



Comparison of Therapeutic Results of Open and Arthroscopic Surgery on Functional Level, Duration of Return to Daily Activity and Satisfaction with Treatment in Patients with ACL Rupture

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Article History:

Received on: 26 Nov 2019

Revised on: 13 Dec 2019

Accepted on: 30 Jan 2020

Keywords:

Anterior cruciate ligament,
Bone-patellar tendon-bone autograft,
Semitendinosus-gracilis

ABSTRACT

Bone-Patellar Tendon-Bone autograft (BPTB) and four-strand semitendinosus-gracilis (hamstring) graft are the most common methods used for reconstructing anterior cruciate ligament (ACL) but there is still controversy over the best method. This study aimed to compare the therapeutic outcomes of two methods of BPTB and hamstring grafts using arthroscopic treatment in patients with ACL rupture. The patients underwent ACL reconstruction surgery, either by bone-patellar tendon-bone autograft (BPTB) (open surgery) (n=23) or four-strand hamstring autograft (semitendinosus-gracilis) (by arthroscopy) (n=25). Lysholm score was used for knee functional status assessment, Lachman test for tendon laxity, and pivot shift test for strength evaluation. The 36-Item Short-Form Health Survey questionnaire (SF-36) was also completed and compared at the last follow-up. Patients were evaluated by type of daily heavy or light activities. Two groups showed no significant difference in the Lysholm score ($P>0.05$) and both groups were classified as "Good". There was no significant difference between the frequency distribution of patients based on the Lachman test and pivot shift scores ($P>0.05$). None of the patients in the two groups had any rupture within two years after treatment. Both groups had good satisfaction with treatment and quality of life and there was no statistically significant difference between the mean SF-36 scores ($P>0.05$). Although complication in short-term follow-up was more in patients undergoing open surgery, the functional level and treatment satisfaction in patients treated by open surgery and arthroscopy were not significantly different after two years.



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ISSN: 0975-7538

DOI: <https://doi.org/10.26452/ijrps.v11i2.2011>

Production and Hosted by

IJRPS | www.ijrps.com

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INTRODUCTION

The anterior cruciate ligament is an extra-synovial element and the fibroblasts are involved in its continuous reconstruction and maintenance. In addition to its major action that prevents the abnormal tibial movement to the forefront, this ligament is also involved in preventing excessive tibial rotation and angulation in the varus and valgus directions (Longo *et al.*, 2012). Currently, one of the most common causes of orthopedic clinic referral is direct and indirect knee trauma leading to rupture of the anterior cruciate ligament. Given the low age of the Iranian population and the high enthu-

siasm of the young population for sports such as football and driving, in many of the accidents which occur, the frequency of anterior cruciate ligament ruptures is significant (Sun *et al.*, 2011). Patients undergoing anterior cruciate ligament reconstruction are often young athletes. Therefore, the examination of their postoperative problems is particularly important (Noyes *et al.*, 2013). The treatment strategies available for patients with this disorder vary between conservative repair, reconstruction, and different reconstruction methods (Melick *et al.*, 2016). Reconstruction of the ruptured anterior cruciate ligament in an active patient is strongly recommended because this will prevent the instability of the knee and its subsequent injuries and the development of early osteoarthritis and meniscus lesions (Maletis *et al.*, 2013; Abbas *et al.*, 2013). Both open surgery and arthroscopic surgery are successful for ligament reconstruction using a variety of grafts (Martin *et al.*, 2002). The technique used for ACL graft fixation should be strong enough to maintain stable knee flexion and strong enough so that it prevents knee buckling and knee movements can be initiated (Freedman *et al.*, 2003; Jansson *et al.*, 2003).

Anterior cruciate ligament reconstruction using patellar tendon graft is one of the most common methods used in this procedure, and over the last three decades, the gold standard for reconstructing this ligament has been patellar tendon grafting which is performed using a middle third of the patellar tendon. This procedure can also be associated with complications such as postoperative infection, anterior knee pain, postoperative knee instability, chronic knee swelling, quadriceps weakness, insensitiveness in front of the knee and deep vein thrombosis (DVT). The use of the semitendinosus and gracilis tendons for the reconstruction of the anterior cruciate ligament has also been increasingly used today. This change has occurred for a variety of reasons, including concerns about knee extensor components injury, greater likelihood of patellofemoral pain and patellar fracture (Salmon *et al.*, 2006). There are potential complications with hamstring grafting, including problems with tunnel volume increase and fixation, which are more common in this method. There are also concerns about the effect of graft removal on hamstring function (Salmon *et al.*, 2006). Other complications include saphenous nerve injury and graft hematoma. Reconstruction of this ligament has had better results compared to its repair, as it is common today. Postoperative rehabilitation of the cruciate ligament is of great importance and results in strengthening of the muscles around the knee and prevention of arthrofi-

brosis. In addition, this rehabilitation should not damage the tendon graft. Nowadays, there is disagreement in the treatment centers regarding the type of graft used in reconstruction of the anterior cruciate ligament (Heckman, 2008). Although numerous studies have been published regarding the results of reconstructing the anterior cruciate ligament, the reported results have not shown the superiority of one method over another. The purpose of this study was to compare the bone-patellar tendon-bone autograft with the four-strand hamstring autograft for ACL reconstruction in a complete rupture of the anterior cruciate ligament.

MATERIALS AND METHODS

After being approved by the Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (Ethic code: IR.AJUMS.REC.1397.482), this retrospective study was performed on 85 patients with ACL rupture aged 17-45 years who referred to Ahvaz Imam Khomeini Hospital from the beginning of 2016 to the end of 2017 who had undergone two years of ACL reconstruction surgery, either by bone-patellar tendon-bone autograft or four-strand hamstring autograft (semitendinosus-gracilis) using arthroscopy. All ligament reconstruction surgeries in each of the two groups were performed by a specialist and a surgical team.

The information of patients who had undergone two years of surgery was extracted from the records in the hospital archive and they were contacted to attend the clinic for clinical examinations and to complete the knee functional assessment (Lysholm) and quality of life questionnaires. The data of 85 patients were evaluated. According to inclusion and exclusion criteria, after removing incomplete records, the therapeutic results of 58 eligible patients treated by open surgery (n= 23) and arthroscopic (n= 25) were evaluated and compared in two groups. The patients were examined separately by a specialist and an orthopedic resident. For each patient, demographic questionnaires including individual characteristics (age, height, weight, and gender), history of illness, daily activity (heavy or light), and duration of surgery and associated injuries (such as osteoarthritis) were recorded. Lysholm score was used for knee functional status assessment, Lachman test for tendon laxity, and pivot shift test for strength evaluation. The 36-Item Short-Form Health Survey questionnaire (SF-36) was also completed and compared at the last follow-up.

The Grading of the Tegner Lysholm Knee Scoring Scale was classified according to standard questionnaire classification: 65 > as "Poor", 65-83 as "Fair",

84-90 as "Good", and 90< as "Excellent". In Lysholm score, "100" indicates no problems, and "0" indicates extreme problems.

The Lachman test is classified into three degrees: normal, +1 (increased knee motion with endpoint), and +2 (increased knee motion without endpoint), and the shift pivot test is classified into three degrees: normal, +1 (slight difference between the two sides), +2 (moderate difference or subluxation), or +3 (clear subluxation). The results of these two tests were also evaluated and compared in both groups of patients.

The 36-Item Short-Form Health Survey questionnaire (SF-36) measures people based on subscales of physical functioning, physical problems and limitations, physical pain, general health, agility and vitality, social functioning, emotional problems, and mental health. This questionnaire is rated on a scale of 0 to 100, so that, the lower score in this questionnaire indicates lower quality of life and vice versa.

Postoperative complications including deep infection, wound infection, patellar fracture, and surgical revision were monitored during follow-up. Differences in knee extension were evaluated by lateral knee radiographs in full extension. Given that patients in both groups were treated and followed by a surgeon, the rehabilitation program was performed according to the knee physiotherapy guidelines for patients in each group with the same conditions and the same protocol. Patients in the two groups were also compared and excluded as a confounding factor in the case of significant differences. Inclusion criteria included diagnosis and confirmation of ACL rupture by clinical examination, arthroscopy or MRI, the maximum time of anterior cruciate ligament injury until surgery of 6 months, complete health of the opposite knee in clinical examination. Exclusion criteria included patient dissatisfaction with the study, patients with serious damage to other ligaments including posterior cruciate ligament, lateral collateral ligament, medial collateral ligament or posterolateral corner, patients with a history of knee injury (except diagnostic arthroscopic), patients with grade 3 or 4 cartilage injury confirmed by arthroscopy or MRI, patients with osteoarthritis, concomitant fracture, multiple ligament injury, history of knee surgery, patients requiring knee reoperation, and patients who did not complete the rehabilitation program as directed by the physician to obtain range of knee mobility and hamstring and quadriceps strength. Data were analyzed using SPSS 22 software and the significance level was considered less than 0.05.

RESULTS AND DISCUSSION

There was no significant difference in mean age, height, weight, duration of surgery and frequency of patients by gender ($P>0.05$) (Table 1).

Patients treated with arthroscopy were significantly better for early complications ($P<0.05$). Deep infection was not reported in any of the two groups (Table 2).

There was no significant difference between the two groups in the Lysholm score ($P>0.05$). There was no statistically significant difference between the frequency distribution of patients with normal, +1, and +2 results and the results were similar between the two groups ($P>0.05$). All patients in both groups had normal or +1 test response and there was no statistically significant difference in frequency distribution between normal and +1 patients ($P>0.05$). Knee buckling and crepitus were reported in 2 patients in the hamstring group and 1 patient in the patella group, but none of the patients in the two groups experienced rupture within two years after treatment. Both groups had good satisfaction with treatment and quality of life and there was no statistically significant difference between the mean SF-36 scores ($P>0.05$) (Table 3).

After separating the patients in two groups according to the type of daily activity, 10 patients (40%) in the hamstring group and 9 patients (39.13%) in the patella group had heavy daily activities such as doing professional exercise, working in the restaurant kitchen, plumbing technician, etc. who returned to their previous activity after surgery. Although the mean score of the Lysholm criterion was reduced in the two groups, the mean score in the two groups was closely matched, and according to the Lysholm criterion classification, the treatment outcomes of the patients in both groups were reported as "Good". Frequency distribution of patients based on the results of the pivot shift and Lachman tests was similar in the two groups. Due to the small number of these patients, the results were not statistically significant and the results were only reported as a percentage. SF-36 scores were also lower among these patients, but patients' satisfaction and quality of life were similar in both groups (Table 4).

After separating the patients into two groups according to the type of daily activity, 15 patients (60%) in the hamstring group and 14 patients (60.87%) in the patella group had light occupations such as employee, housekeeper, software system operator, etc. who returned to their previous activity after surgery. The mean Lysholm score was not

Table 1: Demographic information of patients in the two groups

Variables		Arthroscopy (n=25)	BTPB (n=23)	P-value
Gender (N, %)	Female	6 (24%)	5 (21.74%)	0.715
	Male	19 (76%)	18 (78.26%)	
Age (year)	Mean±SD	31.25±9.54	29.63±10.11	0.88
Height (cm)	Mean±SD	169.94±9.12	168.72±9.03	0.891
Weight (kg)	Mean±SD	68.36±11.20	72.09±6.77	0.128
Time of Surgery(min)	Mean±SD	59.86±10.12	70.15±5.01	0.056

Data are expressed as mean±SD or number (%); The statistical test used was t-test or Chi-square test

Table 2: Comparison of early complications in patients of the two groups

Complication	Arthroscopy (n=25)	BTPB (n=23)	P-value
Knee Pain	2 (8)	6 (26.09)	<0.0001*
Number of physiotherapy sessions	10.12±5.07	16.11	<0.0001*
Superficial Infection	-	3 (13.04)	<0.0001*
Return to daily activities (month)	1.01±0.82	2.71±0.51	0.002*

Data are expressed as mean±SD or number (%); The statistical test used was t-test or Chi-square test; *P-value<0.05 was considered as statistical significance level

Table 3: Comparison of treatment outcomes in the two groups

Variables		Arthroscopy (n=25)	BTPB (n=23)	P-value
Lysholm Score		87.12±6.82	89.52±5.64	0.821
SF36 Score		63.08±5.10	64.12±4.64	0.88
Luchman test	0	20 (80%)	19 (82.61%)	0.72
	+1	4 (16%)	3 (13.04%)	
	+2	1 (4%)	1 (4.35%)	
Pivot shift test	0	21 (84%)	20 (86.96%)	0.812
	+1	4 (16%)	3 (13.04%)	
	+2	-	-	
	+3	-	-	

Data are expressed as mean±SD or number (%); The statistical test used was t-test or Chi-square test

Table 4: Comparison of the results of patients in two groups with heavy daily activity

Variables		Arthroscopy (n=10)	BTPB (n=9)
Lysholm Score		84.15±4.96	85.89±4.22
Luchman test	0	5 (50%)	5 (55.56%)
	+1	4 (40%)	3 (33.33%)
	+2	1 (10%)	1 (11.11%)
Pivot shift test	0	6 (60%)	6 (66.67%)
	+1	4 (40%)	3 (33.33%)
SF36 Score		62.71±3.26	64.41±4.92

significantly different between the two groups, and according to the Lysholm criteria classification, the results of the patients in both groups were classified as "Excellent". Frequency distribution was similar based on the results of the pivot shift and Lachman tests, and all patients in both groups had normal test results. The mean score of SF-36 questionnaire and patients' satisfaction and quality of life were similar in both groups and there was a high level of satisfaction with treatment (Table 5).

Bone-patellar tendon-bone autograft (BPTB) and four-strand hamstring autograft are the most common methods for reconstructing the anterior cruciate ligament, and there is still controversy as to which one works best. In the present study, there was no significant difference between the two groups in Lysholm score ($P > 0.05$). In a study by Razi et al. (2013), IKDC patients' functional level was evaluated. During 36 months of follow-up, 34 patients (91.89%) in the patella group and 28 patients (82.35%) in the hamstring group had a "good" to "excellent" IKDC score. There was no significant difference between the two groups ($P > 0.05$). They concluded that the two groups had similar results regarding the level of knee activity and function (Mahdi et al., 2013). In the study of Webster et al. (2016), the functional level of patients including knee pain and laxity was not significantly different between the two groups of patella and hamstring (Webster et al., 2016), which was in agreement with the results of the present study. The results of Heijne and Werner's study showed that daily activity and function in the patellar group was significantly better than the hamstring group one year after surgery (Heijne and Werner, 2010), which was not consistent with the results of the present study. The results of the study by Xie et al. (2015) showed no significant difference between knee function based on IKDC score in patients in both patella and hamstring groups ($P = 0.31$) (Xie et al., 2015) which was consistent with the results of the present study.

In the present study, there was no significant difference between the frequency distribution of patients based on Lachman test results with normal, +1, and +2 results in two groups and the results were similar between the two groups ($P < 0.05$). In the study of Razi et al. (2013), Lachman test was normal in 23 patients (62.16%) in patella group and 11 patients (32.35%) in hamstring group ($P = 0.043$). They concluded that there was a greater tendency to increase laxity in patients undergoing knee replacement by hamstring method than patella method (Mahdi et al., 2013). The study results of Xie et al. (2015) showed no significant difference between the Lachman test

results in patients in both patella and hamstring groups ($P = 0.58$) (Xie et al., 2015) which was consistent with the results of the present study. In the present study, there was no significant difference in the frequency distribution of patients in the two groups based on the results of the pivot shift test ($P > 0.05$). In the study of Razi et al. (2013), pivot shift test was normal in 29 patients (78.38%) in patella group and 15 patients (44.12%) in hamstring group ($P = 0.038$) (Mahdi et al., 2013). They concluded that there was a greater tendency to increase the pivot shift test grade in patients undergoing knee reconstruction using hamstring method than patella. In the study of Xie et al. (2015), the results of pivot test and ability level to return to previous activities were reported to be significantly better in patella group. They concluded that BPTB reconstruction could improve knee stability and rotation at higher level (Xie et al., 2015). The results of the study by Shuzhen et al. (2012) showed that the negative response of the pivot test was higher in the hamstring group than in the BPTB group (Li et al., 2012). In the Heijne and Werner's study, the results showed a significant improvement in the stability of knee rotation in the first 9 months after surgery in the patella group (Heijne and Werner, 2010).

In the present study, there was no statistically significant difference between patients' satisfaction with treatment outcome and their quality of life ($P > 0.05$). 10 patients (40%) in the hamstring group and 9 patients (39.13%) in the patella group had a heavy daily activity who returned to their previous activity after surgery. Although the mean score of the Lysholm criterion was reduced in the two groups, it was to be close in the two groups, and according to the Lysholm criterion classification, the patient outcomes of both groups were reported as "Good". The results of the study by Webster et al. (2016) showed that the patellar graft method is more suitable for people with heavy activities or athletes (Webster et al., 2016). Heijne and Werner in their study stated that because of better reconstruction of range of motion and greater stability in the patella method than the hamstring method, this method can be used in athletes with heavy activity (Heijne and Werner, 2010). The results of the two studies did not agree with the results of the present study, which did not show any significant difference between the two groups.

The mean score of the Lysholm score in patients with daily light activities was not significantly different between the two groups, and the treatment outcomes were "Excellent" in both groups. Also, the level of patients' satisfaction and the time required

Table 5: Comparison of results of patients in two groups with light daily activity

Variables		Arthroscopy (n=15)	BTPB (n=14)
Lysholm Score		90.98±5.42	91.05±4.03
Luchman test	Normal	15	14
Pivot shift test	Normal	15	14
SF36 Score		67.72±5.11	68.63±4.94

to return to the previous activity were not significantly different between the two groups.

The limitations of the present study were retrospectivity and the lack of access to all treated patients, which reduced the sample size in the study. The strength of the study was that patients in each group were operated on by a single and experienced surgeon and there was the same treatment follow-up protocol for the patients.

CONCLUSION

Based on the results, although short-term follow-up was more common in patients undergoing open surgery, since the level of functional and treatment satisfaction in patients treated by open surgery (bone-patellar tendon-bone autograft) and arthroscopy (four-strand hamstring autograft) were not significantly different after two years, both methods, according to the surgeon’s diagnosis or the patient’s choice, can be the method of choice with acceptable therapeutic outcomes in reconstructing the anterior cruciate ligament.

ACKNOWLEDGEMENT

This study was approved in Ahvaz Jundishapur University of Medical Sciences (AJUMS). The study was financially supported by AJUMS (Grant.No.: U-97130).

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