

A COMPARATIVE STUDY OF ARTHROSCOPIC RECONSTRUCTION OF ACL USING BONE PATELLAR TENDON BONE GRAFT AND QUADRUPLED HAMSTRING TENDON GRAFT

Research Article Orthopaedics

Kasukurthi Raja Shekhar¹, Kopuri Ravi Kiran², G Jagadesh³

¹ - Assistant Professor Department of orthopaedics Dr PSIMS & RF, Chinnaoutpalli Gannavaram Andhra Pradesh

² - Professor department of orthopaedics Dr PSIMS & RF, Chinnaoutpalli Gannavaram – Andhra Pradesh

³ - Professor of Orthopaedics and Director Balaji Institute of Surgery, Research and Rehabilitation for the Disabled (BIRRD (T) HOSPITAL); TTD. Tirupathi. Andhra Pradesh

Corresponding Author:

Dr. Kasukurthi Raja Shekhar
Assistant Professor Department of orthopaedics
Dr PSIMS&RF, Chinnaoutpalli
pin: 521286
Andhra Pradesh
Mail – drkasukurthi@gmail.com
Mobile: +919849692248

Article submitted on: 10 May 2017

Article Accepted on: 12 May 2017

Abstract :

Anterior Cruciate Ligament reconstruction (ACLR) using either autologous Bone patellar tendon bone (BPTB) graft or Quadrupled hamstring tendon graft has equal number of proponents worldwide. The aim of this study is to find out the advantages and disadvantages of each procedure in terms of outcome at 3 year of post-operative follow-up.

Methods : In this study 30 patients underwent ACLR of which 15 patients each were allocated randomly to undergo either BPTB or Quadrupled hamstring graft. Subjective as well as objective outcome measures such as analog scales, international knee documentation committee (IKDC) form, Tegners scale, stress radiographs and Lysholm scores were used to document pre-operative and postoperative patient characteristics related to ACL deficiency and knee joint, were used in the study. Statistical analysis was used to compare preoperative status and postoperative outcome for all the variables measured in the study. Outcome was statistically analysed using PSPP software.

Results : ACLR using either BPTB or hamstring graft yielded statistically significant improvement (p values 0.001 and 0.002 respectively) when compared to preoperative IKDC subjective scores. At 3 year postoperative follow-up, subjective & objective IKDC scores, Tegner's scale, Lysholm scores and stress radiographs showed no significant difference between the two groups. PTB group had graft donor site related complaints including anterior

knee pain in 3 patients and numbness lateral to patella in 1 patient.

Conclusion : ACLR using either graft results in improved knee function in terms of stability and pain at 3 year follow-up. This study could not demonstrate clear advantage of either graft over the other in terms of functional outcome. Overall hamstring graft has marginal advantage with less graft site morbidity when compared to BPTB graft.

Key words: Anterior cruciate ligament, reconstruction, Bone Patellar tendon bone graft, Hamstring tendon graft.

Introduction

In the present world of professional athleticism, motor sports and recreational activities involving high physical activity such as skiing, knee is the second most commonly injured joint next only to ankle.

Ligament injury accounts for nearly 40% of all knee injury problems and isolated anterior cruciate ligament injury constitutes nearly 50% of all knee ligament injuries (1). Male athletes are less likely to be injured than female athletes (2). Better understanding of injury mechanisms lead to prevention strategies against anterior cruciate ligament injury (3) with some effectiveness although, anterior cruciate ligament injury is still not fully preventable.

Anterior cruciate ligament was considered of little importance for the long term function of the knee in the past. Studies have shown that there is greater risk of meniscal and articular injuries in short term progressing to radiological and clinical changes of joint degeneration in the long term in anterior cruciate ligament deficient patients compared to subjects with normal anterior cruciate ligament function (4).

Early surgical methods such as primary repair of anterior cruciate ligament injury with or without augmentation (5) showed a modest to poor improvement over non-operative management in terms of subjective and functional outcome of symptomatic knee instability (6).

Reconstruction of anterior cruciate ligament is by far has better edge over all other methods of management with failure rate of around 10 % (7). Varieties of graft materials available for surgeons' choice are autografts, allograft and synthetic graft materials. Success rates of ligament

reconstruction using autografts are higher than when either allograft or synthetic graft materials were used (8). Method of graft-fixation is an important determinant of successful anterior cruciate reconstruction. Arthroscopic method of reconstruction is definitely preferable to open reconstruction (9). By far, two well accepted methods of reconstruction are those involving autologous bone patellar tendon bone (BPTB) or tripled-quadrupled hamstring tendons. Each graft has its own advantages and disadvantages so does surgeons' choice (10, 11), supported by different studies with conflicting verdicts. Present available evidence is not in favour of either of the two grafts, hence, the need for this study.

Materials and Methods

We performed a prospective study in 30 patients who were diagnosed clinically by Lachman test, anterior drawer test and confirmed by diagnostic arthroscopy to have ACL deficiency, underwent ACL reconstruction by same surgeon equally proficient in two methods. All these patients were followed up for a period of 3 years postoperatively.

Patients with collateral ligament injury, posterior cruciate ligament injury and osteoarthritis were excluded from our study. Preoperative Evaluation included a detailed history, clinical evaluation & subjective evaluation form IKDC, Tegners activity level scale, and Lysholm scoring scale.

Post operative evaluation Included final IKDC form, Tegners' score and Lysholm scores. Postoperative complications were documented.

Surgical steps of anterior cruciate ligament reconstruction with bone patellar tendon bone graft

Graft harvestation

A single midline incision from lower pole of patella to a point over 1cm just medial to tibial tuberosity is given. Paratenon is incised in the same vertical line and tendon borders identified. Central third of the patellar tendon is taken with proximal (10 × 25-mm) and distal (9 × 25-mm) bone plugs using a handheld oscillating saw from lower end of patella and tibial end of patellar tendon.

Graft preparation

The bone blocks were prepared to fit through a 9-mm sizing tunnel for the patellar bone block and a 10-mm tunnel for the tibial bone block. Two holes drilled through the patellar bone fragment and two through the tibial tuberosity bone. No. 5 Ethibond sutures are passed through holes.

Tunnel preparation

Arthroscopic examination of knee performed and intraarticular pathology identified dealt with and notchplasty was performed to adequately visualize the over-the-top position on femoral side (with femoral tunnel at 11 'o clock (right) or 1 'o clock (left) position). A posterior cruciate ligamentreferencing tibial guide set at 55° was used to place a tibial guide pin into the posterior half of the tibial anterior cruciate ligament attachment site.

Graft fixation

Through accessory anteromedial portal soft threaded interference screw placed intraarticularly on femoral end of graft over cancellous bone plug anterolaterally and posterior to tibial end bone plug with cancellous bone surface facing posterior. Knee laxity examined. Wound closed in layers. R-J compression bandage applied post operatively.

Surgical steps anterior cruciate ligament reconstruction with quadrupled hamstring tendon graft

Graft harvestation

A 3cms medial skin incision is made midway between tibial tuberosity and medial most aspect of upper tibia. The tendons were palpated and the sartorius fascia was incised parallel to the fibers of the fascia just above the thicker and more distally inserted hamstring tendons. After the vinculae had been cut under visual control, the distal end of tendons is cut and graft is harvested with a semiblunt, circular closed tendon stripper.

Hamstring tendon graft harvestation

Graft preparation

The tendon was prepared for quadruple graft, depending on the length of the tendon. The minimum accepted length for the final graft was 7 cm. No.2 Ethibond suture is used for preparation of proximal and distal ends of the graft by whip stitch method. Two No. 5 nonabsorbable Ethibond sutures were used as the lead sutures at the distal and proximal ends.

Tunnel preparation

After arthroscopic examination of knee joint is done and tibial tunnel prepared by placing zig. Through an accessory anteromedial portal guide wire is placed in 10 o'clock position over lateral femoral condyle inner aspect 2mm from posterior most corner of cortex and femoral tunnel drilled with knee in 100 to 110 degrees of flexion.

Graft placement and fixation

Graft placed in position and secured with soft threaded interference screws on femoral side (after paratunnel osteotomy). After the femoral screw had been inserted, firm traction was applied to the graft during the insertion

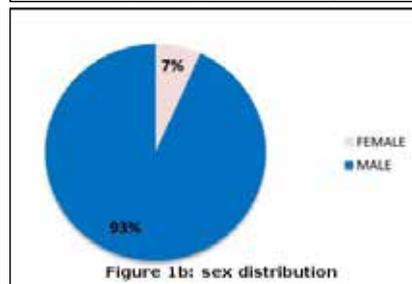
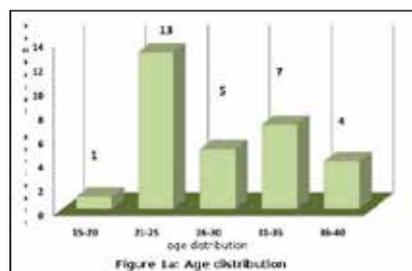
of the tibial screw, posterior to the graft without tunnel osteotomy, with knee in 90 degrees of flexion. Knee laxity examined. Wound closed in layers. R-J compression bandage applied post operatively.

Rehabilitation Protocol

Goals of rehabilitation are pain and swelling control, maintaining range of motion, protection of anterior cruciate ligament graft till it anchors to parent bone, building hamstring and quadriceps muscles and regaining near normal strength and return to pre injury level of activity. Patients were allowed sports activities only after 6 months

Results

Patients were between the ages of 21 to 35 years with mean age of 28.3 years (fig 1 a'). 19 patients presented with only complaint of pain and 3 with only complaint of giving away. 8 patients complained of pain and giving away at presentation.

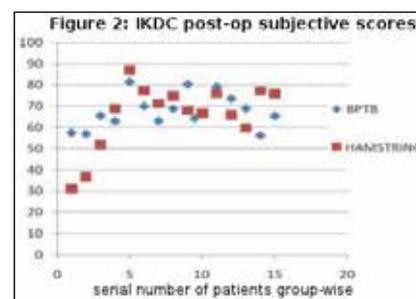


IKDC-subjective-score range was 13.8 - 65.5. The mean value was 47.98. Pre-operative Tegner's scores was 2-9 with mean value 4.33 suggestive of average activity levels of moderately heavy labour. Pre-operative Lysholm

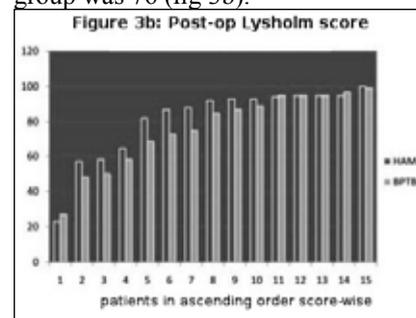
scores range was 13-100 with mean value was 53.166. Time period from injury to surgical intervention was between 1.5 months to 12 months.

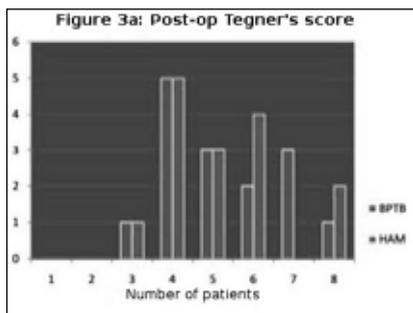
Out of the 13 patients without meniscal involvement at surgery, 7 had ACLR with BPTB graft and 5 had ACLR with quadruple hamstring tendon graft. 4 patients had osteochondral, 1 had chondromalacia patella changes.

Post-operative IKDC subjective assessment score was 66.7 with least score of 31 and maximum score of 87(fig 2). Patients who had ACLR with quadrupled hamstring tendon had mean score of 65.7 (minimum score 31 and maximum score 87) and patients who had ACLR with BPTB graft had mean score of 67.7 (minimum score 51 and maximum score of 81.6).



Over all mean post-operative Tegner's score was 5.86. Mean postoperative Tegner's score for BPTB graft patients was 5.66 and Hamstring graft patients was 6.06 (fig 3a). Over all mean post-operative Lysholm score was 78.6. Mean post-operative Lysholm score for Hamstring graft group was 81.13 and BPTB graft group was 76 (fig 3b).





Mean post-operative activities of daily living recorded on visual analogue scale was 8.8. Mean postoperative score in BPTB graft group was 8.6. Mean postoperative score in Hamstring graft group was 9.

Post-operative objective grading was also done following criteria given in IKDC form 2000 (table 1).

Table 1: IKDC physical examination (Post-operative)

IKDC PHYSICAL EXAMINATION FINDINGS	GROUPS	GRADES			
		A	B	C	D
Knee Effusion	Quadrupled hamstring	9	5	1	-
	BPTB	12	3	-	-
Passive motion deficit Lack of extention Lack of flexion	Quadrupled hamstring	15	-	-	-
	BPTB	11	2	2	1
Lack of extention Lack of flexion	Quadrupled hamstring	14	-	1	-
	BPTB	10	2	2	1
Ligament examination Lachman test Pivot shift	Quadrupled hamstring	12	3	-	-
		11	4	-	-
	BPTB	13	2	-	-
		9	6	-	-
Compartment findings crepitus with pain Anterior compartment Medial compartment Lateral compartment	Quadrupled hamstring	11	2	2	-
		10	3	2	-
		11	-	4	-
	BPTB	14	-	1	-
		10	5	-	-
		13	-	2	-
Harvest site pathology	Quadrupled hamstring	5	7	3	-
	BPTB	8	7	-	-
x ray findings	Quadrupled hamstring	14	1	-	-
	BPTB	15	-	-	-
Stress laxometry	Quadrupled hamstring	9	6	-	-
	BPTB	8	7	-	-
One leg hop test	Quadrupled hamstring	6	8	-	1
	BPTB	6	8	1	-

Complications

Out of 30 patients 1 had fixed flexion deformity of knee due to arthrofibrosis which belonged to hamstring tendon graft group. In BPTB graft group anterior knee pain was seen in three patients and numbness lateral to patella seen in one patient. In Hamstring tendon graft group early infection seen in one patient, pain at terminal 10 degrees of extension seen in one patient and screw loosening was seen in one patient.

Ethics

Research proposal was approved by institute ethics committee before study and research process was constantly monitored and reviewed by the same.

Statistics

Results were statistically analysed using PSPP software (Table 2). Wilcoxon Signed Ranks test for within group comparison of pre-op to post-op variables and Mann-Whitney U test for comparison of outcomes between the groups.

Table 2: Statistical analysis of results

POST OP SCORES		bone patellar tendon bone group	Hamstring tendon group	Significance (p -value) BPTB vs Ham
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= statistically insignificant P value.

Discussion

The goal of treatment of anterior cruciate ligament deficient knee is to provide stable knee and prevent early onset of osteoarthritis associated with anterior cruciate ligament deficient knee. The most accepted method of surgical management at present for anterior cruciate ligament deficient

knee is anterior cruciate ligament reconstruction using autologous bone patellar tendon bone or quadrupled hamstring tendon graft depending on operating surgeon's preference.

In our study we selected our patients into two groups, depending on the type of graft used for reconstruction, according to their order of attendance

in outpatient department at our institute for post-operative follow up 3 year after surgery.

Our aim of the study was to compare both groups in terms of subjective and objective outcomes. These procedures were performed by a single surgeon equally proficient in both methods of reconstruction.

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 with consistently significant improvement (P values < 0.05) in terms of IKDC 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 (12, 13). 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 and Beynon et al (14, 15) 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.

Our study showed, hamstring tendon group has a slightly more laxity, lesser post-operative activity level in female patients and less anterior knee pain when compared to bone patellar tendon bone graft group. These findings are similar to that of Laxdal et al (16).

In our study of comparison of post-operative subjective IKDC 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 (P values > 0.05). We have found that there is correlation between laxity measurements by manual Lachman test and stress laxometry method suggesting this method could be used as a inexpensive objective method for recording postoperative outcome. In this study no statistically significant difference could be found in laxity levels between two groups at 1 year follow up (P values 0.7 and 0.6 respectively). This study shows no statistically significant difference in single leg hop test between two groups (P value= 0.9). However, patients in either group failed to reach pre-injury 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.

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 (17,18,19), paradoxical lesser laxity (possibly due to remodelling process) in the long term (18) and lesser kneeling pain (20).

A meta-analysis of various studies (20), 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 recent

meta-analysis (21) with newer surgical techniques shows no significant difference between the two groups in terms of complications.

Conclusion

Arthroscopic anterior cruciate ligament reconstruction by either quadrupled hamstring tendon graft or bone patellar tendon graft gives satisfactory results in short term follow up of 3 years in terms of patient satisfaction, activities of daily living and return to near normal or higher activity than before surgery. Our preliminary study suggests no clear cut advantage for either quadrupled hamstring tendon graft or bone patellar tendon graft in terms of post-operative outcomes or complications. While there was limitation of our study in terms of small sample size. 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.

Acknowledgments

None of the authors received any kind of contribution, financial support or grant from any person, pharmaceutical or medical instrumentation company for the research or writing this article. We declare no conflicts of interest.

References

1. Bollen S. Epidemiology of knee injuries: diagnosis and triage. *Br J Sports Med.* 2000; 34;227-8.
2. Comstock RD, Fields SK, Ingram JG and Yard EE. Epidemiology of Knee Injuries Among Boys and Girls in US High School Athletics. *Am J Sports Med* 2008 36: 1116-22.
3. Griffin LY. Understanding and

- Preventing Noncontact Anterior cruciate ligament Injuries .Am J Sports Med 2006 ; 34: 1512-32
4. Porat AV, Roos EM, Roos H. High prevalence of osteoarthritis 14 years after an anterior cruciate ligament tear in male soccer players- a study of radiographic and patient- relevant outcomes. *Ann Rheum Dis* 2004; 63:269-273.
 5. O'Donoghue DH: Surgical treatment of injuries to the knee. *Clin Orthop* 1960;; 18:11-36.
 6. Strand T, Mølster A, Hordvik M and Krukhaug Y .Long- term follow- up after primary repair of the anterior cruciate ligament: clinical and radiological evaluation 15-23 years postoperatively. *Arch Orthop Trauma Surg* .2005; 125(4):217- 21.
 7. Maletis GB, Cameron SL, Tengan JJ and Burchette RJ. A Prospective Randomized Study of Anterior cruciate ligament Reconstruction. *Am J Sports Med* 2007;35: 384- 94.
 8. Prodromos C, Joyce B, Shi K .A meta-analysis of stability of autografts compared to allografts after anterior cruciate ligament reconstruction..*Knee Surg Sports Traumatol Arthrosc.* 2007 ; 15(7):851-6.
 9. Cameron SE, Wilson W, St Pierre P. A prospective, randomized comparison of open vs arthroscopically assisted ACL reconstruction. *Orthopedics.* 1995; 18(3):249-52.
 10. Carmichael JR and Cross MJ . Why Bone – Patella Tendon – Bone grafts should still be considered the gold standard for Anterior cruciate ligament Reconstruction. *Br. J. Sports Med.*2009 ; 43(5):323-5.
 11. Pinczewski L, Roe J and Salmon L. Why Autologous Hamstring Tendon Reconstruction Should Now Be Considered The Gold Standard For Anterior cruciate ligament Reconstruction In Athletes. *Br. J. Sports Med.*2009 ; 43(5):325-7.
 12. Eriksson K, Anderberg P, Hamberg P, Lofgren AC, Bredenberg M, Westman I et al. A comparison of quadruple semitendinosus and patellar tendon grafts in reconstruction of the anterior cruciate ligament. *J Bone Joint Surg Br* 2001;83(3):348-54.
 13. Ejerhed L, Kartus J, Sernert N, Köhler K, Karlsson J. Patellar tendon or semitendinosus tendon autografts for anterior cruciate ligament reconstruction? A prospective randomized study with a two-year follow- up. *Am J Sports Med.* 2003;31:19-25.
 14. Aglietti P, Zaccherotti G, Buzzi R, De Biase P. A comparison between patellar tendon and doubled semitendinosus/gracilis tendon for anterior cruciate ligament reconstruction. A minimum five-year followup. *J Sports Traumatol Rel Res.* 1997;19:57-68.
 15. Beynon BD, Johnson RJ, Fleming BC, Kannus P. Anterior cruciate ligament Replacement: Comparison of bone-patellar tendon-bone grafts with two- strand hamstring grafts.a prospective, randomized study. *J Bone Joint Surg Am* 2002; 84:1503-13.
 16. Laxdal G, Sernert N,Ejerhed L,Karlsson J and Kartus JT. . A prospective comparison of bonepatellar tendon-bone and hamstring tendon grafts for anterior cruciate ligament reconstruction in male patients. *Knee Surg Sports Traumatol Arthrosc* 2007; 5:115-25.
 17. Pinczewski LA, Deehan DJ, Salmon LJ, Russell VJ, and Clingeleffer A. A Five Year Comparison of Patellar Tendon Versus Four-Strand Hamstring Tendon Autograft for Arthroscopic Reconstruction of the Anterior cruciate ligament . *Am J Sports Med* 2002 ; 30: 523- 36.
 18. Roe J, Pinczewski LA, Russell VJ, Salmon LJ, Kawamata T and Chew M. A 7- Year Follow- up of Patellar Tendon and Hamstring Tendon Grafts for Arthroscopic Anterior cruciate ligament Reconstruction. *Am J Sports Med* 2005; 33(9): 1337-45.
 19. Pinczewski LA, Lyman J, Salmon LJ, Russell VJ, Roe J and Linklater J. A 10- Year Comparison of Anterior cruciate ligament Reconstructions With Hamstring Tendon and Patellar Tendon Autograft. *Am J Sports Med* 2007; 35: 564-74.
 20. Biau DJ, Tournoux C, Katsahian S, Schranz PJ, Nizard RS. Bone–patellar tendon–bone autografts versus hamstring autografts for reconstruction of anterior cruciate ligament: metaanalysis. *BMJ.*2006; 332(7548):995-1001.
 21. Biau DJ, Katsahian S, Kartus J, Harilainen.A Patellar Tendon versus Hamstring Tendon Autografts for Reconstructing the Anterior cruciate ligament: A Meta-Analysis Based on Individual Patient Data. *Am J Sports Med* 2009; 37(12): 2470-8.