Comparison of Results of Anterior Cruciate Ligament Reconstruction via Two-stranded and Four-stranded Hamstring Autografts

Abstract
Background: Anterior cruciate ligament (ACL) is one of the key ligaments that help stabilize the knee joint. Considering the high rate of ACL ruptures, especially in athletes, reconstruction of this ligament is of paramount importance. The present study aimed to compare the level of function improvement and satisfaction of patients with ACL reconstruction by two-stranded and four-stranded hamstring autografts (HAs) with the diameter above six millimeters.

Methods: In total, 60 patients with ACL ruptures, who referred to healthcare centers in a four-year period (2013-2017) and underwent arthroscopic ACL reconstruction via two-stranded and four-stranded HAs, were called to the clinic to assess their satisfaction with the surgery, time to return to unrestricted sports and work activities, the number of postoperative physiotherapy sessions, postoperative complications, range of motion of the injured knee after the surgery, and Lysholm score. Moreover, data analysis was performed using independent sample t-test.

Results: In this study, both groups were homogenous in terms of the evaluated parameters. In addition, the four-stranded and two-stranded HA groups had excellent and good grades, respectively, and their mean Lysholm scores were 91.05 and 88.98, respectively. While significantly different lysholm scores were obtained by the groups, no significant difference was observed between the research groups with regard to a slight numerical difference between the two means (P=0.585).

Conclusion: According to the results of the study, no significant difference was observed in the functional and clinical outcomes of the participants, thereby confirming the equal effectiveness of the two-stranded and four-stranded HAs in arthroscopic ACL reconstruction. It seems that both surgery methods, provided that the graft diameter is equal to or above six millimeters, will have a similar success rate with close acceptable results.

Keywords: Knee ACL Reconstruction, Arthroscopy, Function

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Introduction

Anterior cruciate ligament (ACL) plays an important role in knee function\(^1\). Rupture of ACL is a common knee injury that causes significant disabilities in individuals, especially athletes. Therapeutic strategies for patients with this injury include nonsurgical management, restoration, and reconstruction in various patterns\(^2\). However, ACL reconstruction leads to return to unrestricted physical activities and delay in the onset of osteoarthritis, which is associated with loss of meniscus function\(^3-5\). While ACL can be treated by open-knee surgery, therapy is mostly carried out by arthroscopic treatment. Despite the low number of complications observed after this surgery, which is 90% successful if implemented accurately, there might be some problems imposed on the patients after the operation\(^6,7\). In this regard, the most important complications include surgical site infections and blood clots in the deep vein thrombosis. In addition, limited knee range of motion can occur due to technical issues during surgery, lack of performing postoperative...
therapeutic exercises, and/or inappropriate patient selection for ACL reconstruction. Knee pain, patellar tendon rupture, and instability are among the other possible complications of this surgery.\(^8,9\)

Currently, there is lack of consensus on the importance of ACL reconstruction of a knee rupture and its lower inefficiency. In this respect, the most controversies are related to the reconstruction techniques and type of grafts. Considering the disappointing results obtained after ACL reconstruction, various techniques have been proposed that include different grafts (e.g., patellar tendon, hamstring tendon, including semitendinosus and gracilis, quadriceps tendon, allograft, and synthetic compounds), each having their own specific benefits and disadvantages.\(^10-12\)

Obtaining a sufficient mechanical stability by using the proper diameter of a graft tendon eliminates the need to remove a greater number of grafts from the hamstrings, thereby imposing less anatomical and functional damages to the surgical site. Therefore, the graft diameter of \(\geq\) six millimeters is considered the appropriate ACL graft. With this background in mind, the present study aimed

**Methods**

This cross-sectional research was conducted on patients with ACL rupture, who required reconstruction based on clinical and paraclinical examinations during 2013-2017. At first, ethical approval was sought from the ethics review board of the university of the city (code:IR.AJUMS.REC.1396.143). After that, patients were divided into two groups of arthroscopy by four-stranded and two-stranded HAs using a suitable graft (diameter \(\geq\) six millimeters). However, subjects in the two-stranded and four-stranded HA were recognized with the titles of ST (semitendinosus) and ST+GR (semitendinosus-gracilis) in the statistical tests. As the first step, the semitendinosus tendon was removed for grafting. Finding a tendon with two six-millimeter strands eliminated the need for more tendons in the construction process. However, four strands containing two semitendinosus and gracilis tendons were applied to those who had grafts below six millimeters. Exclusion criteria included previous knee injury, simultaneous fractures, osteoarthritis, or serious damage to other ligaments, including posterior cruciate ligament, external collateral ligament, internal collateral ligament, and posterolateral corner collateral ligament. It is notable that all reconstructions were performed by an orthopedic surgeon. Before the surgery, patients received physiotherapy to restore their range of motion, muscle strength, and knee efficiency. Knee function was measured by assessing the subjects’ ability to bear weight, difficulty in climbing the stairs, running ability, and difficulty in sitting in a cross-legged position. In addition, postoperative complications, including deep infections, surgical site infections, and repetitive surgeries (due to recurrent ruptures), were evaluated.

After reconstruction surgery via two HA methods, the functional and clinical outcomes of the patients were assessed in terms of stability, pain, swelling, and the ability to perform regular activities and exercises over time. In addition, the standard Tegner Lysholm Knee Scoring Scale was applied and the results were interpreted based on the classification in Table 1.\(^13\) It is noteworthy that the procedure for postoperative rehabilitation was similar for all patients. Moreover, the results of the last follow-up in this study were related to six-nine months after the surgery.

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<tr>
<th>Score</th>
<th>Interpretation</th>
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<tr>
<td>90-84</td>
<td>Good</td>
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<td>&gt;90</td>
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Data analysis was performed in SPSS version 20 using independent sample t-test. In
addition, P-value of less than 0.05 was considered statistically significant.

**Results**

In this research, the patients underwent two-stranded (ST) (N=27) and four-stranded (ST+GR) (N=33) HAs after considering the inclusion and exclusion criteria. In addition, the mean age of the participants in the ST and ST+GR groups was 33.45±4.14 and 31.95±5.06 years, respectively, which showed no significant difference between the subjects in this regard (P=0.72). In this study, patients participated in a similar rehabilitation program before the surgery. The number of postoperative physiotherapy sessions required by patients to achieve acceptable recovery was recorded and compared in both groups. In this regard, the mean number of 21.02±4.08 sessions was observed for the ST group, whereas the ST+GR group required 20.45±5.17 sessions, which indicated no significant difference between the research groups (P=0.34).

In terms of time to return to daily activities, patients were assessed and compared by month. In this respect, the mean duration required to return to daily activities after the surgery was 2.13±0.19 months for the ST group and 2.02±0.41 months for the ST+GR group, which demonstrated no statistically significant difference (P=0.80). Patients evaluated in this study were normal people and not professional athletes. Therefore, the parameter of physical activities in this study was evaluated based on the ability to run without pain or fast walking during daily walks, and a general capability to perform heavy activities. According to the results, mean duration of return to unrestricted activities was estimated at 3.74±0.85 and 3.91±0.92 months in the ST and ST+GR groups, respectively, showing no significant difference in this regard (P=0.82).

In the ST group, mean Lysholm score was reported at 88.98±8.06, which was classified as a good grade in terms of the functional level of the patients. In the ST+GR group, mean Lysholm score of 91.05±2.16, which was categorized as an excellent grade regarding the functional level of the participants. While no significant difference was observed between the Lysholm scores of the research groups (P=0.585), the subjects in the ST+GR group had a clinically higher functional level, compared to the ST group (excellent vs. good), which was reported significant. Moreover, the incidence rate of postoperative complications was assessed in all patients. In the ST group, only two patients reported muscle weakness and one patient complained about pain during intense activities. In the ST+GR group, one patient had muscle weakness and one individual had complaints about pain when sitting. It is notable that none of the patients required another surgery or reconstruction.

**Discussion**

After a search in the relevant databases, it was concluded that no similar studies have been conducted to compare the two-stranded and four-stranded HAs. However, several studies have assessed and compared the therapeutic outcomes of these two treatment methods to other ACL reconstruction techniques, results of which are compared to our findings in this section of the article.

In a prospective, randomized, controlled trial, Beynnon et al. (2002) compared two surgery methods of two-stranded HA and bone–patellar tendon–bone autograft in ACL reconstruction. These researchers followed up the subjects for a mean of 39 months (in a range of 36-57 months), reporting equal level of satisfaction with surgery outcomes, level of daily activities, and knee function (weight tolerance, sitting in a cross-legged position, going up the stairs, marching in place) in patients after three years of follow up.
While the present and the mentioned studies were homogenous in terms of sample size, the higher efficiency of the results obtained by Beynnon et al. was due to their longer duration of follow up (three years). In the mentioned study, patients had equal levels of satisfaction with surgery outcomes, daily activities, and knee function (bearing weight, sitting in a cross-legged position, going up the stairs, marching in place). Therefore, it was concluded that both reconstruction methods could have appropriate functional results.

In a single blind randomized trial, Aune et al. (2001) compared two methods of four-stranded HA and bone–patellar tendon–bone autograft in ACL reconstruction. Follow-ups were performed at 6, 12, and 24 months after the surgery. While the HA group obtained better results in the single-leg jump test at 6 and 12 months, more efficient results were observed in both groups at month 12. After six months, subjects in the HA group had a better isokinetic knee extensor strength, compared to the patellar group. However, similar results were obtained for both groups at 12 and 24 months. On the other hand, a significant weakness was observed in the isokinetic knee bending strength in the HA group.

While both groups were homogenous in terms of anterior knee pain, the total pain intensity was significantly lower than the normal pain after ACL reconstruction in the HA group after 24 months. In the mentioned research, patients experienced faster clinical and functional improvement after ACL reconstruction via HA method, compared to those receiving the bone–patellar tendon–bone autograft (15). A similarity was detected between the results obtained by Aune et al. and our findings. In the present research, duration of return to daily and unrestricted activities was below six months after the surgery. In addition, our subjects gained clinical and functional recovery in the first few months after the surgery, which is one of the advantages of this treatment method.

In a prospective uncontrolled study by Leo et al. (2009), 10-year results of treatment by four-stranded HA and bone–patellar tendon–bone autograft were compared for patients undergoing ACL reconstruction surgery. After 10 years of follow up, 20 and 9 ACL ruptures were reported in the patellar and ACL groups, respectively, which showed a significant difference between the groups in this regard (P=0.02). In addition, the normal and relatively normal function was reported at 97% in both groups. In the patellar group, pain when sitting cross-legged and problems in graft removal were more prevalent, compared to the four-stranded AH group. Moreover, pain during intense physical activities was greater in the patellar group, compared to the four-stranded HA group (P=0.05). In the end, Leo et al. concluded that while both evaluated methods provided acceptable treatment outcomes, ACL reconstruction through the four-stranded AH technique was the final suggestion due to a lower level of problems in graft removal and radiographic osteoarthritis (16).

Compared to our findings, better results were obtained by Leo et al. due to longer follow-up duration. In terms of functional results, Leo et al. reported an excellent grade for the four-stranded group, which is in congruence with our findings. In addition, four-stranded HA method was preferred to the bone–patellar tendon–bone autograft due to a lower number of ACL ruptures and less pain. One of the major drawbacks of the current research was performing rehabilitation and recovery processes by different individuals and in various healthcare centers.

### Conclusion

In the current study, both research groups were homogenous in terms of clinical and functional abilities and had a similar level of excellence in ACL reconstruction if the graft diameter is equal to or above six millimeters. It is recommended that further studies be conducted over longer periods and on larger
sample populations with the same rehabilitation conditions.

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References