Results of an Anatomical Single Bundle Anterior Cruciate Ligament Reconstruction by the Anteromedial Method

Engin Çetinkaya[1], Harun Mutlu[2], Umut Yavuz[1], Murat Gül[1], Ümit Çetin[2], Ufuk Özkaya[2]

[1]Clinic of Orthopedics and Traumatology, Baltalimanı Osteopathic Training and Research Hospital, İstanbul, Turkey
[2]Clinic of Orthopedics and Traumatology, Gaziosmanpaşa Taksim Training and Research Hospital, İstanbul, Turkey

ABSTRACT

Objective: This study aimed to evaluate the results of patients undergoing single-bundle anatomical reconstruction of the anterior cruciate ligament (ACL) with the anteromedial portal technique and the effects of surgical timing on the results.

Methods: A total of 47 patients (44 males, three females; mean age: 27 years) were included in this study. Lachman test, pivot shift test and KT- 2000 arthrometry, International Knee Documentation Committee (IKDC) and Lysholm activity scoring were used in the preoperative and final follow-up in order to clinically evaluate. Furthermore, 17 patients undergoing early surgery (within the first 6 months) and 30 patients undergoing late surgery were compared for the presence of additional pathologies and functional results.

Results: The mean follow-up period was 25 months (range: 13–36 months). Lachman test, Pivot-shift test, KT-2000, Lysholm, and IKDC scores significantly improved during the final follow-up according to the preoperative values. Eighty-two percent (14/17) of patients in the early surgery group (ten medial, three lateral, and one bilateral) and 96% (29/30) of patients in the late surgery group (seventeen medial, five lateral, and seven bilateral) had meniscus tear, and the difference was statistically significant. Four patients requiring microfracture were present in the late surgery group. Functional outcome was better in patients in the early surgery group, although the difference was statistically not significant.

Conclusion: Anatomical reconstruction of ACL with the anteromedial portal technique is an effective method to improve clinical and functional results. Additionally, early surgery will improve functional results because it will decrease the frequency of additional pathology. *(JAREM 2016; 6: 88-93)*

Keywords: Anterior cruciate ligament reconstruction, anteromedial portal, single bundle, stability, surgery timing

INTRODUCTION

Anterior cruciate ligament (ACL) injury is a sports injury commonly seen in men and women with high physical activities, and ACL reconstruction is one of the most commonly performed orthopedic procedures (1). Clinical and biomechanical studies comparing various methods for assessing functional outcomes after ACL reconstruction are published every year, and these studies may change the course of clinical practice.

Currently, double-bundle ACL reconstruction has been stated to provide a better rotational control and functional recovery than the single-bundle method (2-4). However, in many studies in which long-term follow-ups have been reported, no difference between the two methods has been observed in terms of anteroposterior stability, rotational stability, or functional results (5-8). The high learning curve, long duration of surgery, difficulty of revision, high rate of complications, and development of instability caused by tunnel expansion reduce the usability of the double-bundle method (9-13). Although the single-bundle method is currently more preferable, when applying this method, the anatomical placement of the graft affects the success of the procedure (13-18). No consensus has been reached on the issues of graft preference, the number of bundles, or the techniques to be used when opening the tunnel.

Studies have shown that the incidence of additional pathologies increased in surgeries that were performed in early and late stages; durations between eight weeks and six months have been reported for the late stage, and it has been observed that the incidence of encountered meniscal and chondral pathologies increased as the duration increased (19-22). The effects of the surgical timing on functional outcomes continue to be investigated.

Many comparative studies on the choice of graft and application technique in the literature have demonstrated that a full consensus has not been reached. In this study, the outcomes of patients who underwent single-bundle ACL reconstruction through the anteromedial portal method and the effects of the surgical timing on the results were evaluated.

METHODS

Forty-seven patients with ACL injuries (44 men, three women) who underwent anatomic single-bundle ACL reconstruction using a hamstring graft through the anteromedial portal technique between 2009 and 2011 were included in the study. The required written informed consent was received from the patients, and the study was performed in accordance with the Ethical Principles for Medical Research Involving Human Subjects in the Helsinki Declaration of the World Medical Association. The mean age of the patients was 27 years (range: 20–43 years). The injury was located

Address for Correspondence: Dr. Engin Çetinkaya, E-mail: drengincetinkaya@gmail.com

Received Date: 13.07.2015 **Accepted Date:** 25.09.2015

DOI: 10.5152/jarem.2015.883

in the right knee in 28 patients and in the left knee in 19. Those who underwent reconstruction in the first six months were accepted for early-stage surgery and those who underwent reconstruction after six months were accepted for late-stage surgery.

After clinical examination of the patients (Lachman test, pivot shift test, and front drawer test), the diagnoses of the patients who were considered to have ACL tears were verified with magnetic resonance imaging. Patients with injuries that may affect the stability of the joint, such as medial collateral ligament tear, external collateral rupture, or posterior cruciate ligament rupture, were excluded from the study.

All operations were performed by a single surgeon. Anteromedial-anterolateral portals were opened as a standard under the control of a tourniquet, and the ACL was confirmed to be torn by performing diagnostic arthroscopy. Meniscus and/or cartilage pathologies were evaluated intraoperatively, and required surgical interventions were performed. Then, the region was entered through pes anserinus tibia endpoints with an oblique incision, and semitendinosus-gracilis tendons were taken. The previous adherence location of the ACL in the lateral condyle of the femur was cleaned using the anteromedial portal, and a guide wire was inserted through the anatomical adhesion location by bringing the knee to hyperflexion (Figure 1). A femoral tunnel was opened by sending a drill compatible with the thickness of the prepared graft over the guide wire. A tibial tunnel was opened with a drill that was consistent with the thickness of the graft prepared by aiming at the footprint of the ACL on the tibial articular surface. The prepared graft was passed through the tunnels and was attached to the femur with the suspension system and to the tibia with the hybrid system (screw-staple). The wound site was closed after inserting the aspiration drain. The operation was terminated by applying an elastic bandage.

During the first two weeks after surgery, rehabilitation was started, with a permitted flexion of 60°. Two weeks later, the sutures were removed. After allowing a flexion of 90° during the following two weeks, complete flexion was allowed after the fourth week. Partial load was applied using crutches within the first six weeks. Full load was allowed without any support after six weeks.

When assessing the knee stability of the patients, the Lachman test and a KT-2000 arthrometer were used to evaluate the anteroposterior stability. The rotational stability was assessed using the pivot shift test. The Lysholm activity score (18) and IKDC score (23) were used to assess the functional outcomes of the patients. IKDC scoring was evaluated as A (normal), B (near normal), C (abnormal), or D (severe abnormal). In the Lysholm scale, 95 points and above was evaluated as excellent results, points between 84 and 94 as good results, and points between 65 and 83 as moderate results. The functional outcomes of the patients who underwent surgery in the chronic phase and at an early stage were evaluated within each group.

Statistical Analysis

The mean, standard deviation, rate, and frequency were used as descriptive statistics of the data. The distribution of the data was verified with the Kolmogorov-Smirnov test. ANOVA (Tukey's test) was used in the analysis of quantitative data. The Chi-square test was used in the analysis of qualitative data, and the Fischer test was used when chi-square conditions could not be provided. The paired sample t-test and sign test were used in repeated measurements. The SPSS 20.0 software program (Statistical Package for the Social Sciences Inc., Chicago, IL, USA) was used for these analyses.

RESULTS

The mean follow-up period of the patients was 25 months (range: 20–43 months). Accompanying meniscus rupture was found in 43 (91.4%) patients during diagnostic arthroscopy. Meniscal tear (medial in ten patients, lateral in three patients, bilateral in one patient) was found in 14 of 17 (36.2%) patients who underwent early-stage surgery after injury (average: 4.4 months; range: 0.5–6 months). After six months (average: 18.2 months, range: 6–60 months), meniscal tears (medial meniscus tear in 17 patients, lateral meniscus tear in five, and bilateral meniscus tear in seven) were observed in 29 of 30 (63.8%) patients who underwent the operation. There was a statistically significant difference when the two groups classified according to the time of surgical intervention were compared in terms of additional pathologies (Table 1). Chondral damage was present, necessitating the implementation of microfracture in four patients; all of these patients underwent late-stage surgery (Figure 2).

The Lachman test and a KT-2000 arthrometer were used to evaluate the anteroposterior stability. Considering the preoperative Lachman test results, four patients were evaluated as stage I, 30 as stage II, and 13 patients as stage III. In the last follow-up, a

Figure 1. a, b. The opening point of the femoral tunnel during arthroscopy. (a) The point where the tunnel can be opened when the transtibial tunnel method is used. (b) The point where the tunnel can be opened when the anteromedial method is used

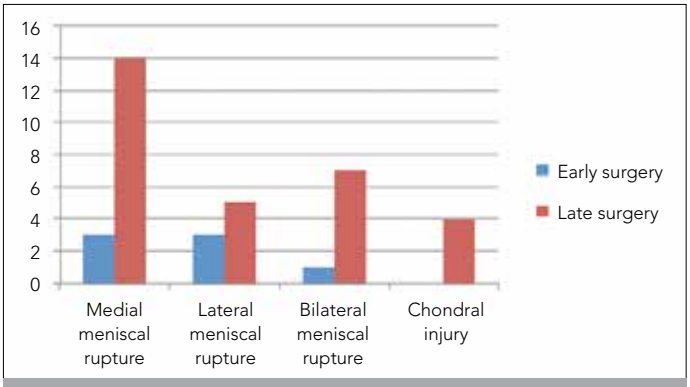

Figure 2. The distribution of additional pathologies according to the surgical time

Table 1. Surgical time and presence of additional pathologies

	Surgical time			
	First 6 months	After 6 months	Total	p
Meniscus tear	14	29	43	0.003
Medial	10	17	27	
Lateral	3	5	8	
Bilateral	1	7	8	
Chondral injury	0	4	4	0.001

Table 2. Comparison of pre- and postoperative clinical examination results

	Preoperative	Postoperative	p
Lachman test			
Stage 0	0	39	0.001
Stage 1	4	6	
Stage 2	30	2	
Stage 3	13	0	
Pivot shift test			
Stage 0	0	35	0.001
Stage 1	10	9	
Stage 2	22	3	
Stage 3	14	0	
KT–2000 (avg. mm)	7.1	2.5	0.018

Avg.: average

significant improvement was observed in the Lachman test; 39 patients were evaluated as stage 0, six as stage I, and two as stage II, and the difference was statistically significant (Table 2). Considering the KT-2000 arthrometer testing results, while the preoperative average was 7.1 mm (range: 3–12 mm), the average during the last control was found to be 2.5 mm (range: 1–5 mm); the difference was statistically significant (Table 2).

The pivot shift test was used to evaluate rotational stability. Considering the results of the preoperative pivot shift test, 10 patients were evaluated as stage I, 22 patients as stage II, and 14 patients as stage III. In the last follow-up, a significant improvement was observed in the pivot shift test; 35 patients were evaluated as stage 0, nine patients as stage I, and three patients as stage II, and the difference was statistically significant (Table 2).

The Lysholm activity score and IKDC score were used to evaluate the functional outcomes of the patients. While the average preoperative Lysholm score was 61.3 (range: 51–79), the average Lysholm score at final follow-up was 95.9 (range: 92–100), and a statistically significant difference was observed (p=0.001). When the Lysholm scores were evaluated according to the time of surgery, although the scores were higher for the patients in the early surgery group (average: 96.4/93.6), the differences were not found to be statistically significant (Table 3). When the average of the preoperative IKDC form results was evaluated, the results were near normal in three patients, abnormal in 37, and poor in seven. When the last control IKDC forms were evaluated, normal results were observed in 24 patients, near-normal results in 20, and abnormal results in three; there was a statistically significant difference between the normal result values (p=0.001). When the IKDC form results were evaluated in reference to the surgical timing, although the rate of normal results was higher (13/10) in those who underwent early surgery, the difference was not found to be statistically significant (Table 3).

Table 3. Comparison of pre- and postoperative functional outcomes

	Preoperative	Postoperative	p
Lysholm score			
General	61.3 (51-79)	95.9 (92-100)	0.001
Early surgery	59.8 (49-79)	96.4 (93-100)	
Late surgery	61.8 (50-78)	93.6 (90-98)	
IKDC			
Normal	0	24	0.001
Near normal	3	20	
Abnormal	37	3	
Severe abnormal	7	0	

IDC: International Knee Documentation Committee

DISCUSSION

This study demonstrated that single-bundle anatomic ACL reconstruction through the anteromedial portal method can significantly improve the rotational stability in addition to the anteroposterior stability. However, it has been observed that additional pathologies will occur less frequently in patients who undergo early surgery, and although this cannot be proved statistically, it has been observed that the functional results of these patients can be better than those of patients who undergo late surgery.

The ACL is divided into two bundles according to the locations of adherence to the tibia and femur. The anteromedial bundle supports the anteroposterior stability of the knee, while the posterolateral bundle contributes to the rotational stability; they also interact with each other (24, 25). Therefore, the anteroposterior and rotational stabilities should also be taken into consideration while ACL reconstruction is performed. Thus, the double-bundle technique was developed over time, and it was stated that placing both bundles on their own adherence places on the anatomical footprint eliminates this problem (26-28). The high learning curve, long duration of surgery, difficulty of revision, high rate of complications, and development of instability due to the formation of a single-wide tunnel secondary to the unification of tunnels in the femur and tibia in most patients have been shown to be the limitations of the double-bundle method; however, this method has gained popularity over time (9, 10). There are many studies showing that opening a single-

bundle tunnel displaying anatomical localization reduces the obliquity of the femoral tunnel and is as effective as the double-bundle method because it provides a more anatomical location in terms of anteroposterior stability, rotational stability, and other functional outcomes (5-8, 29, 30). The superiority of one method over the other is controversial, and it is obvious that there is no full consensus. We chose single-bundle anatomic ACL reconstruction in our patients because of the limitations of the double-bundle method and because single-bundle anatomical reconstruction recovers the rotational stability. When the results were evaluated, we observed that stability was provided in both planes, consistent with findings in the literature; additionally, the functional outcomes showed statistically significant improvement.

Different tunnel positions, attachment options, and graft types have been proposed in order to provide anatomical placement during anterior cruciate ligament reconstruction (Figure 1) (31, 32). Although some studies state that single-bundle ACL reconstruction is the standard treatment (33-35), other studies support the view that rotational stability increases and that the development of arthrosis is slowed by protecting the meniscus when the double-bundle method is used (26-28). Over time, studies have emerged that indicate that placing the femoral tunnel in the anatomical location increases the rotational stability when the single-bundle method is performed (5-7, 15, 36). Rue et al. (32) demonstrated that the tibial tunnel could be opened in a more anatomical location of the femoral tunnel by moving it in a more proximal and medial direction using the transtibial technique; however, medial collateral ligament injury, the development of attachment failures due to damage at the adherence location of the pes anserinus, and shortness of the tibial tunnel have been reported as complications of this method. Harner and Poehling (17) have showed that opening the femoral tunnel using an anteromedial portal instead of the transtibial technique enables graft placement in a more anatomical location of the femur; however, it increases the obliquity of the femoral tunnel. Increasing the obliquity of the femoral tunnel, i.e., lowering the tunnel placement from the 11 or 1 o'clock position to the 10 or 2 o'clock position in the coronal plane, enables the graft to adhere to the anatomical location; by this means, rotational stability is obtained (15, 36-38). In this study, our arthroscopic evaluation showed that the tunnel opened using the anteromedial portal was placed more anatomically. When we evaluated the clinical and functional results, consistent with those in the literature, we observed that the stability was provided in both planes; concomitantly, the functional outcomes significantly improved.

Although ACL rupture is one of the most common sports injuries, it is not always easy to make an early diagnosis. The mechanism of injury is usually typical; however, because swelling depending on hemarthroses and concomitant severe pain occurs in the knee, medical examination is often difficult. Therefore, the rate of diagnosis in the emergency room is approximately 20% (19). It has been stated that when the diagnosis is delayed, the incidence of additional injury increases. Ghodadra et al. (36) divided 709 patients into three groups of 0–4 weeks, 4–8 weeks, and after eight weeks according to the surgical time; they reported that the rate of cartilage pathologies in the medial compartment and meniscus tears was statistically higher in patients who underwent surgery after the eighth week. Dumont et al. (37) demonstrated that the rate of meniscal pathologies was higher in patients who underwent surgery after five months and later. Sri-Ram et al. (38) conducted a study including 5086 patients and indicated that the rate of concomitant meniscus tear doubled when surgery was delayed 5–12 months and increased up to four times in patients who underwent surgery after 12 months. It has been shown in the same study that the rate of chondral injury increases as the time of surgical application and age increases. In this study as well, consistent with the literature, the incidence of chondral damage and meniscal tears significantly increased as the surgical time was delayed. When these results are evaluated, ensuring the stability of the knee will reduce the number of additional pathologies, along with early diagnosis and surgery. As additional information, we observed that the functional results were numerically better in patients who underwent early surgery, although this result was not statistically significant. We believe that prospective studies involving more patients and a control group are necessary to assess the impact of the surgical time on these results.

The lack of a control group, the small number of patients, and the lack of an additional imaging modality to arthroscopic observation in order to evaluate the obliquity of the femoral tunnel are the limitations of this study. However, the strengths of this study are that the patients were operated on by a single surgeon, the study has a long follow-up duration, and it compares the functional results according to the surgical time.

CONCLUSION

The use of the anteromedial portal method while performing ACL reconstruction increases not only the anteroposterior stability but also the rotational stability by ensuring that the femoral tunnel is opened close to the anatomical location. Thus, providing the stability in both planes will increase the clinical and functional outcomes in a positive way. Additionally, because the incidence and severity of meniscal and chondral pathologies increase as the time after injury increases, early diagnosis and surgery will increase the clinical success of ACL reconstruction.

Ethics Committee Approval: Authors declared that the research was conducted according to the principles of the World Medical Association Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects", (amended in October 2013).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - E.Ç., U.Ö.; Design - E.Ç., Ü.Ç.; Supervision - M.G.; Resources - M.G., U.Y., H.M.; Materials - M.G., H.M., Ü.Ç.; Data Collection and/or Processing - Ü.Ç.; Analysis and/or Interpretation - H.M., U.Y., U.Ö.; Literature Search - U.Y., U.Ö., M.G.; Writing Manuscript - E.Ç.; Critical Review - U.Ö., U.Y.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

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