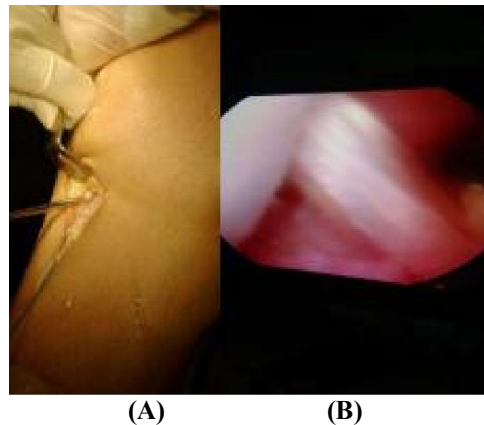
Femoral tunnel placement was done by detecting femoral foot print in the notch over the medial wall of lateral femoral condyle. Flexion of the knee to 120 degrees with hip abduction then guide passer inserted through most medial and slightly inferior point to ensure exit of the guide from lateral wall femur. Cannulated drill bit of a size 4 mm made a drill hole around the guide along the whole length of the canal, then length was measured.

Another larger sized drill bit of the same diameter as the femoral side of the graft entered and make a drill hole to a definite length calculated by adding size of the endobutton to 8mm which is the length of the button in order to allow release of the button from lateral cortex of the femur for flipping (e.g. if the femoral length is 40mm, we use endobutton of 20mm size, we drill all the tunnel by 4mm bit, then using bit of the same diameter as femoral side of the graft to the length of  $20+8=28$ mm). Through eye of the guide passer, we passed thread from the medial portal through the femoral tunnel to outside the skin over the lateral thigh.

C-guide angle of tibial tunnel adjusted to 55 degrees, and was put at angle of 30 degrees to the shaft of the tibia, and passed through anteromedial portal to rest in the center of tibia just behind the anterior horn of lateral meniscus, then the guide wire was entered through the angle protecting its tip inside the knee to avoid chondral injury, size of tibial tunnel was the same as diameter of tibial side of the graft (figure 4).



**Figure 4:** Tunnel placement (A) Site of femoral tunnel. (B) Placement of C-angle for tibial tunnel exit inside the joint.



**Figure 5:** Graft fixation. (A) graft was tightened, and biodegradable screw for fixation of the graft in tibial tunnel with knee flexed 15 degrees, (B) Arthroscopic view of the new ACL after complete work had finished.

Threads brought to outside through tibial tunnel using a hook, then pulling the threads of the end button to outside the femur. Passing the graft then flipping of the button, cycling the graft for tensioning by pushing the leg to make repeated cycles of flexion-extension while grasping the tibial side firmly, we stayed grasping tightly while fixing the graft in tibial tunnel by biodegradable interference screw of size larger than tunnel by 1-2 mm with knee flexed 15 degrees (figure 5).

After decompression of the tourniquet, suction drain size 12 was passed into the joint then closure of donor site and portals then wrapping the knee with cotton and Crepe bandage (figure 6).



**Figure 6:** wound closure over a suction drain.

Early post-operative follow-up, treatment was given in the form of fluids, parenteral triple antibiotic combination ( Metronidazole drip every 12 hours for the first 48 hours, ceftriaxone 1 gm. vial every 24 hours for 5 days, ampicillin-sulbactam 1.5 gm. every 12 hours for 5 days), analgesic, anti-edematous, for 5 days, and anti-embolic for 10 days.

#### Follow-Up

Range of knee motion to 30 degrees was allowed in the bed just after effect of anaesthesia on the lower

limbs had disappeared, with increased degree of knee flexion by 30 degrees every week till full knee flexion. Heel was elevated from a bed by about 15 cm. to attain full extension of the knee. Quadriceps exercises started from 2<sup>nd</sup> post-operative day.

Suction drain was removed usually after 48 hours, judged by amount of blood inside to be less than 50 cc over the last 24hrs. Surgical stitches were removed after 14 days post-operative.

Ambulation using 2 crutches, bearing is started 3rd day post-operative on the sound limb, then partial weight bearing from the day 21 post-operative till full weight bearing without assistance.

Patients were advised to come to orthopedic outpatient clinic in Al-Azhar university hospital, Damietta, for follow-up every 2 weeks for the first 3 months post-operative, then every month till the end of 12 months. In every visit for each patient, clinical examination was done for tenderness, effusion, range of motion, infection, thigh circumference was measured, evaluation of new ACL done by ligamentous examination by Anterior drawer, Lachman tests, and reported in his own sheet.

Plain X-ray done every 3 months, MRI done by 9 months post-operative.

In our study we had followed rehabilitation protocol which ends by 24 weeks post-operative, Based on Wright et al 2008.<sup>(10)</sup>, Meara O and Brown V 2012<sup>(11)</sup>.

#### Post-Operative Radiological Assessment

Radiological assessment was done using plain X ray and MRI.

From each method specific data was obtained to evaluate the reconstructed ACL and associated lesions if found.

By X ray we could determine; tunnel orientation, enlargement, hardware type, and other concomitant bony pathology.

### 3. Results

#### Grading Of the Results

**Table 2:** The end result

RESULT		NUMBER	PERCENTAGE	AVERAGE SCORE
Satisfactory	Excellent	20	66 %	45
	Good	8	27 %	43
Unsatisfactory	Fair	2	7 %	40
	Poor	0	0 %	0
<b>TOTAL</b>		30	100 %	43

In this study, the average total score, was 42.5 at the one year of follow up with range 40\_45 points. This compared to the preoperative average score of 30 points. There were 20 patients (67%) with excellent

results, (average score 45 points), 8 Patients (27%) with good result (average score 43 points). 2 patient (7%) with fair result (average score 40 points) and no patients (0 %) with poor result score 32. (table2)

**Subjective knee score management**

In our study we used a questionnaire to assess knee score, applied through Lysholm knee score and IKDC scoring scales according to Collins et al., 2011<sup>(12)</sup> as the following:

The Lysholm Scale currently consists of eight items that measure: pain (25 points), instability (25 points), locking (15 points), swelling (10 points), limp (5 points), stair climbing (10 points), squatting (5 points), and need for support (5 points). Every question response has been assigned an arbitrary score on an increasing scale. The total score is the sum of each response to the eight questions, and may range from 0-100. Higher scores indicate a better outcome with fewer symptoms or disability

IKDC is a subjective scale that provides patients with an overall function score. The questionnaire looks at 3 categories: symptoms, sports activity, and knee function. The symptoms subscale helps to evaluate things such as pain, stiffness, swelling and giving-way of the knee. Meanwhile, the sports activity

subscale focuses on functions like going up and down the stairs, rising from a chair, squatting and jumping. The knee function subscale asks patients one simple question: how was their knee immediately after injury versus how is their knee at present after operation.

Scores were obtained by summing the individual items, then transforming the crude total to a scaled number that ranges from 0 to 100. This final number is interpreted as a measure of function with higher scores representing higher levels of function<sup>(12)</sup>.

It was found that 90% of patient total subjective score less than 30 points and 10 % more than 30 points, the maximum score were 35 points. The minimum score was 15 points.

**Objective evaluation**

**Ligament examination**

**Anterior Drawer test**

19 Patients (63%) who had negative ADT was recorded as excellent, 9 patients (30%) who had grade I was recorded as good results, while grade II ADT recorded as poor results in 2 patients (7%). (table3)

**Table 3:** Relation of ADT to the end results.

ADT	Satisfactory				Unsatisfactory				Total		Preoperative	
	Excellent No	%	Good No	%	Fair No	%	Poor No	%	No	%	No	%
<b>Negative</b>	19	63	0	0	0	0	0	0	19	63	0	0
<b>Grade I</b>	0	0	9	30	0	0	0	0	9	30	4	13
<b>Grade II</b>	0	0	0	0	2	7	0	0	2	7	17	57
<b>Grade III</b>	0	0	0	0	0	0	0	0	0	0	9	30
<b>Total</b>	19	63	9	30	2	7	0	0	30	100	30	100

**Lachman test**

17 patients who had negative Lachman test were recorded as excellent and 11 patients (37%) had good

results. the relation between Lachman test and end results described in (table 4).

**Table 4:** The relation of Lachman test to end results.

Lachman test grades	Satisfactory				Unsatisfactory				Total		Preoperative	
	Excellent		Good		Fair		Poor					
	No	%	No	%	No	%	No	%	No	%	No	%
<b>Negative</b>	17	56	2	7	0	0	0	0	19	63	0	0
<b>Grade I</b>	0	0	9	30	0	0	0	0	9	30	3	10
<b>Grade II</b>	0	0	0	0	2	7	0	0	2	7	20	67
<b>Grade III</b>	0	0	0	0	0	0	0	0	0	0	7	23
<b>Total</b>	17	56	11	37	2	7	0	0	30	100	30	100

**Pivot shift test**

26 patients (86%) who had negative Pivot shift test were recorded as excellent and 4 patients (14%) had good results. the relation between Pivot shift test and end results described in (table5).

evaluation either by aspiration or removal of one or two stitches at donor site. Superficial infection occurred in 2 patients (7%) one of them was cleared completely by antibiotics, the other entered operative theater for debridement of the donor site, and tightening over the tibial interference screw. No deep infection was encountered in this series. No septic arthritis.

**Complications**

**Early Complications**

5 patients (17%) developed post-operative hematoma at site of graft harvest which required

### Late Complications

Contractions; 7 Patients (23%) had a post-operative limitation of either flexion or extension. By

continuation of physiotherapy combined with home exercise six to seven month post-operative, 3 patients regained satisfactory range of movements.

**Table 5:** The relation of Pivot shift test to end results.

Pivot Shift test grades	Satisfactory				Unsatisfactory				Total		Preoperative	
	Excellent		Good		Fair		Poor		No	%	No	%
	No	%	No	%	No	%	No	%				
<b>Negative</b>	26	86	0	0	0	0	0	0	19	63	0	0
<b>Grade I</b>	0	0	4	14	0	0	0	0	9	30	4	13
<b>Grade II</b>	0	0	0	0	0	0	0	0	2	7	20	67
<b>Grade III</b>	0	0	0	0	0	0	0	0	0	0	6	20
<b>Total</b>	26	86	4	14	0	0	0	0	30	100	30	100

### End result

According to Lysholm score, there is twenty patient (67%) with excellent result, eight patients (27%) with good result, and only two patients (6%) with fair result.

According to IKDC score, there is seventeen patient (57%) with excellent result, ten patients (33%) with good result, and three patients (10%) with fair result.

### 4. Discussion

The study comprises 30 patients who underwent single bundle anterior cruciate ligament reconstruction using quadrupled hamstring graft in Al-Azhar university hospital Damietta, followed up for average period of 12 month. All patients were operated for anterior cruciate ligament reconstruction using endobutton on the femoral side using trans-portal technique (accessory antero-medial) and interference screw on the tibial side.

All patients were male and no female in our study because of less exposure of them to sport injuries in our society as males, Ages ranging from 20 to 40 years of age. 60% were injured in the right knee and 40% were injured in the left knee. Brown et al studied the incidence of the sidedness of limb injury and sex incidence and stated that although their study pointed that females are more prone to this injury, the incidence is yet, more in males due their increased exposure to work and sport injuries<sup>(13)</sup>.

Traditionally, age beyond 40 years was viewed as a relative contraindication for ACLR, this matches with our believes in this study. While favorable outcomes may be achieved nonoperatively, residual instability and activity restrictions may be undesirable to a mounting number of older adults. Therefore, over the last two decades, studies have challenged this principle, demonstrating positive outcomes in patients over 40 years of age<sup>(14)</sup>.

In This study we had to exclude patients with bilateral ACL injuries, as it needs two-stage bilateral ACL reconstruction, so it is much more time consuming as well as it needs long time for follow up, and two rehabilitation programs at two different times. Matjaz Sajovic in 2013<sup>(15)</sup> had challenged this principle and decided to perform one-stage bilateral ACL reconstructions using hamstring tendon autograft in a case report. At 7 years follow-up, the patient's opinion was that both ACL reconstructed knees had normal function and he was still on his preinjury level of activity. He recommends performing one-stage, bilateral ACL reconstructions using hamstring tendon autograft. The overall result of the Lysholm knee score for left knee was 95 and for right knee were 100. On clinical examination, he had no effusion and his range of movement was full from 5° of hyperextension to 135° of flexion in both knees. He had negative Lachman and pivot shift signs in both knees.

Some studies suggested waiting for at least 3 weeks before ACL reconstruction from the time of injury<sup>(16)</sup>. It is similar to protocol of management in our study, as we had to delay surgery after medical treatment and pre-operative physiotherapy program for at least 3 weeks. We found that delay in surgery did not grossly affect the outcome.

Clinical evaluation of the patients for ACL reconstruction was done using the anterior drawer, Lachman and the pivot shift tests. All cases in our study had complete ACL tear.

Our results are nearly similar to that of Dr Deepak CD et al. 2015<sup>(17)</sup> had a study on 25 patients 21 male and 4 female patients underwent ACL reconstruction using quadrupled STG tendon autograft and all these patients underwent graft fixation using endobutton in the femoral tunnel and hybrid fixation with suture disc and an anchoring interferential screw within the tibial tunnel, femoral tunnel had done using transportal technique. He conclude that the functional

outcome of arthroscopic anterior cruciate ligament reconstruction using quadrupled semitendinosus and gracilis tendon autograft is excellent to good (92%). Using IKDC scoring, the results were normal in 14, nearly normal in 10 and abnormal.

Our results are nearly similar to some studies had used Semi-Tendiosus and Gracilis tendon grafts but used different techniques. Comparing clinical results Benea et al.2013<sup>(18)</sup> had compared results using all-inside (group A) and transtibial techniques (group B) done for 46 patients over follow up period of 6 months. Final assessment using IKDC score at 6 months, 81.3 group (A), 81.1 group (B) with no significant difference, he did not use Lysholm. Regarding complications, he had 1 septic arthritis, 1 hemarthrosis.

Schurz et al. 2015<sup>(19)</sup> had a study done for 24 patients using All-inside technique with follow up period over 2 years. He used IKDC score which improved to 88.6 and Lysholm score 88.4 with no complication were reported. IKDC scores in our study improved but is not clearly accurate because there is the lack of some patients contribution to item selection indicating that content validity cannot necessarily be assumed.

Although the IKDC system is less subjective than most other scoring systems, it is possible it may give a less favorable result compared to other evaluating systems<sup>(20,2)</sup>. This appeared clearly in our study, as we used Lysholm and IKDC scores for assessment of knee function, we found that According to Lysholm score, there was twenty patient (67%) with excellent result, eight patients (27%) with good result, and only two patients (6%) with fair result. When IKDC score used, there was seventeen patient (57%) with excellent result, ten patients (33%) with good result, and three patients (10%) with fair result.

We used a rehabilitation program that recommend delay of weight bearing to 7th post-operative day with aid of knee immobilizer and 2 crutches with closed chain exercises for the first 2 weeks, with continuous protocol of rehabilitation that ends by 24 weeks. we had 27 patients (90%) were able to return to full previous pre-injury activity level, 3 patients (10%) returned to only light recreational activity.

Gulick TD<sup>(20)</sup> in 2002 studied on 57 patients and concluded that 84% of their patients returned to pre injury level of function. He used rehabilitation program which not recommend the use of knee immobilizer, and allowing parial weight bearing from day one post-operative by aid of crutches. We found that our results are better.

## Conclusion

The goals of ACL reconstruction are to restore stability of the knee, allow the patient to return to normal activities, including sports, and to delay the onset of osteoarthritis with associated recurrent injuries to the articular cartilage and loss of meniscal functions. During the past decades arthroscopically assisted techniques have been an accepted method of reconstructing the ACL.

## Recommendation

We recommend starting physiotherapy as early as possible after injury to avoid thigh muscle atrophy. Planning for arthroscopic reconstruction should be after a period of three months to allow enough time for healing of simple injuries inside the knee as synovitis, chondral lesions, and other ligamentous sprain, also for physiotherapy to strengthen thigh and calf musculature.

Also, we recommend using quadrupled semitendinosus and gracilis (hamstring) tendons autograft because they have less morbidity and lower rate of complications.

After surgical reconstruction, a rehabilitation program is recommended to allow early return to a painless and fully functional daily life. Cyclic follow up and frequent assessment of knee stability together with quadriceps and hamstring strengthening exercises will decrease the load on the graft and allow easy comfortable daily activities, also early return to sport practice.

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