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Original Article

Patellar tendon donor-site healing during six and twelve months after Anterior Cruciate Ligament Reconstruction

Hamed Yazdanshenas [a,b], *Firooz Madadi* [c,*], *Firoozeh Madadi* [c], *Eleby Rudolph Washington III* [b], *Kristofer Jones* [a], *Arya Nick Shamie* [a]

[a] *University of California, Los Angles (UCLA), David Geffen School of Medicine, Los Angeles, CA 90095, USA*
[b] *Charles R. Drew University of Medicine and Science, College of Medicine, Los Angeles, CA 90059, USA*
[c] *Shahid Beheshti University of Medical Sciences and Health Services, Tehran, Iran*

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ABSTRACT

Background: Bone-Patellar Tendon-Bone Graft is one of the most acceptable methods of treatment for Anterior Cruciate Ligament rupture (ACL). This study evaluates the recovery process of the graft donor site.

Methods: This study evaluates the graft donor site recovery in 23 patients with ACL reconstruction, 6 and 12 months after the patellar tendon graft surgery.

Results: In 70 percent of the cases, the healing process was completed after 6 months and the remaining 30 percent recovered after 12 months.

Conclusion: Time is an important factor in the recovery process of the patellar tendon for reconstruction of the ACL.

1. Introduction

The Anterior Cruciate Ligament (ACL) is most frequently injured structure of the knee and ligament in the body. Given the increasing injury prevalence, there is undoubtedly a growing need for clinical decision-making among healthcare providers. It is estimated that 175,000 ACL reconstructions were performed in the year 2000 in the United States at a cost of more than $2 billion.[1–6] Besides the immediate associated morbidity and costs, an ACL tear significantly increases the risk of premature knee osteoarthritis.[1,7–9] It is estimated that osteoarthritis develops in 50% of patients with ACL tears 10–20 years after the injury, while they are still young.[1,7,8,10,11]

Based on previous studies, the rupture of the Anterior Cruciate Ligament (ACL) is the most common and most neglected—in terms of diagnosis—acute knee injury.[12] It may be impossible to diagnose this injury with a simple stress test since the muscle pain and spasm associated with it could mislead doctors.[13] Hence, it can only be diagnosed with specific instruments, such as arthroscopy. Therefore, the decision

* *Corresponding author*. Department of Orthopedic Surgery Akhtar Hospital, Shahid Beheshti University of Medical Sciences and Health Services, Apt 5, No 1835, Shariati Ave, Tehran 19338-43653, Iran. Tel.: +98 912 1133213.
E-mail address: Fmedadi@yahoo.com (F. Madadi).
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to treat ruptured ACLs and the various options for treatment have further increased the importance of diagnosis.

The ACL increases the stability along the anterior-posterior line of the knee. In addition, it plays an important role in preventing hyperextension and excessive axial rotation of the knee.[14] However, many cases presenting with normal knee function have, in fact, experienced an ACL rupture in arthrotomy.[15,16] It should be mentioned that ACL rupture becomes apparent when other fractures are simultaneously present, such as injury or degeneracy of the meniscus posterior horn and its subsequent meniscectomy, or even a gradual stretching and capsular injury with medium intensity[16]. Furthermore, many believe that ACL rupture is the beginning of the destruction of the knee, which has led to a vast number of studies regarding the anatomy and function of the ACL.[17]

The surgical approach to ACL tears for the past two decades has involved the reconstruction of the ACL with the use of a graft (a piece of tendon) passed through tunnels drilled into the tibia and femur at insertion points of the ligament to approximate normal anatomy, with the goal of eliminating ACL instability. Reconstruction is preferred over repair since randomized trials have shown that ACL repair is no better than non-operative treatment[3,18] and that ACL reconstruction significantly improves knee stability and the likelihood of return to pre-injury activity over repair alone or repair with augmentation (insertion of a tendon graft or synthetic graft).[3,19]

The commonly used sources of tendon in this surgery are quadriceps tendon, patellar tendon, hamstring tendon, and iliotibial band. Study results have shown that the patellar tendon is the preferred graft in replacing the ACL.[20]

Noyes et al have demonstrated that a patellar tendon graft has an acceptable strength in comparison to the ACL, where a 9 or 10 mm graft has approximately 112% of a normal ACL's strength. Additionally, in many studies, it has been demonstrated that bone tunnel widening is only slightly seen when patellar tendon is used, which has no effect on clinical outcomes.[21] Hence, these characteristics have made the patellar tendon graft a good replacement in ACL injuries.

In this study, we have evaluated the restoration of the patellar tendon graft donor site by ultrasonography in patients whose ACL has been replaced with this graft 6 and 12 months after harvesting in Anterior Cruciate Ligament Reconstruction.

2. Methods

2.1. Human subjects and entry criteria

Between 2008 and 2011, 23 patients with an average age of 30.17 ± 5.7, a history of knee torsion and positive Lachman, and positive pivot and anterior drawer tests, were diagnosed as having an ACL tear by an orthopedic surgeon, and reconstruction was performed. ACL reconstruction with an autogenous bone–patellar tendon–bone graft method at two orthopedic surgery hospitals (Baher Clinic) who were invited to participate. Patients were included if 1) they were moderately active, evidenced by a Tegner scale of 5 or greater before injury, 2) they only suffered from pure ACL rupture or ACL and meniscal lesion, and 3) they were candidates for ACL reconstruction with an autogenous bone-patellar tendon-bone graft. Subjects were excluded if they had an earlier injury or operation to either knee, evidenced by osteoarthritis via radiograph, simultaneous fracture, concurrent injury to the posterior cruciate ligament (PCL), or articular cartilage lesions with exposed bone observed during arthroscopy. Patients who were candidates for ACL-HTO (High Tibial Osteotomy) combination, Medial Collateral Ligament (MCL) repair, MCL reconstruction, combined ligament reconstruction, and other grafts were included.

The investigation was approved by our institutions' Committee on Human Research before commencement, and all subjects signed informed-consent forms before participation. Also, the patients and/or their families were informed that data from the case would be submitted for publication, and gave their consent. The surgeries were carried out by one surgeon using the bone-patellar tendon-bone grafting technique. At the time of arthroscopy, the knee was examined, and associated joint pathology was documented. The femoral notch was enlarged as necessary to improve visualization and to avoid later impingement against the graft.

2.2. Surgical technique

2.2.1. Bone-patellar tendon-bone grafting technique

After standard arthroscopic examination of the joint, followed by removal of irreparable fragments of torn menisci, the bone-patellar tendon-bone graft was constructed from the central third of the tendon of the ipsilateral knee. The graft was removed from the tibial tubercle and patella, and the patellar defect was grafted with cancellous bone trimmed from the bone blocks or with bone curetted from the bed of the tibial donor site. An Acufex drill-guide system was used to place guide-pins in the center of the tunnels to be reamed in the tibia and femur. The tibial pin was located at the junction of the middle and posterior thirds of the normal site of attachment of the anterior cruciate ligament to the tibia. The bone blocks of the graft were trimmed to appropriate sizes. The graft was pulled through the tunnels so that the patellar bone block was within the femoral tunnel and the tibial bone block was within the tibial tunnel. The graft was positioned and an interference-fit screw was used in the femoral tunnel to fix the bone block. Tension was then placed on the distal part of the graft, and the knee was cycled through a range of motion. The knee was then extended, and the graft was pulled in a distal direction. Next, the graft was recessed and was fixed at an appropriate tension within the tibial tunnel with use of an interference screw.

2.3. Postoperative rehabilitation program

A hinged brace for knee immobilization was placed on the knee and was worn constantly for four weeks. Patients walked in a toe-touch, weight-bearing manner using crutches, and quadriceps activity against gravity was permitted. Moreover, hamstring contractions were permitted. Hamstring strengthening physical therapy was started right away after surgery focusing on the hamstring (semitendinosus) and hip for 35 sessions for all patients. Additionally, quadricepses were strengthened partially during the first three months and completely over nine months.

2.4. Follow-up evaluations

All knees were examined before surgery: in the operating room immediately after the procedure and at two, four, six, and twelve months. Patients were followed up by anterior-posterior knee laxity with the Lachman test, the pivot-shift sign, and the active and passive ranges of knee motion (with the end of the range of motion established by the patient and the examiner) for one year. The paraclinical outcome was gauged by the echogenic changes of the patellar tendon in the operated knee via ultrasonography 6 and 12 months after surgery.

2.5. Study design

This study was a cohort observational study on 23 patients who underwent ACL reconstruction surgery using the bone-patellar-tendon-bone method. Six and 12 months after the surgery, the patients were evaluated by an ultrasonography of the area where the patellar tendon was removed, which was compared to the patellar tendon of their other knee. The demographic information of the patients, the date of their surgery, and their ultrasonography report were recorded one month later, and this information was analyzed after compilation.

2.6. Statistical analysis

Statistical analysis was performed with the SPSS® program (SPSS 20.0 for Windows, SPSS Inc., Chicago, IL, USA). In addition to a descriptive analysis of all variables, bivariate and multivariate analysis was conducted to determine the correlates of independent variables. At the descriptive level, the distribution and frequency of all items were examined. In the bivariate analysis, chi-square and analysis of variance were performed to examine the association between independent variables and outcome variables. For evaluation of the discrete variables, the chi-square test was used, and for comparison of the continuous variables, a Student's t-test was used. $P_v < 0.05$ was considered statistically significant, and all continuous variables were expressed as Mean + SE_{mean} (the average standard deviation from the mean).

3. Results

In this study, 17 men (74%) and 6 women (26%) formed the study group of a total of 23 patients with an average age of 30.17 ± 5.7. The donor site in 10 subjects (43.5%) was the right knee and in the other 13 subjects (56.6%), it was the left knee.

3.1. Six months after the surgery

The ultrasound showed that in 16 of the patients, the echogenicity of the patellar tendon in the operated knee was similar to their other knee even though there was some heterogeneity in all subjects; this indicated that the recovery rate was measured to be 70% using ultrasonography 6 months later (Table 1).

Table 1 – Frequency and age of recovered patients after 6 months.

	In total subjects	In recovered group	P. Value
Number and percentage of recovered females	6 (26%)	5 (31%)	Not significant
Number and percentage of recovered males	17 (74%)	11 (69%)	Not significant
Average age	30.17 ± 5.7	32.23 ± 4.9	Not significant

In seven patients, the tendon was reported as a hypoechoic mass, though the width of the tendon had increased which indicates regeneration (Table 1).

In order to evaluate the effect of sex and age, individual statistical groups were formed, and it was determined that among the cases that had recovered from the surgery, 11 were men and 5 were women. Analyzing these results using the chi-square test indicated that there was no significant difference among these two groups (P value > 0.05) (Table 1).

Using the Student's t-test, we defined that the age factor had no impact on recovery rate. The average age of the recovered patients (32.23 ± 4.9) was not significantly different from the total age factor of the subjects ($P_v > 0.05$) (Table 1).

3.2. Twelve months after the surgery

The recovery among seven patients, whose tendon was reported as a hypoechoic mass, was complete and the echogenicity of the patellar tendon in the operated knee was similar to their other knee.

4. Discussion

In this study, we evaluated 23 patients and showed that injuries were mostly seen in men, which is natural due to the difference in lifestyle. The main finding was that in 70% of the cases, the patellar tendon graft recovered in 6 months (in 16 cases, the graft donor site was isoechoic to the other knee 6 months after the surgery). Furthermore, the recovering process was clearly active in 30% of the patients and in all cases the patellar tendon graft recovered in 12 months. This study indicated that after approximately 6 months, in most patients, the patellar tendon recovered and other symptoms around the graft donor site, such as pain, also alleviated. Additionally, the study showed that this site was compatible enough as a graft donor site in possible future ACL injuries; this could be highly important for athletes and individuals who are at risk of repeating ACL injuries.

Regarding the use of ultrasound, it should be noted that this device is non-invasive and does not cause complications in the patients. In addition, it provides an objective criterion for evaluating the graft site. Based on this evaluation, it can be decided on how to control and continue effective treatment. These two advantages have been the basis for selecting

ultrasound in this study. Additionally, many studies have mentioned the advantageous use of ultrasound in analyzing ACL injuries.[4,21–23]

Our study showed that after an acceptable duration, the graft would regenerate, which is the known advantage of using the bone-patellar-tendon-bone graft in ACL restoration.

In order to define the impact of age and gender, we performed analytical analysis on different age and gender groups, and our results indicated that in recovered individuals, age and gender had no significant difference compared to the total population. It appears that the only important factor in the recovery process was time for the graft site to regenerate and recover. Furthermore, this study demonstrated that the increased length of the patellar tendon in 30% of the population occurred in the healing process, but this process was slower than in the other 70%. These results are consistent with the results of other studies.[23]

Wiley et al asserted that the tendon becomes wider and more heterogenic during the recovery process. Their study was conducted on 14 patients with ACL injury undergoing reconstruction with a graft of the middle 1/3 of patellar tendon. This study reported that the graft site of 59% of the cases recovered after 6 months and in 100% percent of the cases, it recovered in 12 months. That study indicated that ultrasound was an effective device for objective analysis of the graft site recovery.[24] Hough et al also used ultrasound as a device to study the recovery trend of the graft site. They indicated that the width and thickness of the tendon increases after the surgery, a trend that continues for up to one year after surgery. Their comparison was based on ultrasound images taken before and after surgery. Their research indicated that the highest rate of recovery was two months after the graft was taken from the donor site, leading to 76% of the patients recovering in 6 months, and all the patients fully recovered in 12 months.[22]

In another study conducted by Kiss et al, 20 subjects were divided into four groups, where groups I, II, III, and IV were studied via ultrasound imaging of the graft site 3, 6, 9, and 12 months after the surgery, respectively. They reported that despite the fact that there is evidence of regeneration in the first three groups; taking a graft from the same donor site is only possible 12 months after the surgery (the fourth group). They indicated that the recovery process is seen even three months after the surgery. In this study, the use of ultrasound device was also emphasized to be a proper technique for objective analysis in patellar tendinitis.[25] In conclusion, comparing the mentioned studies and our study, it is shown that treating the ACL rupture using a bone-patellar tendon-bone method is a suitable and effective method. In approximately 70% of the patients, the graft donor can be repeated again 6 months after the surgery, and in all cases, the recovery process is complete one year after the surgery. If these regenerated part of patellar tendon qualified enough to be used again, needs further histologic and biomechanical evaluation.

Conflicts of interest

The author has none to declare.

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