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Comparison of the anatomic femoral and the transtibial tunnel technique in the arthroscopic anterior cruciate ligament reconstruction

Anatomic femoral and transtibial technique

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Abstract
Aim: In this study, we aimed to compare the functional results of the transtibial tunnel (TT) and anatomic femoral tunnel (AFT) technique in arthroscopic single-bundle anterior cruciate ligament reconstruction.
Material and Methods: We performed arthroscopic single-bundle anterior cruciate ligament reconstruction with autogenous hamstring tendons in 40 patients using the transtibial tunnel technique and 43 patients using the anatomic femoral tunnel technique. We used radiological X-Ray and MR imaging. We evaluated patients on physical examination before and after surgery using Anterior-drawer, Lachman and Pivot-shift tests and Tegner, Lysholm and International Knee Documentation Committee (IKDC) functional scoring systems.
Results: Among the patients included in the study, 95.2% (n = 79) were male and 4.8% (n = 4) were female. The mean age of the patients was 30,4 years. In fifty (59.5%) patients, the right knee was affected, in thirty-three (40.5%) patients, the left knee was affected. We followed our patients for an average of 18.9 months. Tegner, Lysholm and IKDC scores are similar in both techniques before and after the surgery. Compared to pre-surgery, significant improvement was observed in the Anterior drawer and Lachman tests of the patients in whom we used the anatomical femoral tunnel technique, while no significant difference was found between the two techniques in the Pivot shift test.
Discussion: The location of the tunnels is one of the most important factors affecting the outcome of the ACL reconstruction. The TT technique is an easier and shorter surgical method. In the TT technique, the location of the tibial tunnel determines the placement of the femoral tunnel. Surgical and learning times are longer in the AFT technique. In the AFT technique, the femoral tunnel is drilled independently of the tibial tunnel position, which makes it possible to place the graft in the center of the femoral footprint. Although both techniques show similar functional results, the AFT technique significantly increases anteroposterior and rotational stability. Accordingly, rehabilitation and return to sports are earlier in the anatomic femoral tunnel technique. It is possible to say that the anatomic femoral tunnel technique is superior, considering the patient satisfaction and the rate of returning to the pre-surgical activity level.

Keywords
Cruciate Ligament, Single Bundle, Anatomic Tunnel, Transtibial Tunnel, Arthroscopic Repair

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Introduction

Anterior cruciate ligament (ACL) injuries are mostly seen in young active people who do sports. These injuries often cause lifestyle changes in people and can lead to serious disabilities [1]. The aim of ACL surgery is to provide normal knee kinematics and stability, protect other anatomical structures, prevent new injuries and regain pre-injury strength, range of motion and functionality [2].

Femoral tunnel placement is important in anterior cruciate ligament reconstruction as it has been shown as the most important reason for graft failure and revision surgery. Femoral tunnel drilling techniques in ACL reconstruction have progressed in the last few decades [3]. In a study conducted in 2006, the most common method in the preparation of the femoral tunnel and the first choice of most surgeons was the transtibial (TT) tunnel technique [4]. However, concerns regarding the possible failure of non-anatomical location using this technique due to limitations in the orientation of the tibial tunnel have also been highlighted [5]. Although femoral tunnel drilling with TT technique is shorter duration and easier, it causes non-anatomical tunnel and graft placement [6].

In a biomechanical experiment, surgeons drew more attention to the placement of the anatomical tunnel instead of the traditional non-anatomical tunnel (TT) placement to improve rotational stability and reduce postoperative patient dissatisfaction. Anatomical femoral tunnel placement provides better anteroposterior and rotational stability in the knee [7].

Recent studies have shown that surgeons have moved significantly change from TT technique to AFT technique in tunnel selection. In this technique, the femoral tunnel is reconstructed through an accessory (distant) anteromedial portal, independent of the tibial tunnel [8]. Many studies have been done on this subject, but there is no comprehensive review. In this study, we aimed to compare the functional results of these two different femoral tunnel techniques in ACL reconstruction.

Material and Methods

In our clinic, between January 2013 and November 2016, we performed arthroscopically anterior cruciate ligament reconstruction with autogenous hamstring tendons in 40 patients using the transtibial tunnel (TT) technique, and 43 patients using the anatomic femoral tunnel (AFT) technique. In our study, we included 83 patients who underwent reconstruction for ACL rupture, who may have additional meniscal tears, and who we followed up for at least 9 months with the transtibial and anatomic femoral tunnel technique. Four patients who underwent revision surgery with bone tendon bone, 11 patients who had microfracture or cartilage matrix due to chondropathy, 8 patients whose follow-up period was less than 9 months, patients who were not followed up and had ACL reconstruction surgery on the same knee, accompanying ligament injury, patients who underwent fracture surgery and bilateral ACL revision were not included in the study.

The anamnesis of our patients was taken and physical examinations (Anterior drawer Pivot-Shift, Lachman tests) were performed. Tests for additional injuries such as meniscopathy, chondropathy, collateral ligament injury (McMurrey, Varus-Valgus Stress Tests) were performed. X-Ray and MR imaging were used radiologically. The patients were evaluated before and after surgery using the Tegner, Lysholm and IKDC functional scoring systems.

Surgical Technique

Surgical procedure was initiated by opening standard anterolateral and anteromedial portals arthroscopically. In addition to ACL, meniscus and cartilage structures were evaluated arthroscopically. Hamstring tendon (semitendinosus and gracilis) autograft was harvested after the ACL was seen to be torn. Determining the location of the tibial tunnel is an important step in ACL reconstruction. The location of the tibial tunnel is important in terms of whether the graft will get stuck in the intercondylar notch and whether it is in proper alignment within the joint.

In the TT technique, the knee was flexed at 90 degrees, and the tibial guide adjusted to 55 degrees, was placed in the anterior part of the medial tibial process in continuity with the inner part of the anterior horn of the lateral meniscus, and the guide wire was inserted. The tibial tunnel was created with a cannulated drill. For the femoral tunnel, a guidewire was passed through the transtibial tibial tunnel, and the femoral lateral condyle was placed in the medial face ACL footprint at 11 o'clock for the right knee and 2 o'clock for the left knee, and a femoral tunnel was created with a cannulated drill suitable for the graft diameter.

In the anatomical femoral tunnel (AFT) technique, it was first started from the femoral tunnel. A new portal (far medial) was opened from the medial of the anteromedial portal and the guidewire was placed in the femoral footprint with the free-hand method. The knee was fully flexed and drilled with a guidewire and a 4.5 mm endobutton cannulated drill. The tunnel length was measured. The tibial tunnel was created with a cannulated drill by placing the knee flexed 90 degrees, the tibial guide was placed at 55 degrees, similar to the TT technique. While the knee was in full extension, the graft was fixed with an endobutton in the lateral cortex of the femur, an interference screw of appropriate thickness in the tibial tunnel, and a U-staple. After fixation, the tension and impingement status of the new tendon was checked with the arthroscope.

Results

The study included 83 patients, of whom 43 patients used the anatomic femoral technique and 40 patients used the transtibial technique; 95.2% (n = 79) of the patients were male and 4.8% (n = 4) were female. The mean age was 30.4 years, the youngest was 20 and the oldest was 45. In fifty (59.5%) patients, the right knee was affected, and in thirty-three (40.5%) patients, the left knee was affected. We followed our patients for a minimum of 9 months and a maximum of 38 months, with an average of 18.9 months.

While performing the statistics of the study, numerical data were given as mean and standard deviation in descriptive statistics, and categorical data were given as numbers and percentages. Fisher's Exact test was used to compare categorical data. A dependent t-test was used to compare preop and postop scores.

The analyzes were made with the SPSS 18 package program. P<0.05. was considered significant.

Thirty-three of our patients had meniscal damage and ACL reconstruction was performed on these lesions. In the preop and postoperative evaluations of the patients, 43 patients in whom pre-operative femoral tunnel technique was used had an average pre-operative Lysholm score of 53.9 and a mean of 88.5 in postoperative control. When we compare it with the transtibial tunnel technique, the Lysholm score, which was 52.8 preoperatively, increased to 88.5 postoperatively and was found to be significant.

In the anatomical femoral tunnel technique, the preop Tegner activity score average was 5.49, while postoperative was 4.84. When compared with the transtibial tunnel technique, the mean Tegner score preoperatively was 5.93 and 5.17 postoperatively. IKDC scores of 43 patients using AFT technique in the preoperative period were as follows: 15 patients were in group C (34.8%), 28 patients were in group D (65.2%); in the postoperative period: 24 patients were in group A (55.8%), and 15 patients were in group B (%). 34.8), 3 patients in group C (6.9%) and 1 patient in group D (2.3%). Among 40 patients who used the transtibial tunnel technique, in the preoperative period, 22 patients were in group C (55%), 18 patients (45%) were in group D, 13 patients were in group A (32.5%); in the postop period 21 patients were in group B (52.5%), 4 patients were in group C (10%), 2 patients were in group D (5%).

There was no significant correlation between the time from trauma to surgery and the preop and postop Tegner and Lysholm scores in both groups.

There was no significant relationship between additional injury (meniscal tear) and any postoperative parameter.

Table 1. Preop and postop scores of the patients followed up

GRUP		Mean	Number	Std. Deviation	p
43 Patients using anatomic femoral tunnel	Preop Tegner	5,49	43	1,549	p<0,001
	Postop Tegner	4,84	43	1,542	
	Preop Lysholm	53,98	43	5,954	p<0,001
	Postop Lysholm	88,58	43	6,111	
40 Patients using the transtibial tunnel technique	Preop Tegner	5,93	41	1,808	p<0,001
	Postop Tegner	5,17	41	1,548	
	Preop Lysholm	52,85	41	5,673	p<0,001
	Postop Lysholm	88,56	41	4,056	

Discussion

The anterior cruciate ligament (ACL) is the most important knee stabilizer located between the femur and the tibia and is the main structure that prevents the anterior translation of the tibia [10]. When deciding on the surgical treatment in patients with anterior cruciate ligament insufficiency, the patient's activity level, job, lifestyle, degree and frequency of instability should be considered [9].

One of the most important factors affecting the outcome of ACL reconstruction is the misplacement of the tunnels. It is thought that the laxity or limitation of movement that may develop in the knee is associated with inappropriate graft placement [11]. Non-anatomical bone tunnel placement may cause non-anatomical ACL reconstruction and thus knee instability [12].

Until 1-2 decades ago, the transtibial femoral tunnel technique was the most popular technique among surgeons in ACL reconstruction and was used almost universally. However, studies on "anatomical" or "independent" reconstruction have increased, since it may result in a more anatomical location of the ACL [13]. In the transtibial tunnel technique, femoral tunnel placement corresponds to the normal localization of the anterior and superior anterior cruciate ligament. Studies have shown that the guidewire cannot be fully anatomically placed in the femoral footprint using the transtibial technique [14]. It is difficult to create the anatomical femoral tunnel position using the TT technique. The non-anatomical ACL applies additional force on the graft, leading to abnormal knee kinematics [15].

The transtibial technique is an easier and shorter surgical method. In the TT technique, the location of the tibial tunnel determines the placement of the femoral tunnel. The position of the femoral tunnel also varies according to the degree of knee flexion [16]. In a cadaver study comparing independent creation of tunnels with the TT drilling technique, it was shown that grafts were placed anatomically and more horizontally in the independent drilling group. In addition, the authors say that horizontal grafts are biomechanically more successful than vertical grafts in providing knee anteroposterior and rotational stability [17]. In the long-term follow-up of patients who underwent ACL reconstruction with the TT technique, it was observed that anterior tibial translation in patients decreased, but rotational instability could not be prevented [18]. Another study showed an increase in rotational instability when the graft was placed more vertically [19].

In ACL reconstruction, the importance of drilling the femoral tunnel anatomically to provide sufficient rotational and

Table 2. Statistical results of IKDC scores

			Postop IKDC				p
			Normal	Close To Normal	Anormal	Serious Anormal	
43 Patients using anatomic femoral detection method	Preop IKDC	Anormal	8	6	1	0	0,922
		Serious Anormal	16	9	2	1	
	Total		24	15	3	1	
40 Patients using the transtibial tunnel technique	Preop IKDC	Anormal	6	14	2	0	0,323
		Serious Anormal	7	8	2	2	
	Total		13	22	4	2	

anteroposterior stability in the knee has appeared [18]. In the anatomical femoral tunnel (AFT) technique, the femoral tunnel is drilled independently of the tibial tunnel position and makes it possible to place the graft in the center of the femoral footprint [20]. Surgical and learning times are longer in the AFT technique. The risk of fracture of the posterior wall of the femur lateral condyle is high. Full flexion of the knee causes the visual field to constrict. Cartilage damage may occur in the femur medial condyle. A meta-analysis of a recent study showed that creating an independent femoral tunnel provides better anatomical graft placement and increased knee stability [21]. In a study comparing TT and AFT techniques, increased horizontal placement of the graft provided better rotational control in addition to anterior-posterior translational stability [22].

The superiority of the anatomical femoral tunnel technique has been identified in both laboratory and clinical studies. Therefore, the development of surgical techniques to find anatomical footprints of natural ACL and restore normal knee kinematics has become an important focus in ACL reconstructive surgery. However, there is no consensus on which surgical technique is best suited to reliably achieve these goals. Some authors have recommended to prepare the femoral tunnel with a modified transtibial technique, although others have advocated independent femoral tunnel drilling via an anteromedial arthroscopic portal [23]. In the light of this information, some surgeons concluded that it is more appropriate to open the femoral tunnel with the knee in hyperflexion through the medial arthroscopic portal [25].

Biomechanical results after ACL reconstruction with the anatomical femoral tunnel (AFT) technique were found to be superior when compared with transtibial ACL reconstruction. Lachman and Anterior drawer tests became negative after ACL reconstruction with AFT, while these tests were found to be positive after transtibial reconstruction. In addition, in manual and instrumented pivot-shift examination, anatomic femoral tunnel ACL reconstruction showed significantly negative findings than transtibial reconstruction. Interestingly, manual rotational and pivot shift rotation component of knee stability did not differ significantly between AFT and transtibial ACL reconstructions [24].

In this study, the number of patients was short and the follow-up period was relatively shorter. Although there was no significant difference between the functional scores after the reconstruction with the TT and AFT technique, the Anterior drawer and Lachman tests were found to be significantly negative in the patients who were performed the AFT technique. We believe that this important advantage of the AFT technique will become widespread among surgeons and will become a current treatment.

Conclusion

Different femoral tunnel drilling methods (transtibial, anatomical, all-inside) are available in the anterior cruciate ligament reconstruction. In our study, compared to the transtibial tunnel technique, the anatomic femoral tunnel technique significantly increased anterior-posterior and rotational stability compared to the pre-surgery period and their return to sports has also shortened. Despite the technical difficulties and the risk of damage to the femoral medial condyle, the anatomic femoral tunnel technique can be considered a current surgical method, considering the patient satisfaction and the rate of returning to the pre-surgical activity level.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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