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**Original Research Article**

# Analysis of Arthroscopic ACL Reconstruction Using Single Bundle Four Strand Semitendinosus graft in ACL Tear in Indian patients

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## Abstract

**Purpose:** The best graft option to replace the injured Anterior Cruciate Ligament (ACL) has been a matter of discussion. There has been paucity in the literature regarding arthroscopic ACL Reconstruction using four strand single Semitendinosus graft.

**Method:** 30 patients underwent arthroscopic ACL reconstruction using single semitendinosus tendon after quadrupling the tendon and fixing on femoral side with endobutton and tibial side with interference screw. The functional outcome was compared using preoperative and postoperative Lysholm II scoring and anterior tibial translation. The secondary outcomes were measurement of harvested and quadrupled Semitendinosus graft length and thickness and its complications.

**Result:** All patients had Poor Lysholm's score pre-operatively (mean= 48) but showed improvement in Lysholm's score at 3 months (mean=89) and 6 months post-operatively (mean=93). The mean pre-operative anterior tibial translation was 11.2mm. Post-operative mean anterior tibial translation was 2.96mm at 1 month, 2.93mm at 3 months and 3.5mm at 6 months. Superficial wound infection at harvested semitendinosus graft site was observed in one case which resolved on daily dressing and antibiotic therapy for 7 days and recurrent knee effusion was observe in two patients who were managed conservatively in the form of anti-inflammatory medications.

**Conclusion:** The reconstruction of the ACL by a quadrupled semitendinosus tendon graft with an endobutton and a bioabsorbable screw can achieve excellent clinical and subjective results after a short/intermediate follow-up of 6 months.

**Keywords:** Semitendinosus, quadrupled hamstring graft, ACL reconstruction, anterior tibial translation.

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## 1. Introduction

Anterior Cruciate Ligament (ACL) is one of the most commonly reconstructed Ligaments of the knee. There is no consensus to what the best graft option is to replace the injured ACL and has been a matter of discussion. Grafts taken from middle third of patellar tendon, as described by Campbell, were widely used in 1980s and 1990s. However, there are several postoperative disadvantages of the Patellar Tendon Bone (PTB) graft, which include anterior knee pain, quadriceps weakness and extension deficit [1]. During the last decade, there has been an increased use of Hamstring Tendon (HT) autografts. This is because of the lower rate of postoperative morbidity with fewer donor-site complications. The quadrupled Semitendinosus tendon is larger in diameter and provides a stronger graft compared with combined Semitendinosus/ Gracilis (STG) transplants and even patellar tendon [2]. Furthermore, compared to a STG graft, the gracilis tendon as an important flexor muscle

can be saved. Although the results with arthroscopic assisted ACL reconstruction by others modalities have been promising, very few studies regarding arthroscopic treatment of ACL reconstruction using four strand single semitendinosus graft has been done. The following study tries to assess the results of arthroscopic treatment of ACL reconstruction using four strand single semitendinosus graft in terms of optimum clinical outcome. Aim of this study is to evaluate the early outcomes of Anterior cruciate ligament reconstruction using single bundle four strand Semitendinosus graft among patients with anterior cruciate ligament tear.

## 2. Materials and methods

A prospective study of 30 patients with ACL tear treated operatively in Orthopaedic department was conducted from July 2017 to June 2018. All skeletally mature patients with clinical sign of ACL tear, radiological sign (Magnetic Resonance Imaging) of ACL tear, ACL tear without meniscal injury and ACL tear with meniscal injury were included. Patients with bony avulsion of ACL, with associated injuries other than meniscal injury, in whom menisectomy was done, skeletally immature patients with ACL injury, with restricted pre-operative range of knee movements and patients with osteoarthritis of knee confirmed radiographically were excluded from the study. After clinical and radiological investigations patients were planned for reconstruction of ACL. Anterior translation of tibia was quantified by Rolimeter [Figure 1]. Written informed consent was taken followed by pre-anaesthetic check-up. Patients were given either regional or general anaesthesia and high groin tourniquet was applied in supine position.

Arthroscopic reconstruction was done in all patients who had indications for ligament reconstruction. Semitendinosus graft was harvested [Figure 2] from ipsilateral leg after arthroscopic confirmation of ACL rupture. The harvested graft was quadrupled and prepared [Figure 3]. Notch debridement and notch preparation [Figure 4] were done in order to prevent the development of arthrofibrosis and graft impingement. Transportal femoral tunnel was made [Figure 5] using femoral tunnel tipaimer. While drilling for femoral tunnel, knee was flexed to maximum flexion (120-140 degree).

In all patients endobutton was used as a femoral fixation, and hence stepped femoral tunnel was made. Tibial tunnel was made [Figure 6] using 55 degree tibial guide positioned at the foot print of the native ACL remnant. Diameter of the femoral and tibial tunnel was decided depending upon the diameter of the graft obtained. Femoral fixation was done using an endobutton and tibial fixation was done using interferences crew. Post-op AP and Lateral X-ray were obtained. [Figure 7 & 8] All patients were subjected to same rehabilitation protocol. Patients were permitted to weight bear as tolerated on crutches immediately after surgery. They were given oral analgesics and subjected to daily physiotherapy sessions. Active exercises were allowed, aimed for full extension of the knee by14$^{th}$ day. Knee brace was advised for two post-operatives weeks. Full range of motion was achieved at around two weeks. The intensive rehabilitation programme included closed-chain exercises and emphasized proprioceptive training. At six weeks, patients began jogging in straight lines.

After 12 weeks, strengthening exercises were continued and an agility programme added. They were encouraged to initiate sports training activities. Return to competitive sports, including jumping, pivoting and side-stepping was prohibited for six months and was allowed after that. Post-operatively patients were followed at 1 month, 3$^{rd}$ month and at 6$^{th}$ month for functional outcome by using Lysholm's knee scoring system. Lachman and Anterior Drawer Test quantified using a rolimeter.

### 2.1 Statistical methods

Data were coded and entered in SSPS (version12) software for analysis. Qualitative data obtained were expressed as proportions and chi-square test was applied to find out statistical significance. For quantitative data, mean and standard deviation were calculated and Student's T test (unpaired) and /or Analysis of variance (ANOVA) were applied to find out the statistical significance.

## 3. Results

Total of 30 patients with ACL tear were included in the study with at least 6 months of follow up. The mean age was 29 years. The youngest patient was 17 years old and oldest being 46 years old. The ratio of male to female patients was 14:1.

Most common cause of ACL tear was road traffic accident (40%), followed by sports injuries (36.7%) and unrelated falls in 23.3% of patients. The location of ACL tear was femoral attachment in 43.3%, mid-substance in 36.7% and tibial attachment in 20%. 36.7% patients had concomitant medial meniscus posterior horn tear, 3.3% had medial meniscus anterior horn tear and 3.3% had associated Posterior Cruciate Ligament (PCL) injury. Mean time-lapse from injury to surgery was 7.6 months, earliest being operated at 1 month and a delay of 30 months for a patient.

The mean semitendinosus graft length was found to be 289mm ranging from 280mm to 312mm. the mean Semitendinosus Quadrupled graft length was 72.27mm, the maximum and minimum length being 78mm and 70mm respectively. The Semitendinosus quadrupled graft diameter ranged between 7mm to 8mm with mean of 7.53mm. The Tibial tunnel diameter ranged between 7mm to 8mm with mean of 7.62mm. The femoral tunnel diameter ranged between 7mm to 8mm with mean of 7.67mm. The mean femoral tunnel length in the present study was found to be

41.33mm, ranging from 35mm to 48mm. The mean tibial tunnel length in our study was found to be 47.33mm with range between 40mm and 55mm. The Anterior Drawer test was positive in all patients (n=30) during preoperative period. Post-operatively the numbers of cases with positive anterior drawer were 5 at 1 month, 6 at 3 months and 7 at 6 months.

Preoperatively 3.33% had grade 2 and 96.66% cases had grade 3 lachman test. Postoperatively 9 patients had Grade 1 positive lachman test at 1 month, 6 patients at 3 months and 7 patients at 6 months has Grade 1 positive lachman test. Pivot shift test was positive in 87% of patients (number=26) during pre-operative period. It was negative in all the patients during follow-up at 1 month, 3 months and 6 months. All patients had Poor Lysholm's score preoperatively (mean= 48). All patients showed improvement in Lysholm's score at 3 months (mean=89) and 6 months postoperatively (mean=93) [Table 1].

**Table 1: Lysholm's Score Statistics**

| | Preoperative | Postop 3 months | Postop 6 months |
|---|---|---|---|
| Mean | 47.53 | 88.97 | 93.23 |
| Range | 29 | 26 | 25 |
| Minimum | 30 | 72 | 75 |
| Maximum | 59 | 98 | 100 |

The mean preoperative anterior tibial translation was 11.2mm. Postoperative mean anterior tibial translation was 2.96mm at1 month, 2.93mm at 3 months and 3.5mm at 6 months. [Table 2]

**Table 2: Rolimeter readings at preoperative period, post operatively 1 month, 3 Months and 6 months (in mm)**

| | N | Range | Min. | Max. | Mean±SD |
|---|---|---|---|---|---|
| Preoperative | 30 | 8 | 6 | 14 | 11.20±1.82 |
| Postop 1 month | 30 | 5 | 1 | 6 | 2.96±1.42 |
| Postop 3 month | 30 | 3 | 2 | 5 | 2.93±1.20 |
| Postop 6 month | 30 | 3 | 2 | 5 | 3.50±1.27 |

Min.: Minimum, Max.: Maximum, SD: Standard Deviation

The mean duration for return of Quadriceps function as judged by static quadriceps exercises and active straight leg raising, was 4 days with range between 1 day and 9 days. The anterior tibial translation of operated knee at 6 months was comparable to unaffected knee joint. There was no subjective difference in pre and postoperative proprioceptive status. Superficial wound infection at harvested semitendinosus graft site was observed in one case which resolved on daily dressing and antibiotic therapy for 7 days. Recurrent knee effusions were observing in two patients and were subjected to further workup. Culture was found to be sterile and there was no evidence of any infection. The inflammation appeared to be sero-negative. These two patients were managed conservatively in the form of anti-inflammatory medications and local therapy. Symptoms resolved subsequently.

**Figure 1: Anterior translation of tibia, quantified by Rolimeter**

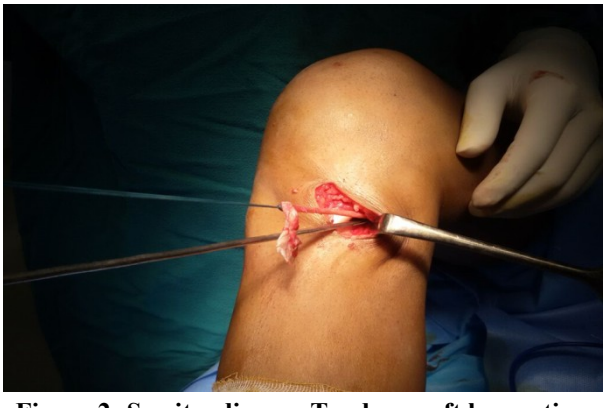

**Figure 2: Semitendinosus Tendon graft harvesting**

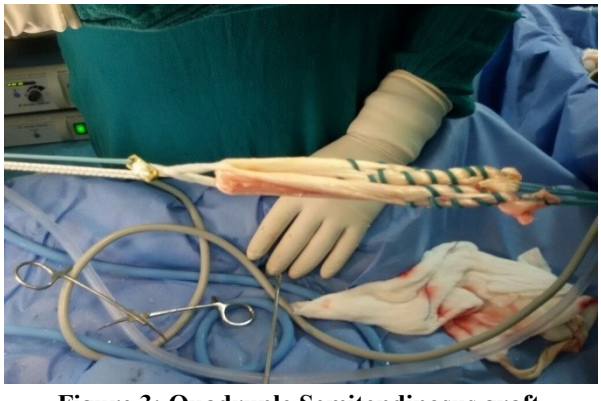

**Figure 3: Quadruple Semitendinosus graft**

**Figure 4: Arthroscopic Notch clearance**

**Figure 5: Femoral tunnel preparation**

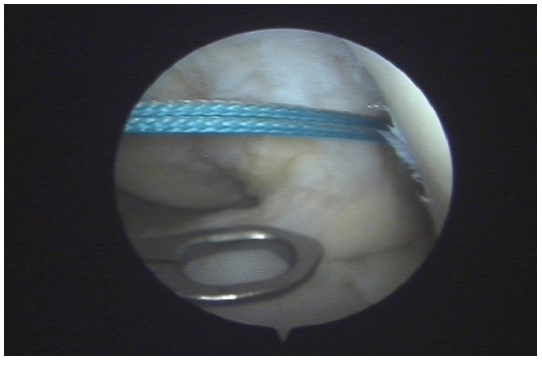

**Figure 6: Tibial tunnel preparation**

**Figure 7: Post op Antero Posterior view showing endobutton and interference screw in place**

**Figure 8: Post op Lateral view showing endobutton and interference screw in place**

## 4. Discussion

An ACL tear predisposes knee joint to instability along with major functional limitation. With increase in sports participation and Road traffic accidents, the burden of ACL tear is increasing. The ACL reconstruction has become a routine surgery in majority of orthopedic and sports injury care facilities.

Our study was a prospective study and was able to demonstrate good clinical and subjective results for patients undergoing ACL reconstruction with an autologous four-stranded Semitendinosus tendon at 6 months follow up. We used quadrupled semitendinosus tendon graft, which is thicker and stronger when compared with Semitendinosus / gracilis (STG) graft and even patellar tendon [3].

Furthermore, patellar tendon being chief knee extensor is saved. Most of the studies in past have used single or double hamstring techniques and others provided results with semitendinosus and gracilis transplants. Short as well as long term studies using isolated semitendinosus quadrupled strand graft are rare[4]. Our study being a short term demonstrates 6 months follow-up results after a standardized arthroscopic ACL reconstruction. In this study, most common cause of ACL tear was road traffic accident followed by sports injury and unrelated fall. Major studies in past have demonstrated sports related injuries to be the major cause of ACL tear [5,6]. This could be due to lesser sports participation in our study group.

DeHaven reported only 27% of ACL tears to be mid-substance [6]. Kennedy *et al*, in a case series of 50 ACL tears reported most common site of ACL tear to be mid-substance one (72%)[7].

In our study approximately 43% ACL tears had femoral attachment location and 37% were mid-substance tears, while only 20% were tibial attachment site tear. The incidence of associated posterolateral corner injuries has been reported between 7% and 13% in cases with ACL tear [8]. The incidence of associated meniscus injuries in our series was seen in 12(36.7%) out of 30 cases.

There was not a single case with lateral meniscal tear. One case had associated PCL injury. Even though there is no consensus in the literature, there are some trends regarding timing of ACL reconstruction. Various authors suggest that ACL reconstruction to be performed at least 3 weeks after injury in order to avoid arthrofibrosis [9,10]. More important than time alone, objective criteria including preoperative swelling, edema, hyperthermia, and range of motion are important indicators of when the surgery should be performed. Preoperative quadriceps strength has also been suggested to influence outcomes following ACL reconstruction.

Eitzen *et al* found that patients with quadriceps strength deficits greater than 20% prior to surgery had significantly greater deficits in strength two years following surgical intervention [11]. Thus; these authors suggest that

surgery be performed only when involved quadriceps muscle strength is 80% of the uninvolved lower extremity. None of the patients in our study had any quadriceps weakness compared to unaffected side in pre-operative period. This could possibly be because of ambulatory status of all patients pre operatively. In our study, the mean time lapse from injury to surgery was 7.6 months. Most of the patients were operated in less than a year of injury. However, all patients had improved functional outcomes irrespective of delay in surgery.

The semitendinosus graft length in our study ranged from 28cm to 31.2cm. The quadrupled semitendinosus graft length varied from 70mm to 78mm with diameter between 7mm and 8mm which are similar to the past studies [12,13]. The femoral tunnel length and tibial tunnel length were 41.3mm and 47.3mm respectively. The femoral/tibial tunnel diameter were chosen the same or slightly larger (up to 0.5mm) than the graft diameter. Post-operatively at 4$^{th}$ week and 3 months only 6 cases out of 30, gained laxity of grade-Ion anterior Drawer test in their knees.

At final follow-up of 6 month, 7 out of 30 cases gained grade-I laxity on anterior Drawer test. In our study, the subjective improvement following ACL reconstruction procedure was evaluated by comparing the preoperative and the postoperative Lysholm's knee scores. The mean preoperative Lysholm's score was 47.3 which improved to approximately 89 and 92 postoperatively at 3$^{rd}$ month and 6$^{th}$ month respectively. These values are comparable to those mentioned in the literature [12,13]. No patient complained of instability after surgery. In Our study we have observed that in patient having some residual laxity in antero-posterior plane as depicted by positive anterior drawer test and Lachman test, didn't experience any functional limitation in terms of their day to day activities and physical performance. The outcomes were comparable to those with use of semitendinosus and gracilis graft and patellar tendon graft [14,15].

Kocher *et al* also reported a significant relationship between the pivot shift test grades and patient satisfaction, where as anterior posterior laxity did not influence the patient subjective assessment two years post operatively [15]. In view of these observations it seems to be clear that one of the main targets of any outcome evaluation of ACL treatment should be the precise documentation of transverse plane rotatory stability. In our study the functional results correlated well with pivot shift test which was negative in all the patients during postoperative period. Quadriceps exercises had been frequently advocated in early preoperative period as it is the main stay of functional outcome during and after rehabilitation period. However, some authors were quite apprehensive regarding initiation of quadriceps exercises in first two weeks as graft strength was weak [16]. Later studies provided a base for early initiation of quadriceps exercises inform of static quadriceps exercises and straight leg raising exercises [17,18].

In our case study the average time period for achievement of quadriceps control, signified by the presence of sustained unassisted active straight leg raising was documented to be 4 days with some patients achieving it on the first post-operative day itself. This is comparable to recent studies which advocated for early quadriceps exercise. In our study, we observed complications in 3 out of 30 cases; superficial wound infection at harvested Semitendinosus incision site was observed in one case which resolved on daily dressing and antibiotic therapy for 7 days. Literature suggests, overall postoperative infection rate is as low as around 1%. Another being recurrent knee effusion and was observed in two patients in whom pus culture and sensitivity was found to be sterile. There was no evidence of infection and were managed conservatively in the form of anti-inflammatory medications and local therapy.

## 5. Conclusion

On the basis of our investigation, we conclude that the reconstruction of the ACL by a quadrupled Semitendinosus tendon graft with an endobutton and a bioabsorbable screw can achieve excellent clinical and subjective results after a short / intermediate follow-up of 6 months. As by using single Semitendinosus tendon graft for ACL reconstruction we spare the gracilis tendon, an important hip flexor thus preserving the hip flexor strength and the gracilis tendon can be used in revision surgery in future. Consequently, we believe that it is a safe alternative for the patients with ACL tear.

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