Arthroscopic Anterior Cruciate Ligament Reconstruction Using Quadrupled Semi-Semitendinosus and Gracilis Tendon without Side Screw Fixation

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Abstract

Background: Several graft options exist for reconstruction of the deficient ACL knees. The Semitendinosus-Gracilis Composit Autografts (STG) is used widely for its advantage over patellar tendon graft. A recent increase in the popularity of hamstring tendon is due to technique which allows it to be doubled or even quadrupled, and this improves tensile strength and cross sectional diameter of the graft. There is a recent increase in the popularity of arthroscopic ACL treatment upon open surgery.

Material and Methods: This study included 40 patients, 4 females and 36 males, the main presentation was repeated episodes of giving way of the affected knee after major trauma during football playing. The mean age at the time of surgery ranged from 20 to 40 years. Diagnosis included MRI and arthroscopic examinations in 25 patients, Lachman’s pivot shift test were positive in all patients. Hamstring tendons were fixed by non absorbable 2 transfixing pins in the femoral tunnel and loop in the tibial tunnel. The results were evaluated according to the International Knee Documentation Committee (IKDC) scale.

Results: Thirty nine out of forty patients with arthroscopic ACL reconstruction returned to the pre-injury level, one patient had reactive laxity. There was neither anterior knee pain nor knee effusion.

Conclusion: Arthroscopic ACL treatment using hamstring tendons achieved very good results, with low rate of complications, such as harvest site morbidity, anterior knee pain and knee effusion.

Key Words: Patellar – A CL – Hamstring.

Introduction

THE anterior cruciate ligament is the main knee stabilizer. It passes anteriorly, medially and distally from the femur to the tibia, twists on itself in a spiral manner not as single cord but rather as a collection of fascicles [1].

That fan out over a broad flattened area. The main function of the ACL is to prevent anterior translation of the tibia in relation to the femur [2]. In addition, it prevents hyperextension of the knee and restrain internal tibial torsion [8].

The incidence of ACL injuries is estimated as 98 knee ligament injuries per 100,000 per year in the United States.

Current techniques of ACL treatment employ a variety of autograft and allograft tissue to replace the injured ligament [4].

The patellar, hamstring autografts are the most commonly used grafts. Other autografts include tendo-achillis and quadriceps tendon [9]. Allograft and synthetic ligament also exist for ACL reconstruction but are associated with high rate of late complications and failure of the implant [11].

The bone - patellar tendon bone graft is typically used for ACL reconstruction and remains the gold standard, its advantages include its high tensile strength and bone to bone healing [11].

Its disadvantages include anterior knee pain, patellar fracture and quadriiceps atrophy [9,10].

A recent increase in the popularity of the hamstring tendons has failed because of many other techniques. Allowing hamstring grafts to be doubled or even quadrupled improved the methods of fixation, the strength of this construct has been shown to be equal to or greater than the strength of bone patellar tendon – bone graft of similar dimension [8].

However, healing of the soft tissue graft to bone and formation of new transition zone takes more time [8].

The use of metal screw fixation offered the advantage of good fixation but was limited with ACL reconstruction using hamstring tendon because of graft laceration [8].
Arthroscopically, assisted techniques for ACL reconstruction have resulted in smaller incision, short recovery and rehabilitation.

It gives the surgeon advantages of visual enhancement, magnification of inter condylar notch, anatomical insertion of tibial and femoral tunnels, as well as treating associated meniscal injuries, cartilage defect and removal of the loose bodies [11].

Patients and Methods

A prospective study of 40 patients with anterior tibial translation due to ACL deficiency was carried out between December 2005 and May 2007 in Bani Suef University and Bani Suef Insurance Hospitals.

These patients were followed-up for an average of 18 months. Thirty six patients were males and only four females in the age group between 20 and 40 years.

The aged group ranged from 20 to 30 years showed the highest incidence of ACL injury.

The right knee was involved in 27 cases while, the left knee was affected in 13 cases. Falling to the ground with rotation of the femur on steady tibia during sports represented the most common mechanism of injury. 10 patients were injured during daily activities, 15 patients had been subjected to MRI investigation. 25 patients had previous knee arthroscopy, either for diagnostic or treating meniscal injuries.

The main time of patients presentation ranged from 2 to 4 months after surgery.

Inclusion criteria for patients in this study were patients with symptomatic ACL deficiency manifested by repeated attacks of giving way with evident history of significant trauma, positive pivot shift, MRI evidence of torn ACL in 15 patients and arthroscopic evidence of torn ACL in 25 patients.

Patients were evaluated according to the International Knee Documentation Committee Scale, and the results were analysed were a $p$ less than 0.05 was considered significant.

Surgical technique:

The ACL was reconstructed with single incision, arthroscopically assisted method. All of them were operated under general or spinal anesthesia. The patients were placed in supine position and pivot shift test was done to confirm the diagnosis.

Antibiotic was given before application of tourniquet. A pneumatic tourniquet was then applied, and sterilization of the skin with betadine solution.

The affected limb was placed in figure of four position to relax tension on the tendinous structures and the saphenous nerve. The incision was centered 9 cm distal to the joint line and 2 cm medial to the tibial tubercle.

The incision was oriented obliquely to avoid injury of infrapatellar branch. Subcutaneous tissue and fascia were incised to expose the tendons.

A right angled retractor was used to apply traction to the tendon. Using blunt finger dissection and scissors, the tendon of the gracilis and semitendinosus could be isolated towards their musculotendinous junction to facilitate passage of the stripper over the tendon to avoid premature amputation of the graft.

While advancing the tendon stripper, counter traction was applied using the right angled retractor. The tendons were dissected with the periosteum to maximize their length. The graft was prepared using periosteal elevator to remove the muscles from the tendon.

The proximal end of the tendon are tapered and folded over themselves to produce a four-strand graft.

The open end of the graft was stitched by a number 5 ethibond for a distance of 2 cm. Each thaw should encircle $\frac{3}{4}$ to $\frac{4}{5}$ the tendon and to be a port to facilitate the passage of tendon through the drill holes.

The folded part of the graft is left free for the passage of the metal loop, then was sized and tensioned using a tensiometer into 20 pounds for 10 minutes to remove any laxity.

Diagnostic arthroscopy was done through standard anterolateral and anteromedial portals. Any meniscal injury was treated. The old ACL remnant was removed to visualize the ACL foot print on the tibia as well as posterolateral wall of the notch.

Tibial and femoral tunnels were created on the basis of measured diameter of four strand hamstring graft from each patient.

The ACL guide (tibial) is passed through the anteromedial portal and placed 7mm in the front of the PCL or more posterior.

The angle of the tunnel is 55 degrees to the tibial plateau. The tibial tunnel is initially drilled...
with a cannulated drill corresponding to the diameter of the four strand graft.

The knee is then flexed 90 degrees and over the top guide is inserted through the tibial tunnel and slipped into over the top position which is 1 o’clock in the left knee, and 11 o’clock in the right knee.

The femoral guide is passed through the tibial tunnel into the over top guide to exit through the posterolateral cortex.

The rigid fix transverse guide was adjusted with diameter equal to the femoral tunnel and inserted through the tibial tunnel into the femoral tunnel under the shoulder of the guide which was viewed passing inside the femoral tunnel.

Then two transverse sleeves were inserted till they reached the lateral cortex, the two pointed pins were drilled through the sleeves till the stopper impinges on the sleeves. The pins were removed leaving the sleeves which allow passage of water.

Case presentation.

A passing pin with eyelet was inserted from the tibial tunnel into the femoral tunnel to project out from the skin of anterolateral femur.

The metal loop is passed through the closed part of the graft to be slinged from it.

The graft was then looped carefully around number 5 ethibond suture which was threaded into the eyelet of the pin pulling the ethibond suture and ACL graft through the tibial tunnel through the femoral tunnel.

The graft is lifted through the femoral tunnel by an assistant and stopped at tibial tunnel by the hook of the metal loop.

The knee was put into cycles of flexion and extension while pulling on the graft from the femoral tunnel to remove any residual laxity.
Two metal pins 3.3 mm was then hammered through the two sleeves using blunt inserter into the graft for fixation.

The stability of the graft was assessed by Lachman’s test, propping the graft by the scope and also impingement of the graft onto the notch was checked arthroscopically and notchplasty using abrader was done if needed.

• Suction drain was inserted for 24 hours.
• Ice packs were applied for 24 hours to minimize swelling and pain.
• The leg was elevated over a pillow to help knee extension.

Post-operative rehabilitation:

The aim of rehabilitation is to obtain stable knee with a full range of motion and strong muscle around the knee.

Isometric quadriceps and hamstring exercises were started from the second postoperative day till the start of open chain exercises at the end of 12 weeks.

Passive knee motion was started at 24-48 hours with the aid of other limb for 15 minutes 3 times daily.

Gradual increase in flexion and extension was done with strict emphasis on reaching knee extension and not exceeding 90 degree of the knee flexion for the first 4 weeks.

Weight bearing with 2 axillary crutches was allowed after 1 week as tolerated. Full weight bearing is then started at 6 weeks.

Use of stair climbing machine or stationary bicycling was permitted at the fourth weeks, and treadmill running at 2 months.

Return back to work was allowed at the third month, while recreational sports were allowed at the seventh or eighth month, and competitive sports were allowed at tenth or twelveth month.

Follow-up and assessment:

Follow-up duration ranged between ten to twenty months, patients were seen weekly for four weeks and then monthly till the end of follow-up.

Postoperative complications:

• Six patients out of twenty complained of anaesthesia, with symptoms along the medial aspect of the leg, resolved within six month.
• One patient had recurrent instability and diagnosed by the scope (torn femoral attachment and was revised by open surgery).
• Three patients had infection at the site of graft harvest which resolved completely with antibiotics.

Results

The International Knee Documentation Committee Scale is an evaluation system that includes 4 groups:

1. Subjective analysis.
2. Symptoms.
3. Range of motion.
4. Ligament examination.

Each group was classified into:

A. Normal.
B. Nearly normal.
C. Abnormal.
D. Severely abnormal.

Grade A and B were considered as excellent and good results, while grade C and D were considered as fair and poor results.

Finally, 39 patients were considered normal or nearly normal (grade A and B) while 1 patient was considered as severely abnormal (grade D), 39 patients out of 40 returned back to the pre injury level of activity.

Three patients undergo partial menesectomy and there were no difference between patients who had meniscal lesions and those who did not suffered from meniscal lesion.

One patient had loose body which has been treated arthroscopically.

Discussion

The ACL reconstruction has evolved from the traditional arthrotomy to the arthroscopic assisted reconstruction [7].

Several techniques are available for ACL reconstruction and several graft options are also available. But the most important factors achieving successful ACL reconstruction are graft placement, types of fixation and management of associated lesions [9].

The Patellar – Bone – Tendon - Bone has many advantages in comparison to other ACL grafts for its high tensile strength, and fixation with bone to
bone healing [11]. On the other hand the only disadvantage is the affection of the extensor mechanism and also anterior knee pain.

The tensile strength of the normal ACL has measured by Nayes to be about 2160 N versus the strength of BTB graft at 2950 N [10].

The hamstring tendon autografts are now becoming the graft of choice for ACL reconstruction. They avoid the violation of the extensor mechanism and theoretically improve the initial tensile strength and increase the cross sectional diameter of the graft [9]. The quadrupled tendon graft provides the strongest tensile strength for a hamstring construct 4500 N to failure versus 1800-2196 N for a normal ACL.

Hamstring muscle function completely restored after 6 months but the regeneration of the normal semitendinosus tendon occurs after 8 months [7].

In our study there was a difficulty in obtaining a proper hamstring tendon graft size and length for quadrupled construct, in one case the graft choice was changed into patellar tendon and open approach.

One of the disadvantages of using hamstring tendon is fixation. The interference screw provide reliable B.T.B graft but hamstring lack of bone and outside tunnel fixation evolved. Outside tunnel fixation has the potential disadvantages of increasing the graft construct length, thus increasing the chance of graft elongation with cycle loading [11].

The stiffness is inversely proportional to the graft length and the ligamentous laxity is greater, as tibial fixation moves away from the tibial plateau [8].

Thus hanging the hamstring graft over a rigid pulley using transfixation pins for femoral fixation has been proven to be one of the best methods of fixing the graft together [10].

In our study femoral fixation was done using two transfixing non absorbable pins of 3.3 mm in diameter. These pins provide intra tunnel fixation that is independent on the posterior wall of the tunnel.

So, if the posterior wall integrity is affected or fractured during drilling, this does not affect the rigidity of fixation [9].

They also decline about 36 degrees from bone to graft contact allowing for circumferential in growth of bone, and also facilitate the use of instrumentation which eliminates the need for intraoperative measuring and screw tapping.

They also allow fixation near to the joint line thus decreasing graft construct length, and minimizing tunnel widening as well as micro motion which minimize the chance of synovial fluid to enter the tunnel [7,8].

The average age in our study is 22 years with male predominance (90%). This corresponds with most published series which focus on treating young active age group.

According to the IKDC score 36 patients 90% were considered as normal or nearly normal.

Corneyt et al. [9] using IKDC system had 94% normal or nearly normal.

Four patients in our study had recurrent laxity (10%) as pivot shift test was positive and Lachman’s test in grade 2. These results are comparable to failure rates in literature that ranges around 10%.

In this study, Lachman’s test demonstrates that 80% of our patients had grade 0 laxity, 10% had grade 1 laxity.

These results are similar to the results of Shaieb et al. [5] who reported 86% of grade 0 laxity. Three patients (7.5%) has associated meniscal injury.

Anterior knee pain was absent in our study, shaieb et al. [5] in 2002 reported higher incidence of anterior knee pain.

Conclusion:

This study showed that arthroscopic ACL reconstruction using quadruplet semitendinosus and gracilis tendon graft produce safe and reproducible results with low incidence of complications as harvest side morbidity, ant knee pain, quadriceps atrophy.

Semitendinosus harvest is also quick and simple, however, optional graft size, graft stiffness graft tissue compatibility, graft positioning, graft fixation strength and the way of post operative rehabilitation, all contribute to biological healing and obtain good results.

References


