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### Hamstring autograft versus bone patellar tendon autograft for reconstruction of anterior cruciate ligament

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#### Abstract

**Objectives:** To do detailed comparative study on bone patellar tendon bone graft and the hamstring tendon graft for reconstruction of anterior cruciate ligament and evaluation of results.

**Materials and Methods:** This was prospective comprised of thirty patients presented with knee instability and/or pain at SMIMER Surat from year August 2012 to August 2015. They were diagnosed clinically and confirmed by MRI to have anterior cruciate ligament tear. Patients with 18 to 40 years of age with ACL tear that occurred more than 4 weeks without previous surgery/ligament damage were included in study while patients with <18 or >60 years of age and evidence of osteoarthritis on plain radiographs were excluded. Outcome evaluation was done using Tegner's score & Lysholm knee score and patients were followed at 4,8,12 weeks, 6 months, 1 year

**Results:** Over all mean post-operative Tegner's score were 5.86 with median value 6 with scores range 3 to 8. Mean postoperative score for bone patellar tendon bone graft patients was 5.66 and with median value of 6 and ranges 3 to 8. Mean postoperative score for Hamstring graft patients was 6.06 and with median value of 6 and ranges 3 to 8. Mean post-operative Lysholm score was 78.6 with median value of 87.5 and scores ranging 23 to 100. Mean postoperative score in Hamstring graft group was 81.13 with median value 92 and range 23 to 100. Mean postoperative score in bone patellar tendon bone graft group was 76.13 with median value 85 and range 27 to 99. Complications like superficial or deep infections, ligament laxity, instability, arthrosis or revision were not seen in our study.

**Conclusions:** Arthroscopic/open anterior cruciate ligament reconstruction by either quadrupled hamstring tendon graft or bone patellar tendon graft gives satisfactory results in short term follow up in terms of patient satisfaction, activities of daily living and return to near normal or higher activity than before surgery. Large scale study with long term follow up is required to corroborate findings of the study and to find out long term functional results in the two graft groups.

**Keywords:** Anterior cruciate ligament (ACL), hamstring autograft, bone patellar tendon autograft

#### Introduction

Anterior cruciate ligament (ACL) tear is the most common serious ligamentous injury to the knee joint<sup>[1, 2]</sup>. The ACL is the primary stabilizer against anterior translation of the tibia on the femur and is important in counteracting rotation and valgus stress. Anterior cruciate ligament deficiency leads to knee instability. This results in recurrent injuries and increased risk of intra-articular damage, especially the meniscus<sup>[3]</sup>. The goals of the ACL reconstruction are to restore stability to 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<sup>[4]</sup>. During the past decade arthroscopically assisted techniques have been an accepted method of reconstructing the ACL<sup>[5]</sup>.

The advantages of arthroscopically assisted anterior cruciate ligament reconstruction include elimination of capsular incisions, decrease in trauma to the fat pad, avoidance of desiccation of the articular cartilage and a lower incidence of post-operative patellofemoral pain than with open reconstruction<sup>[10]</sup>. The advantages of open procedure include better visualization of femoral condyles and technically less demanding procedure. The primary disadvantage of arthroscopically assisted technique is that the technique has a long learning curve and is a technically demanding procedure<sup>[11]</sup>.

The bone-patellar tendon-bone and the hamstring tendon are the two most commonly used Auto grafts for reconstruction<sup>[12]</sup>.

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The bone-patellar tendon-bone auto graft has been widely accepted as the gold standard for ACL reconstruction with a high success rate [13]. However, donor site morbidities and extensor mechanism problems associated with the use of the bone-patellar tendon-bone have led to increasing popularity of the hamstring tendon graft which had advantages of low donor site morbidities, avoidance of extensor mechanism problems and better cosmesis.

### **Aims and Objectives**

To do detailed comparative study on bone patellar tendon bone graft and the hamstring tendon graft for reconstruction of anterior cruciate ligament and evaluation of results.

### **Materials and Methods**

This was a prospective study of thirty patients presenting with chief complaint of the knee instability and/or pain presenting to SMIMER Surat from year August 2012 to August 2015 were diagnosed clinically by Lachman test, anterior drawer test, pivot shift test and confirmed by diagnostic arthroscopy or MRI to have anterior cruciate ligament tear. These patients were treated with anterior cruciate ligament reconstruction using either autologous ipsilateral hamstring or bone patellar tendon bone graft through open or arthroscopy assisted technique.

### **Inclusion Criteria**

- Age of patients ranging from 18 to 40 years
- Anterior cruciate ligament tear that occurred more than 4 weeks
- No previous surgery performed on the affected knee
- No previous cruciate ligament damage sustained in the affected knee

### **Exclusion Criteria**

- Patients with less than 18 years of age, Patients with posterior cruciate ligament laxity
- Evidence of osteoarthritis on plain radiographs

**Type of study:** Prospective observational

**Source of Funding:** Nil

**Conflict of Interest:** Nil

### **Rehabilitation Protocol**

Static Quadriceps and Static hamstring exercises are started immediately the next post-operative day. Knee bending was allowed on 3 weeks with range of motion exercise.

### **Statistical Analysis Methods**

Statistical analysis was done using SPSS software (Statistical Package for Social Science, V 10.5 package). Within the same group preoperative variables versus post-operative variables comparison was done by Wilcoxon signed rank test and within same group variables correlation was done by spearman correlation test. Comparison of variables between groups was carried out by the Mann-Whitney U test. A *P* value of <0.05 was considered statistically significant.

**Study duration & sample size:** 3 years with 30 patients

**Follow Up:** 4,8,12 weeks, 6 months, 1 year

**Outcome Evaluation:** Tegner's score & Lysholm knee score

### **Results**

The study included 30 patients who had undergone anterior cruciate ligament reconstruction surgery from August 2012 to August 2014. Most of the patients presented in the 21 to 35

years of age group. The average age was 28.3 years. Out of 30 patients operated, 4 were women and 26 were men. Right side anterior cruciate ligament deficiency was seen in eighteen (60%) patients while twelve patients (40%) had left side involvement. Number of patients presented with only complaint of pain was 19. Number of patients presented with only complaint of giving away was 3 and number of patients presented with complaint of pain associated with giving away was 8. Out of 30 patients, 13 had valgus external rotation, 9 had varus internal rotation, 6 had extension internal rotation and 2 had acceleration deceleration type of injury in extension.

### **Pre-operative evaluation data**

#### **Pre-operative international knee documentation committee scores**

International knee documentation committee score range was 13.8 to 65.5. The mean value was 47.98 with median value was 51.1.

#### **Pre-Operative Tegner's Scores**

Range of scores was 2-9 with mean value 4.33 and median value 4 suggested average activity levels of moderately heavy labour.

#### **Pre-Operative Lysholm Scores**

Range was 13-100 with mean value was 53.166 with median value of 53.5

#### **Function Before and After Injury**

Recorded on visual analog scale all patients scored 10/10. Function after injury recorded on visual analogue scale range was 2-9 with mean value was 6.53 with median value of 7.

#### **Time from Injury to Surgical Intervention**

Time period from injury to surgical intervention was between 1.5 months to 120 months with mean of 17.08 months and median of 10 months.

#### **Status of Meniscus at time of Surgical Intervention**

Out of thirty patients at the time of anterior cruciate ligament reconstruction, thirteen patients had normal medial and lateral menisci out of which seven patients had anterior cruciate ligament reconstruction with bone patellar tendon bone graft and five patients had anterior cruciate ligament reconstruction with quadruple hamstring tendon graft. Six patients had medial meniscus tear only, out of which four patients had anterior cruciate ligament reconstruction with bone patellar tendon bone. Four patients had only lateral meniscus tear, out of which one had anterior cruciate ligament reconstruction with quadrupled hamstring tendon graft.

Out of three Patients who had both medial and lateral menisci tears, one had anterior cruciate ligament reconstruction with bone patellar tendon bone graft. Four patients had osteochondral lesions out of which two had medial compartment lesions, one had chondromalacia patella changes only and one had both medial and lateral compartments lesions. One of the two patients, who had medial compartment osteochondral lesions, had anterior cruciate ligament reconstruction with bone patellar tendon bone graft.

#### **Post-operative subjective assessment**

##### **International knee documentation committee scores**

Overall mean post-operative international knee documentation committee subjective assessment score was 66.7 with least score of 31 maximum score of 87 and median

value of 66.7. Patients who had anterior cruciate ligament reconstruction with quadrupled hamstring tendon had mean score of 65.7 with minimum score 31 and maximum score 87 and patients who had anterior cruciate ligament reconstruction with bone patellar tendon bone graft had mean score of 67.7 with minimum score 51 and maximum score of 81.6.

**Post-operative tegners' activity level scores**

Over all mean post-operative Tegners' score was 5.86 with median value 6 with scores range 3 to 8. Mean postoperative score for bone patellar tendon bone graft patients was 5.66 and with median value of 6 and ranges 3 to 8. Mean postoperative score for Hamstring graft patients was 6.06 and with median value of 6 and ranges 3 to 8.

**Post-Operative Lysholm Scores**

Mean post-operative Lysholm score was 78.6 with median value of 87.5 and scores ranging 23 to 100. Mean postoperative score in Hamstring graft group was 81.13 with median value 92 and range 23 to 100. Mean postoperative score in bone patellar tendon bone graft group was 76.13 with median value 85 and range 27 to 99.

**Post-operative activities of daily living**

Mean post-operative activities of daily living recorded on visual analogue scale was 8.8 with median value of 9 and scores ranging 4 to 10. Mean postoperative score in bone patellar tendon bone graft group was 8.6 with median value 9 and range 4 to 10. Mean postoperative score in Hamstring graft group was 9 with median value 9 and range 6 to 10.

**Post-operative range of motion**

Out of 30 patients 1 had fixed flexion deformity of knee and active range of motion of 0-110 in 2 patients and 0-120 in 4 patients and 0-140 in 24 patients.

**Table 5:** Compartment Findings

Graft groups	Compartments	Grades			
		A	B	C	D
Hamstring tendon graft	Anterior	11	2	2	0
		Medial	10	3	2
		Lateral	11	0	4
Bone patellar tendon bone	Anterior	15	0	0	0
		Medial	10	5	0
		Lateral	13	0	2

**Table 6:** Hop test

Hop test grading	A	B	C	D
Hamstring tendon graft	6	8	0	1
Bone patellar tendon bone graft	6	8	1	0

**Table 7:** Radiographic findings

Radiographic findings	A	B	C	D
Hamstring tendon	14	1	0	0
Bone patellar tendon bone	15	0	0	0

**Table 8:** Radiographic Stress Laxometry

IKDC Grades	A	B	C	D
Hamstring tendon graft	9	6	0	0
Bone patellar tendon bone graft	8	7	0	0

Statistical analysis was done using SPSS software. Assuming that samples obtained were of non-gaussian distribution, nonparametric tests were employed for comparison and relationship determination. Comparisons of results within the same groups suggested statistically significant improvement of all international knee documentation committee, Tegners and Lysholm post operative scores than preoperative scores and there was statistically significant correlation between manual Lachman test and stress Laxometry findings. There was no statistically significant difference between scores of two groups suggesting both groups performed similarly in terms of post-operative subjective satisfaction, activity levels and knee stability.

**Table 1:** International Knee Documentation Committee Effusion Grading

International knee documentation committee grades	A	B	C	D
Hamstring	9	5	1	0
Bone patellar tendon bone	12	3	0	0

**Table 2:** Passive Motion Deficit

Grading		A	B	C	D
Hamstring graft	Flexion	11	2	1	1
	Extension	15	0	0	0
Bone patellar tendon bone graft	Flexion	10	2	2	1
	Extension	14	0	1	0

**Table 3:** Ligament Examination

International knee documentation committee grades	A	B	C	D	
Hamstring Tendon graft	Lachman	12	3	0	0
	Pivot	11	4	0	0
Bone patellar tendon bone graft	Lachman	13	2	0	0
	Pivot	9	6	0	0

**Table 4:** Harvest site pathology

IKDC Grades	A	B	C	D
Hamstring tendon graft	8	7	0	0
Bone patellar tendon bone graft	5	7	3	0

**Table 9:** Scores bone patellar hamstring tendon

Post Op Scores		bone patellar tendon bone group	Hamstring tendon group	Significance (p -value)
International knee documentation committee	Preop vs postop	67.76%	65.76%	N.S 0.771
		S 0.001	S 0.02	
Activities of daily living (visual analog)	Preop vs postop	8.6	9	N.S 0.37
		S 0.003	S 0.001	
Tegners' score	Preop vs postop	5.66	6.06	N.S 0.549
		S 0.031	S 0.01	
Lysholm score	Preop vs postop	76.13	81.13	N.S 0.617
		S 0.02	S 0.001	
Lachman test		1.66	1.73	N.S 0.768
Stress laxometry	Correlation	2.53 S 0.001	2.4 S 0.01	N.S 0.603
Hop test		85.93%	83.93%	NS 0.901

Preop vs. Postop =Statistical difference within groups. Statistically significant P value NS was statistically insignificant P value

Complications like superficial or deep infections, ligament laxity, instability, arthrosis or revision were not seen in our study.

## Discussion

Thirty patients were included in the study. There were 15 patients in the BPTB group and 15 patients in the hamstring group. There was no difference in the number and the distribution of grading of instability in both groups. Our aim of the study was to compare both groups in terms subjective and objective outcomes. These procedures were performed by two surgeons randomly selected equally proficient in both methods of reconstruction mentioned in this study. Post-operative evaluations including ligament laxity tests were done by single observer and were documented.

In our study overall post-operative results were satisfactory within each group in terms of international knee documentation committee subjective scores, Lysholm score, activities of daily living by visual analog scale and Tegner's activity levels scores, when compared to pre-operative scores. These short term results are consistent with short term study results reported by Eriksson *et al.* and Ejerhed *et al.* [71]. This emphasizes the fact that both types of reconstruction are effective methods of restoring knee stability.

Anterior cruciate ligament reconstruction with bone patellar tendon bone graft was initially thought to be the gold standard method because of theoretical advantage of early graft integration in tunnels and mechanical strength when compared to two stranded hamstring tendon graft. Studies by Agiletti *et al.* 1997 and Beynon *et al.* 2003 [72, 73] reported better results for bone patellar tendon bone grafts in terms postoperative sagittal knee laxity studied by manual and instrumented Lachman tests.

Later on, with understanding and improvement of graft fixation such as by aperture fixation method and newer devices and equal tensioning of parallel strands of quadrupled hamstring tendon grafts, no significant differences were found between the two types of grafts in short term studies [63]. In this study there was slightly more laxity in hamstring tendon group, slightly lesser post-operative activity level in female patients and less anterior knee pain when compared to bone patellar tendon bone graft group. Results of recent short term study by Laxdal *et al.* 2006 [74] also showed that no clinically significant differences could be found between two groups.

In a similar study, Corry, *et al.* found that the two grafts did not differ in terms of clinical stability, range of motion and general symptoms [63]. The hamstring tendon group also had a lower graft harvest site morbidity [63]. In our study of comparison of post-operative subjective international knee documentation committee scores, Lysholm scores, activities of daily living scores and Tegner's activity levels scores between two groups no statistically significant difference could be found even in Tegner's activity levels scores.

In this study no statistically significant difference could be found in laxity levels between two groups at 1 year follow up. This study shows no statistically significant difference in single leg hop test between two groups. However, patients in either group failed to reach preinjury activities of daily living by 1.2 over all points on visual analogue scale. Overall, 80% of the people in either group scored normal or near normal and 20% of people scored abnormal or severely abnormal IKDC grades.

Other results were anterior knee pain was noted in three patients with bone patellar tendon bone graft and none of our hamstring tendon graft group had anterior knee pain. Significant numbness lateral patella was another complication noted in one patient with bone patellar tendon bone graft and incidence of early infection in one patient, pain at terminal extension in one patient were seen in Quadruple hamstring

tendon graft patients.

Advantages of hamstring tendon graft over bone patellar tendon bone graft as given by authors of studies which showed better results for hamstring tendon graft group are lesser future risk of osteoarthritis, paradoxical lesser laxity (possibly due to remodeling process) in the long term and lesser kneeling pain [78].

In 2001, Yunes, *et al.* were the first to report a meta-analysis conducted from controlled trials of patellar tendon versus hamstring tendons for ACL reconstruction [75]. They found that the patellar tendon patients had a greater chance of attaining a statically stable knee and nearly a 20% greater chance of returning to preinjury activity levels. They concluded that although both techniques yielded good results, patellar tendon reconstruction led to higher postoperative activity levels and greater static stability than hamstring reconstruction.

In 2003, using the same and extended numbers of controlled trial, Freedman, *et al.* concluded that patellar tendon autografts had a significantly lower rate of graft failure and resulted in better knee stability and increased patient satisfaction compared with hamstring tendon autografts. However, patellar tendon autograft reconstruction resulted in an increased rate of anterior knee pain [77].

A met-analysis of various studies by Biau *et al.* 2006 [78], although, questioned methodological quality of studies reviewed, suggested no significant differences between two grafts and advised against bone patellar tendon bone graft in certain ethnic groups and occupations requiring kneeling activities and sports activities which involves jumping. However, another recent meta-analysis (also done by same authors) [79] of individual patient data shows with newer surgical techniques no significant difference could be found between the two groups in terms of complications and considers bone patellar tendon bone graft continues to be an attractive option.

Rupture of the ACL impairs the stability of the knee, resulting in difficulty with athletic performance, increases risk of subsequent meniscal injury, and increased risk of early degenerative joint disease. The outcome of repair alone is inferior to the results after reconstruction or repair with augmentation. Anterior cruciate ligament reconstruction has been advocated to improve knee stability and reduce the incidence of later meniscal tears, although the latter has not been proved by scientific experimentation.

Many techniques for ACL reconstruction have been proposed and tested, including prosthetic ligament, allograft, autograft, graft with prosthetic augmentation, and extraarticular reconstruction. Auto grafts of patellar tendon or hamstring tendon are now preferred by most surgeons, and extraarticular reconstruction is rarely used instead placcation of capsule is used. Furthermore, studies have shown no difference in results when an extraarticular augmentation was added to an intraarticular patellar tendon graft. Open and arthroscopic techniques of graft substitution have been compared but have not shown significant differences in outcome.

## Conclusion

The outcome for patients in this study undergoing ACL reconstruction with a hamstring tendon graft did not differ from that of patients with a patellar tendon graft in terms of clinical stability, range of motion, and general symptoms. The Bone Patella Tendon Bone group had comparatively more mechanical strength and more kneeling pain where as the hamstring tendon group had lower graft harvest site morbidity

as demonstrated by less kneeling pain at 1 year, and slight extension lag.

Arthroscopic/open anterior cruciate ligament reconstruction by either quadrupled hamstring tendon graft or bone patellar tendon graft gives satisfactory results in short term follow up in terms of patient satisfaction, activities of daily living and return to near normal or higher activity than before surgery. Large scale study with long term follow up is required to corroborate findings of the study and to find out long term functional results in the two graft groups.

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