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Comparison of Transtibial and Anteromedial Portal Techniques Used in Anterior Cruciate Ligament Repair Using Autogenous Hamstring Tendon Graft

Ön Çapraz Bağ Tamirinde Otojen Hamstring Tendon Grefti Kullanılarak Uygulanan Transtibial ve Anteromedial Portal Tekniklerin Karşılaştırılması

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ABSTRACT

Aim: The aim of this study was to investigate the effects of transtibial (TT) and anteromedial portal (AMP) techniques used in anterior cruciate ligament repair on knee joint function after anterior cruciate ligament reconstruction.
Material and Methods: Sixty patients who were surgically treated in our clinic for anterior cruciate ligament tear were included in the study. Thirty patients underwent TT technique and 30 patients underwent AMP. Functional evaluations were performed according to Lysholm, International Knee Documentation Committee (IKDC) and Tegner scoring preop and postop. The angle between the femoral tunnel and the distal joint face was measured in postoperative Anteroposterior and Lateral knee graphs and its effect on the knee joint functional outcome was examined.
Results: Eighty percent of the patients included in the study were male (n=47) and 20% were female (n=13). The gender distribution according to the groups was homogeneous (p=0.476). The mean age of the subjects was 32.75±8.81 (16-53) years. The postoperative Lysholm score was significantly higher in the AMP group than in the TT group (p<0.001). The postoperative Tegner score was significantly higher in the AMP group than in the TT group (p<0.001). Mean femoral tunnel obliquity was 59.3° in the TT group and 41.4° in the AMP group.
Conclusion: It is thought that oblique femoral tunnel placement is more beneficial for the rotational stability of anterior cruciate ligament. In our study, we think that AMP technique is more beneficial than femoral obliquity in terms of functional outcome.
Keywords: Anatomic anterior cross ligament reconstruction; autogenous hamstring; anteromedial portal; trans tibial technique.

ÖZ

Amaç: Bu çalışmada, ön çapraz bağ tamirinde kullanılan transtibial (TT) ile anteromedial portal (AMP) teknik arasındaki farklılıkların, ön çapraz bağ rekonstrüksiyonu sonrası hastaların diz eklemi fonksiyonları üzerine etkilerinin araştırılması amaçlanmıştır.
Gereç ve Yöntemler: Çalışmamıza kliniğimizde ön çapraz bağ yırtığı nedeniyle cerrahi olarak tedavi edilen 60 hasta dahil edildi. Otuz hastaya TT teknik, 30 hastaya AMP teknik uygulandı. Fonksiyonel değerlendirmelerde Lysholm, Uluslararası Diz Belgelendirme Komitesi (International Knee Documentation Committee, IKDC) ve Tegner skoru preop ve postop olarak bakıldı. Postoperatif anteroposterior ve lateral diz grafilerinde femur tüneli ile distal eklem yüzü arasındaki açı ölçüldü ve diz eklemi fonksiyonel sonucu üzerine etkisi incelendi.
Bulgular: Çalışmaya dahil edilen hastaların %80'i erkek (n=47) ve %20'si kadındır (n=13). Gruplara göre cinsiyet dağılımı homojendir (p=0.476). Bireylerin ortalama yaşı 32.75±8.81 (16-53) olarak tespit edildi. AMP uygulanan grupta ölçülen operasyon sonrası Lysholm skor değeri, TT teknik uygulanan grupta ölçülen değerinden anlamlı düzeyde daha yüksek bulunmuştur (p<0.001). AMP tekniği uygulanan grupta ölçülen operasyon sonrası Tegner skoru değer, TT teknik uygulanan grupta ölçülen değerinden anlamlı düzeyde daha yüksek bulunmuştur (p<0.001). Ortalama femur tüneli oblikitesi TT grubunda 59,3°, AMP grubunda ise 41,4° bulunmuştur.
Sonuç: Oblik femoral tünel yerleşiminin, ön çapraz bağın rotasyonel stabilitesine daha fazla yarar sağladığı düşünülmektedir. Çalışmamızda AMP teknik uygulanmasının TT tekniğe göre femoral oblisite artışının fonksiyonel sonuca katkısının daha yararlı olduğu kanaatindeyiz.
Anahtar kelimeler: Anatomik ön çapraz bağ rekonstrüksiyonu; otojen hamstring; anteromedial portal; trans tibial teknik.

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INTRODUCTION

Anterior cruciate ligament (ACL) injuries often occur as a result of non-contact pivot injuries. The inadequacy of ACL providing proprioception, stabilization against valgus and varus stresses, tibial rotation, anterior translation of the tibia will prevent the knee from performing its normal function (1,2). ACL injury is the instability injuries that may cause knee symptoms such as meniscal tears or chondral injuries and osteoarthritis (3,4). It is estimated that around 3,000 ACL injuries occur in our country with the increasing interest of the society in sports. Therefore, the diagnosis and treatment of ACL is one of the most important issues in today's sports surgery. ACL is one of the most injured structures in the knee (Figure 1).

Discussions on ACL injuries focus on the timing of surgery, graft selection and the most appropriate surgical technique. The main purposes of the reconstruction of this ligament are to increase the range of motion and stability of the knee joint for individuals interested in sports and to make their stability be able to sport; to prevent complaints from instability for individuals who are not interested in sports actively; to regain the range of motion and stability of knee joint. Studies on ACL reconstruction have reported that femoral tunnel placement applied by using the transtibial (TT) technique is more difficult than the anteromedial portal (AMP) technique (5). A better approach to the natural femoral origin of the ACL has been adopted with femoral tunnel placement, which has been shown to play a vital role in biomechanical, stability and clinical outcomes after ACL reconstruction. The AMP approach technique is thought to locate the femoral tunnel better within the footprint of the natural ACL and drill the graft hole more posteroinferior to the lateral femoral condyle wall than the traditional TT approach (6). In this study, we concluded that the reconstruction of the ACL applied by using AMP technique is clinically and functionally more successful than TT technique.

MATERIAL AND METHODS

This study was approved by Duzce University Clinical Research Ethics Committee (05.05.2016 and 2016/03). It was decided to recruit a total of sixty patients to obtain clinically and statistically significant difference in accordance with the study with a 5% significance level,

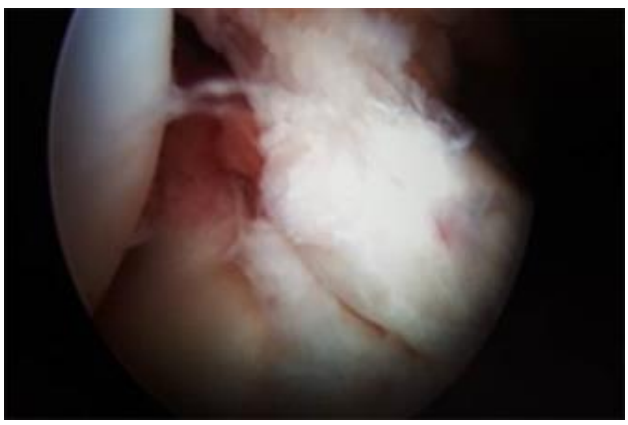

Figure 1. Intraoperative arthroscopic view of anterior cruciate ligament rupture

80% power and an effect size of 0.32. Totally 60 patients with autogenous hamstring tendon graft half of whom (n=30) were operated with AMP Technique, and half of whom (n=30) operated with TT technique were evaluated retrospectively due to the total ACL tear between January 2003 and June 2016. Eighty percent of the patients (n=47) included in the study were male and 20% were female (n=13). The average age at surgery was 30.03±7.83 (18-45) in the AMP technique and 35.37±9.03 (16-53) in the TT technique group. In the AMP technique group, 17 patients had right-sided lesions and 13 patients had left-sided lesions. There were 15 right and 15 left side lesions in the TT technique group. The attention was paid on that all patients had primary ACL rupture and autogenous hamstring tendon graft was used. In addition, endobutton was used for femoral fixation and biodegradable screws and U-Screws was used for tibial fixation in all the patients.

Drawing forth, the measurement of the knee flexions, Lachman and Pivot-Shift tests were performed during the examination, under anesthesia and postoperatively. In addition to the examination findings of our patients, the results were confirmed by performing magnetic resonance imaging (MRI). Lysholm score, Tegner activity score and International Knee Documentation Committee (IKDC) evaluation form were filled in all patients' preoperative and control examinations.

A standard arthroscopy protocol was performed and ACL rupture was confirmed before the removal of the graft. Hamstring autograft was used in all patients. Standard technique was applied in both TT and AMP groups for tibial tunnel. The tibial tunnel was prepared at a 45° angle to the tibial shaft at the footprint of the ACL (7). In the TT group, the standard targeting guide with a 7 mm offset was placed through the tibial tunnel at the right knee 11 and the left knee at the 1 o'clock position (8). Three-portal techniques (anterolateral, central anteromedial and low anteromedial) were used in the AMP group. The low AMP formed under arthroscopic imaging; A spinal needle just above the anterior horn of the medial meniscus and 1.5 cm medial to the medial border of the patellar tendon was carried forward and the femoral tunnel was created independently from the tibial tunnel (9). The midpoints of the remnants of the anteromedial and posterolateral bundles of ACL were marked with a microfracture instrument. Lateral intercondylar and lateral bifurcated protrusion were determined as femoral anatomical bone point (10). The lateral bifurcated protrusion is an osseous sign extending from the anterior to posterior and separating the femoral attachment region of the anteromedial and posterolateral bundles (11). The surgical position was designed to allow knee flexion of 120-130 degrees and the guide wire was placed in the middle of the two insertion areas and low AMP (11). A femoral drill was selected according to the graft diameter and the tunnel was drilled with a cannulated reamer. An endobutton device was used for femoral fixation of the graft. The anterior stretch of the graft was performed by flexing and extending the knee across the range of motion. It was confirmed with an arthroscopic examination whether the graft was stuck or not. The tibial fixation was performed by using a biodegradable screw and U-screw over the remnant graft at 20° flexion of the knee.

In the TT group, the accessory AMP was not required. The tibial guide angle was adjusted to 45 degrees in the way that the bottom part of the guiding system remained in the incision. The other side of the tibial guide was placed in 5-7 mm front of the posterior cruciate ligament and on the lateral edge of the medial eminence by inserting into the portal drilled from the anteromedial (7). The attention was paid on keeping the angle of the guide on the frontal plane and on the tibia approximately 30 degrees. After that, the guide wire was sent from the bottom of the guide inside to the knee while the guide was being held in the appropriate position. The exit point of the guide wire was checked and the reachable enterance point for the femoral tunnel, which will be drilled through the tibial tunnel, by directing towards the medial wall of the femoral lateral condyle and whether there will be any associated compression or not were checked. The tibial tunnel was drilled with a reamer suitable to graft's diameter. In the next stage, the intraarticular exit point of the tunnel was adjusted by cleaning with a shaver to prevent the graft damage while passing through the tunnel. Later, the femoral guide off-set (Bull's Eye), whose thickness was calculated to be two mm greater than the semidiameter thickness of the hamstring autograft was placed in the way of its notch standing up to the posterior cortex by passing inside of the tibial tunnel. Thus, it was aimed to prevent posterior penetration of femoral tunnel. The femoral tunnel was engraved directly via endobutton drill on the guidewire and the tunnel distance was calculated. Next, the femoral tunnel was drilled directly over the guidewire with a reamer suitable for the previously determined graft diameter. A 4-layer autogenous hamstring graft was suspended from the middle with a carrier rope pulled towards the tibial tunnel. The carrier rope's endpieces standing outside were pulled towards the proximal of the graft (Figure 2).

Arthroscopically, the tension of the graft and the presence of compression were evaluated, and the procedure was ended when no problem was detected. After the anatomic closure of the layers, the tourniquet was ended by placing the hemovac drain. The postoperative two-sided knee radiography was performed in all the postop patients. It is identified that the femoral tunnel obliquity was lower in AMP-treated patients (Figure 3-4).

The preoperative infection prophylaxis was applied with cefazolin sodium 2x1 g/iv for 72 hours. The low-molecular-weight heparin (LMWH) prophylaxis was completed to 3 weeks. Our patients used angle-adjustable locked knee braces for 4 weeks by increasing the graded flexion enabling the knee to reach its full range of motion at 3th week. After the knee brace removed, rapid walking was allowed. The flat racing at the 5th month; the training after the 6th month; and competition sports were allowed after 9 months.

Figure 2. Placement of the graft in tunnels

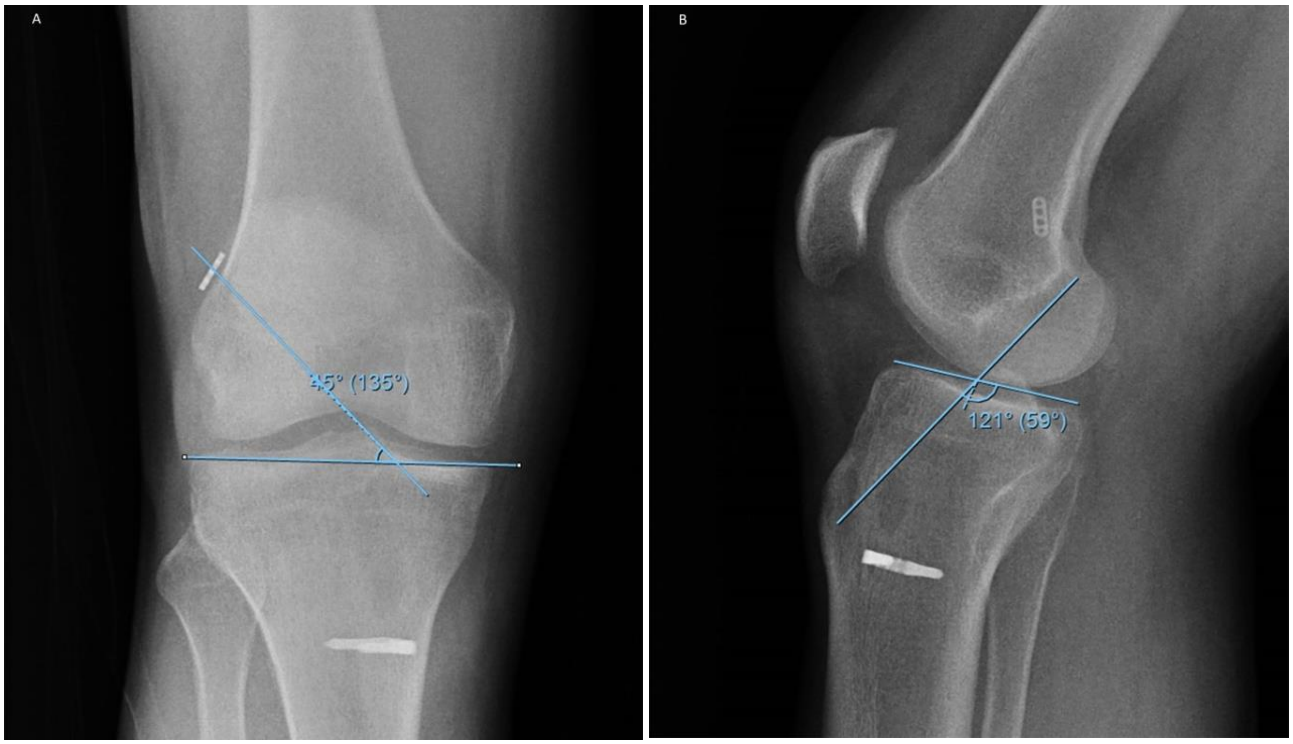

Figure 3. A) Anteromedial portal anterior cruciate ligament radiological image anteroposterior, B) Anteromedial portal anterior cruciate ligament radiological image lateral

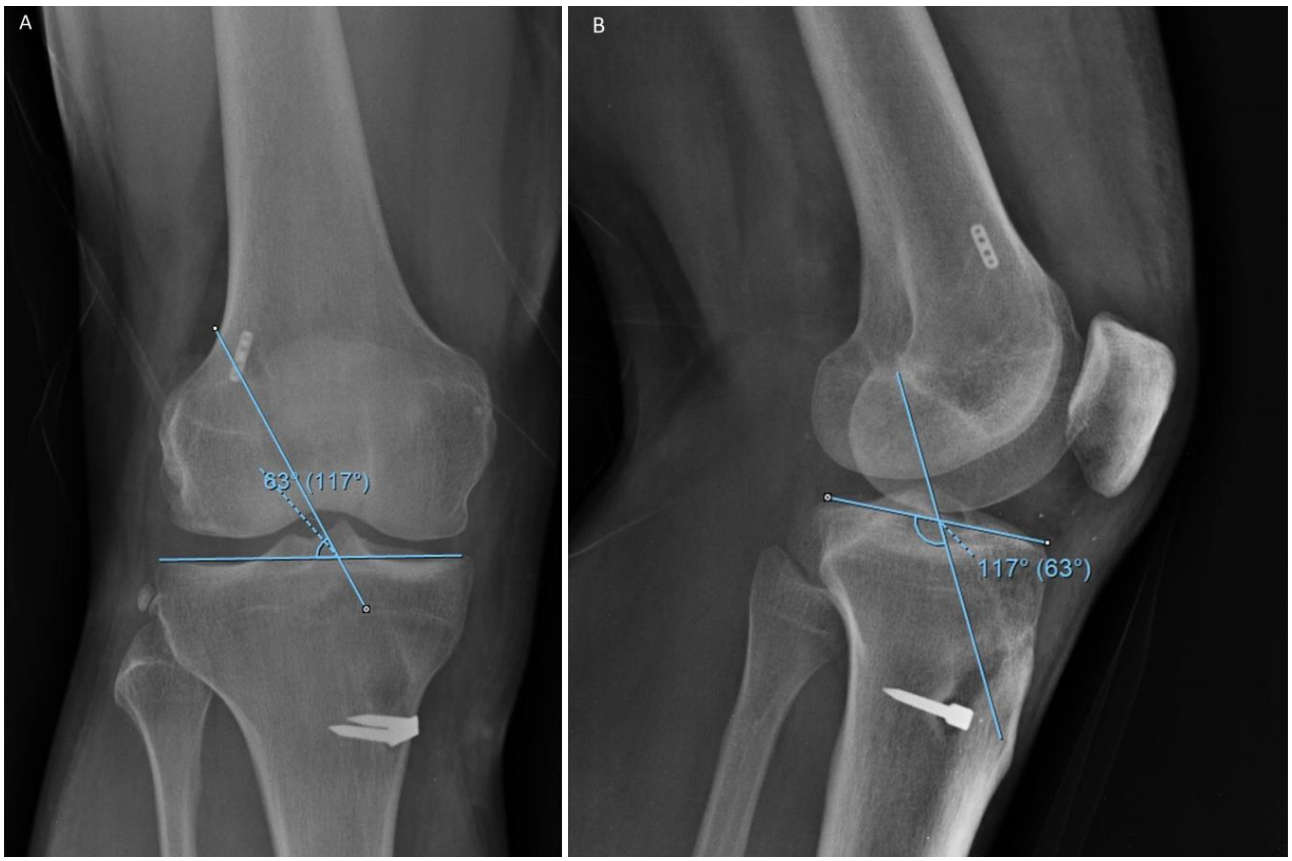

Figure 4. A) Transtibial anterior cruciate ligament radiological image anteroposterior, B) Transtibial anterior cruciate ligament radiological image lateral

Statistical Analysis

Patients were evaluated functionally using IKDC knee evaluation form, Lysholm knee score and Tegner activity scores and compared with preoperative functional scores. Descriptive statistics (average, standard deviation, median, minimum, maximum, Interquartile range-IQR) of all data in the study were calculated. The normality assumption of quantitative variables was examined with Shapiro-Wilk test. Independent samples t test was used for comparisons between groups. Parameter estimations were obtained with the help of the most appropriate model using the Generalized Estimating Equations method (Gamma with log link, ordinal probit and logistic models; post hoc: LSD) in the comparison of score variables' measurement values, which did not provide the normality assumption in different periods between groups. The Pearson Chi-Square and Fisher-Freeman-Halton tests were used for the relationships between categorical variables. Statistical evaluations were performed in SPSS v.22 program. $p<0.05$ was considered significant statistically.

RESULTS

Eighty percent of the individuals included in the study are male and 20% are female. The gender distribution according to the groups is homogeneous (p=0.476). The average age of the individuals is 32.75±8.81 (16-53). There is no significant difference between groups in terms of average age (p=0.052). The sociodemographic and clinical characteristics of the patients are given in detail (Table 1).

Descriptive values of knee flexion and Lysholm scale score and comparison results are given in Table 2. It is found that the difference between preoperative and postoperative knee flexion measurements is significantly different both in two groups or the difference between the groups changes in each period ($p<0.001$). According to the post hoc test results, the preoperative knee flexion measurement value in AMP group was significantly higher than TT group ($p<0.001$). Whereas there is no significant difference between preoperative and postoperative knee flexion measurements in AMP group (p=0.098), the preoperative knee flexion measurement is found to be significantly lower than the postoperative measurement in TT group ($p<0.001$). In addition, the change in knee flexion measurement value measured in TT group is approximately 112% higher than in AMP group ($p<0.001$). It is found that the difference between Lysholm score values measured preoperative and postoperative was different significantly in both groups; or the difference between the groups changed in each period ($p<0.001$). According to the advanced test results, preoperative Lysholm score values were similar in both groups (p=0.389). The postoperative Lysholm score was significantly higher in AMP group than in TT group ($p<0.001$). In addition, the change in Lysholm score value measured in TT group is approximately 37% less than in AMP group ($p<0.001$). In both groups, preoperative and postoperative knee extension values were zero.

Descriptive values and comparison results of IKDC and Tegner score values are given in Table 3. There is a

significant difference between the groups in terms of the change between preoperative and postoperative IKDC scores (p<0.001). While there is no significant difference between preoperative and postoperative IKDC scores in TT group (p=0.480), preoperative IKDC values were significantly lower than postoperative values (p<0.001) in AMP group. In addition, the positive change in IKDC score value measured in AMP group is approximately 518% higher than the change in TT group (p<0.001). The difference between preoperative and postoperative Tegner score values is found to be significantly different in both groups, or the difference between the groups is changed in each period (p=0.049). According to the advanced test results, the preoperative Tegner score values were similar in both groups (p=0.345). The postoperative Tegner score is significantly higher in AMP group than in TT group (p<0.001). While the preoperative Tegner score measured in AMP group was significantly lower than the postoperative measured value (p<0.001 for each), no such change was observed in TT group.

Table 1. Sociodemographic and clinical characteristics of patients

	Anteromedial Portal			Transtibial			Total			p
	n	Row%	Column%	n	Row%	Column%	n	Row%	Column%	
Sex										
Male	22	46.8	75.9	25	53.2	83.3	47	100	79.7	0.476
Female	7	58.3	24.1	5	41.7	16.7	12	100	20.3	
Side										
Right	17	53.1	58.6	15	46.9	50.0	32	100	54.2	0.506
Left	12	44.4	41.4	15	55.6	50.0	27	100	45.8	
Etiology										
Sport İnjuries	20	51.3	69.0	19	48.7	63.3	39	100	66.1	
Traffic Accident	0	0.0	0.0	2	100	6.7	2	100	3.4	
Work Accident	2	100	6.9	0	0.0	0.0	2	100	3.4	0.504
Fall	1	33.3	3.4	2	66.7	6.7	3	100	5.1	
Other	6	46.2	20.7	7	53.8	23.3	13	100	22.0	
Tracking Time*	16,31±7,68 (7-36)			18.37±8.23 (4-39)			17.36±7.96 (4-39)			0.325
Age*	30.03±7.83 (18-45)			35.37±9.03 (16-53)			32.75±8.81 (16-53)			0.052

*mean±standard deviation (minimum-maximum)

Table 2. Descriptive values of knee flexion measurement value and Lysholm scale score and comparison results

	Group	Period	Mean±SD	Median	Min-Max	IQR	OR for Group*Period (95% Wald CI)
Knee Flexion	**Anteromedial Portal**	Preop	127.8±9.9	130	90-135	10	1.127 (1.049-0.210)
		Postop	132.8±2.9	135	125-135	5	
	Transtibial	Preop	109.3±21.5	115	50-130	40	
		Postop	128.0±5.4	130	110-135	0	
Lysholm	**Anteromedial Portal**	Preop	42.2±5.8	40	34-58	8	0.634 (0.561-0.717)
		Postop	90.7±8.5	95	55-98	10	
	Transtibial	Preop	44.9±16.8	47	10-76	20.25	
		Postop	61.3±7.6	60	45-78	11	

SD: Standard Deviation, Min: Minimum, Max: Maximum, IQR: Interquartile Range, OR: Odds Ratio, CI: Confidence Interval

Table 3. Descriptive values and comparison results of IKDC and Tegner score values

	Group	Period	Median	Min-Max	IQR	OR for Group*Period (95% Wald CI)
IKDC[#]	**Anteromedial Portal**	Preop	1	1-2	1	6.186 (2.673-14.317)
		Postop	4	1-4	2	
	Transtibial	Preop	2	1-3	1	
		Postop	2	2-4	1,25	
Tegner	**Anteromedial Portal**	Preop	5	3-7	2	3.081 (1.006-9.435)
		Postop	7	3-7	1,5	
	Transtibial	Preop	5	4-7	1	
		Postop	5	4-8	0,5	

Min: Minimum, Max: Maximum, IQR: Interquartile Range, OR: Odds Ratio, CI: Confidence Interval, IKDC: International Knee Documentation Committee, [#]Scoring A:4, B:3, C:2, D:1

DISCUSSION

Anterior cruciate reconstruction with AMP technique was superior to TT technique. ACL injuries are the most common sports injury of the knee joint (12). Conservative treatment in patients with ACL tear can be selected according to the age, lifestyle and physical activity of the patient (13,14). Patients who are followed up with conservative treatment may have instability attacks even if they change their lifestyle and maintain their lives in that way. In untreated knees with ACL lesions, meniscus lesions and chondral damage are likely to take place due to instability attacks (3).

Sports injuries are the leading cause of ACL injuries (12). According to Howell et al. (15), it is stated that the rate of ACL tears due to sports injuries is 93%. In this study, it was found that this rate is 63.3% (19 of 30 patients) of the patients operated with TT technique and 69% (20 of 29 patients) of patients operated with AMP portal technique.

There are also undesirable side effects of allografts depending on the immunogenic properties such as rejection, long remodeling time and being expensive (16). Since 4-layer semitendinosus-gracilis tendons had 138% more durability than patellar tendon, we preferred to use autogenous hamstring tendon graft for all our patients. In the studies performed by Eriksson K et al. (17) and Tuncay et al. (18), no significant difference was found between hamstring tendon grafts and patellar tendon bone graft in terms of knee stability and functional results after the surgery.

While there was an age limit for patients over 45 years and having unclosed epiphysis children in the past, these criteria also changed nowadays. Thus, in cases of that the reconstruction is socially necessary, the surgery is applied before epiphysis closing (19). In our study, while the average age was 30.03±7.83 (18-45) in the group performed with AMP technique, it was 35.37±9.03 (16-53) in TT technique without taking a definite limit on age, which is appropriate for the literature.

In a retrospective study of 47 patients, Alentorn-Geli et al. (20) compared clinical and functional outcomes of 26 patients operated with AMP technique and 21 patients operated with TT technique. In the group of patients operated with AMP technique, they reported a higher IKDC knee Evaluation Form Score and a shorter return time to athletic activity. In our study, it is observed that the preoperative IKDC value was significantly higher in the AMP group than the postoperative values ($p<0.001$). In addition, it is found that the positive change in IKDC score in the group applied anatomic technique was approximately 518% higher than the change in TT.

Kim et al. (5) found that the Lysholm score in 33 cases performed with AMP technique was preop 45.3, postop 86.2. Also, in 33 cases performed with TT technique, preop Lysholm score was 45.8 and postop score was 86.4. In our study, we found the Lysholm score 42.2 postoperatively and 90.7 preoperatively in the AMP group. We found that the Lysholm score was 44.9 preop and 61.3 post op in TT technique. The postop Lysholm score value measured in AMP technique was found to be significantly higher than TT technique group. ($p<0.001$).

The TT femoral tunnel drilling technique may not be effective to reduce the inclination of the femoral tunnel because the curvature of the femoral tunnel is determined by the tibial tunnel. Loh et al. (21) and O'Neill DB (22) reported that the femoral tunnel obliquity is very important for achieving rotational stability. Moreover, Kim et al. (5) found that the average femoral tunnel obliquity is 59° in the TT group and 31° in the AMP group. We found femoral tunnel obliquity 59.3° in the TT group and 41.4° in the AMP group.

In a recent cadaver study by Tompkins et al. (23) compared the TT technique to the AMP technique, it showed that the tunnel was placed more accurately in the opening of the femoral tunnel in the AMP approach. It is showed that the AMP technique placed 97.7% of the tunnel in the natural femoral footprint and 61.2% was seen with TT perforation. The AMP method also stabilizes the graft in a more horizontal direction, providing a better rotation control and inhibiting translation stability. In our study, we demonstrated that ACL reconstruction allows the anatomic reconstruction of ACL using AMP technique and it is effective in improving an anterior stability and a rotational stability.

Eysturoy et al. (24) showed a significantly different postoperative Tegner score when AMP and TT technique were compared, thus it is proved that it provides a higher level of return to sports activities. In our study, we found that the postoperative Tegner score value applied with the AMP technique is significantly higher than the value measured by TT technique.

The traditional TT approach for femoral tunnel placement is limited to the opening of the tibial tunnel, which restricts the placement of the femoral tunnel and places the femoral tunnel higher into the intercondylar notch, typically resulting in a nonantomic proximal femoral and posterior tibial tunnel placement (8). In our study, we found that the femoral tunnel placement of AMP technique is easier than TT.

CONCLUSION

We concluded that the anteromedial approach is a better surgical technique than TT technique, with its good visual field, low obliquity, closer anatomical reconstruction, the better rotation function and the knee stability during ACL reconstruction.

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