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Outcomes of isokinetic tests and functional assessment of anterior cruciate ligament reconstruction: Transtibial versus single anatomic femoral tunnel technique

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ABSTRACT

Objective: The aim of the study was to compare the outcomes of the transtibial and anatomical femoral single tunnel surgical techniques in ACL reconstruction.

Methods: A total of 30 patients, with 16 patients (15 males and 1 female; mean age: 27.2 ± 7.04) with anatomical femoral single-tunnel technique (AFT) and 14 (12 males and 2 females; mean age: 29.4 ± 8.82) with transtibial technique (TT) were included into the study. All patients were evaluated with isokinetic tests at an angular velocity of 60°/s and 180°/s and the IKDC and Lysholm tests were performed preoperatively and in third, sixth, and 12th months postoperatively. The results were compared between the groups. The mean follow-up time was 17.1 ± 6.48 months.

Results: Postoperative third month changes in extension parameters of peak torque (AFT: −93.286, TT: −61.500), peak work (AFT: −77.071, TT: −47.500), peak torque ext/kg (AFT: −1.182, TT: −0.773), peak work ext/kg (AFT: −0.982, TT: −0.604), peak work (AFT: −55.143 TT: −33.063) at an angular velocity of 60°/s and postoperative third month change in extension parameter of peak power (AFT: −86.786 TT: −54.875) at an angular velocity of 180°/s were found to be better in the transtibial group ($p < 0.05$) and postoperative sixth month peak torque (AFT: 1.429, TT: −5.688) value at an angular velocity of 60°/s was found to be less in the anatomical femoral single-tunnel group ($p < 0.05$). The IKDC (AFT: 94.671, TT: 90.025) ($p < 0.05$) and Lysholm (AFT: 96.714, TT: 92.375) ($p < 0.05$) scores of the anatomical femoral single-tunnel group were better than the transtibial group regarding to the postoperative final follow-up. There are positive intermediate correlations between preoperative IKDC and Lysholm scores with preoperative and postoperative some isokinetic test ratio ($r = 0.539$; $p = 0.031$), and preoperative peak power extension ($r = 0.541$; $p = 0.030$) at the both angular velocity of 60°/s and 180°/s in the transtibial group. There was no significant difference between the two groups with regards to the Lachman, anterior drawer and pivot shift tests ($p < 0.05$).

Conclusion: There were differences in terms of isokinetic parameters in early outcomes but there was no statistical difference between isokinetic parameters at the end of 1st year between two groups. There were some correlations between IKDC and Lysholm scores with some isokinetic parameters.

Level of Evidence: Level III, Therapeutic Study.

Introduction

The anterior cruciate ligament (ACL) is one of the most frequently injured ligaments of the knee.[1] Injuries to the ACL can lead to progressive instability of the knee and may cause meniscal and cartilaginous injuries.[2,3] ACL reconstruction is often

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recommended to achieve knee stability and protect patients from knee joint degeneration. Accurate femoral and tibial tunnel positioning is key to successful ACL reconstruction.[4] Several ACL reconstruction methods have been demonstrated in the literature.[5] Transtibial and single-tunnel anatomic techniques are the most common methods used. However, there is no consensus regarding superiority of graft choice, location, number of femoral and tibial tunnels, or the use of fixation materials in ACL reconstruction.[6–8]

Several tests and examination methods are used to evaluate ACL reconstructions. The Lysholm Knee Score, the International Knee Documentation Committee (IKDC) score, the Tegner scale, and the Cincinnati scoring system are the most commonly used for the functional evaluation of patients after ACL reconstruction.[9,10] However, these tests and scoring systems are largely based on subjective criteria and the results may vary depending on the operating surgeon.

Computer-assisted digital isokinetic evaluation methods are available to assess muscle strength loss and postoperative status.[11,12] Such evaluations offer an independent means of examination to evaluate the clinical results of ACL reconstruction. Isokinetic contraction is defined as the exercise of the muscle group with all its power in conditions with a constant velocity. During isokinetic contraction, the maximum tension is maintained constantly at all selected angles and all muscle fibers are fully contracted.[13,14]

Isokinetic tests provide an objective and reliable assessment of a patient's muscle strength. Muscle performance can be assessed at different rates, converted into data, recorded, and tracked. In addition, the performance of agonist and antagonist muscle groups can be evaluated comparatively.[15]

Isokinetic force tests use several important electromechanical components of the machine, including a dynamometer, speed selector, data recorder computer, and the seat, to measure function. Resistance to a movement is supplied at a constant speed, and the dynamometer measures parameters such as force, torque, and angular velocity. The computer records and analyzes the data, providing numerical and graphical demonstrations of the measured values.[13,16]

This study is a comparison of the outcomes of the transtibial technique (TT) and the single anatomic femoral tunnel (AFT) surgical technique applied in ACL reconstruction using isokinetic tests and the classic functional evaluation methods of the IKDC and Lysholm tests.

The study hypothesis was that there would be no difference between the 2 techniques in the surgical outcome in terms of isokinetic parameters and that there would be a correlation between functional knee scores and isokinetic parameters.

Patients and methods

Patients who were diagnosed with an ACL injury in our clinic between 2012 and 2015 were initially included in this retrospective study. A total of 30 patients (16 patients who underwent reconstruction with the single-tunnel AFT technique, and 14 for whom TT was applied) were included. The criteria for inclusion are presented in Table 1. The demographic data are provided in Table 2. Additional injuries and treatments for ACL injury are shown in Table 3.

The study protocol was approved by the Balıkesir university ethics committee (decision no. 2015/66). Written, informed consent was obtained from each participant. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Isokinetic test protocol

All of the patients were subjected to isokinetic testing at an angular velocity of 60°/s and 180°/s, preoperatively and during the postoperative 3rd, 6th, and 12th months. All of the tests were performed on both the healthy and the operated side by the same physician. The patients completed 10 min of warm-up exercises and 5 min of stretching exercises before the test. After the exercises, the patient was positioned on a computer-controlled isokinetic dynamometer (IsoMed 2000; D&R Ferstl GmbH, Hemau, Germany). The waist support was adjusted so that the waist-thigh angle of the patient would be 85° during flexion. The thigh, pelvis, and trunk were fixed to the device with straps. The center of motion was identified as the lateral femoral condyle. The range of motion of the joint was determined as between 0° and 90°.[17,18] Following the standardization procedure, the test was first conducted on the intact extremity, followed by evaluation of the limb operated on for an ACL injury. The patient completed 1 repetition by bringing the knee from a 90° flexion position back to the starting point after a full extension. After 4 repetitions at a speed of 60°/s and 180°/s, there was a 10-s rest followed by another 2 repetitions, providing recorded results for a total of 6 repetitions.

The ratios of peak torque, peak effort, peak power, flexion, and extension angles formed by peak torque and peak effort, body weight to peak torque, and peak effort during flexion and extension were included in the isokinetic protocol.

Clinical and functional assessment

The IKDC and Lysholm tests, as well as the Lachman, anterior drawer, and pivot shift tests were administered to all of the patients preoperatively and repeated at the final follow-up, and the results were recorded by a single physician (KB). All of the patients were followed up for a minimum of 12 months. The mean follow-up time was 17.1 ± 6.48 months.

Surgical technique

In the single-tunnel AFT group, the anteromedial portal (AMP) was opened 1 cm medial to the patellar tendon, with care taken to avoid any injury to the medial femoral condyle while advancing the femoral reamer through the portal, and by reaming the medial aspect of the lateral femoral condyle. After visualizing the ruptured ACL arthroscopically, the procedure continued with the harvesting and preparation of the gracilis and semitendinosus graft. This was

Table 1
Inclusion and Exclusion Criteria.

Inclusion criteria	Exclusion criteria
• Age between 15 and 45 years	• Use of grafts other than Hamstring autograft
• Performance of transtibial and anatomic femoral single-tunnel techniques	• Accompanying ligament injury
• Use of autogenous hamstring tendon graft	• Revision surgery
• Performance of isokinetic muscle tests	• Bilateral anterior cruciate ligament injury
• Having undergone clinical and functional assessment	• Follow-up period less than one year
• Follow-up period of at least one year	• Patients lost to follow-up
• Absence of concomitant ligament injury	• History of wound site infection
• Absence of systemic and neurologic problem	• Patient not consenting to participate in the study

Table 2
Demographic Data of the Patients.

	Anatomic femoral single-tunnel (n = 14)	Transtibial (n = 16)	*P*-value
Age	29.4 ± 8.82	27.2 ± 7.04	0.460
BMI	26.3 ± 4.19	25.7 ± 3.35	0.622
Gender			
Male	12 (85.7)	15 (93.8)	0.586
Female	2 (14.3)	1 (6.2)	
Injury-surgery time (month)	9 (156-1)	6.5 (120-1)	0.978
Side			
Right	7 (50.0)	7 (43.8)	1
Left	7 (50.0)	9 (56.2)	
Injury type			
Sport	11 (78.6)	14 (87.4)	0.784
Accident	1 (7.1)	1 (6.3)	
Falling	2 (14.3)	1 (6.3)	
Surgery history			
None	13 (92.9)	15 (93.8)	1
A.M	1 (7.1)	1 (6.2)	

A.M: Arthroscopic menisectomy.

followed by the preparation of the tunnels. While the knee was in 120° flexion, the femoral tunnel was reamed anterior to the anteromedial bundle footprint, 6–7 mm anterior to the posterior cortex, at the 10 o'clock position in the right knee, and 2 o'clock in the left knee. The tibial tunnel was opened 7 mm anterior to the posterior cruciate ligament insertion, posterior to the anterior horn of the lateral meniscus and lateral to the medial tibial tubercle using a 55° angled ACL guide inserted through the AMP.[19–21] The graft was then positioned with a 1-gauge suture loop. Femoral and tibial fixation was then performed.

In the TT cases, the tibial tunnel was created as described above. Then, with the guidance of the tibial tunnel, a femoral tunnel was opened at the 1 o'clock position in the left knee and the 11 o'clock position in the right knee using a guiding pin while the knee was in 90° flexion.[22–24] The pre-prepared graft was passed through the tunnel with the aid of a suture loop. This was followed by femoral and tibial fixation.

An Endobutton (Smith & Nephew plc, London, England) was used to provide femoral fixation in all of the single-tunnel AFT patients. In the TT group, 4 Transfix (Arthrex, Inc., Naples, FL, US), 6 Aperfix (Cayenne Medical, Scottsdale, AZ, USA), and 6 Endobutton devices were used. Transtibial fixation was performed using staples and bio-screws. The surgical procedures were performed by 2 surgeons: 1 performed only TT and the other performed only the single-tunnel AFT technique.

Statistical analysis

The isokinetic test results of the 2 groups, as well as the clinical and functional results, were statistically compared. Potential correlations between the IKDC and Lysholm scores and the isokinetic test results were assessed and analyzed.

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 22.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed as numbers, percentages, and in the form of mean and SD. The Mann–Whitney U test was used to compare quantitative continuous data between 2 independent groups. The difference in repeated measurements was analyzed using the Wilcoxon test. A *p* value <0.05 was considered statistically significant.

Results

The isokinetic test results are provided in Table 4. Each patient underwent isokinetic testing of the healthy limb and the ACL limb. The difference was statistically evaluated. A result closer to zero in the ACL knee indicated an outcome approaching the measured parameters of the healthy knee. There was no significant difference between the 2 groups in the results of the Lachman (AFT [n = 14]/TT [n = 16]: 0:12/13, +:2/3; $p < 0.05$), anterior drawer (AFT [n = 14]/TT [n = 16]: 0:12/13, +:2/3; $p < 0.05$), or pivot shift tests (AFT [n = 14]/TT [n = 16]: 0:14/16; $p < 0.05$).

The Lysholm and IKDC scores were significantly higher after the final postoperative follow-up in comparison with the preoperative assessment in both groups. The postoperative Lysholm and IKDC scores of the AFT group were determined to be better than those of the TT group ($p < 0.05$) (Table 5).

Correlations between the IKDC and Lysholm scores and the isokinetic test results were explored. An intermediate positive correlation between the preoperative Lysholm score with preoperative peak effort extension/flexion ratio at the angular velocity of 60°/s in the AFT group ($r = 0.588$; $p = 0.027 < 0.05$). There were intermediate-level positive correlations between the preoperative IKDC and the preoperative peak torque extension ($r = 0.539$; $p = 0.031 < 0.05$), preoperative peak torque extension/kg ratio ($r = 0.539$; $p = 0.031 < 0.05$), and preoperative peak power extension at the angular velocity of 60°/s and 180°/s ($r = 0.541$; $p = 0.030 < 0.05$) in the TT group. There was an intermediate negative correlation between the postoperative Lysholm score and the postoperative 12th month peak torque extension angle at both 60°/s and 180°/s angular velocity ($r = -0.601$; $p = 0.023 < 0.05$ and $r = -0.546$; $p = 0.043 < 0.05$, respectively) in the AFT group. There were also negative correlations between the postoperative Lysholm scores and the postoperative 12th month peak torque flexion ($r = -0.625$; $p = 0.017 < 0.05$), peak effort flexion ($r = -0.537$; $p = 0.048 < 0.05$), peak torque flexion/kg ratio ($r = -0.571$; $p = 0.033 < 0.05$) at the angular velocity of 180°/s and a negative intermediate correlation between the postoperative IKDC and peak torque flexion ($r = -0.536$; $p = 0.048 < 0.05$) at the angular velocity of 180°/s in the AFT group. There was a high negative correlation in

Table 3
Additional Injuries and Treatments.

		Surgical technique		*P*-value
		Anatomic femoral single-tunnel	Transtibial	
		N = 14(%)	N = 16 (%)	
Additional Injury	Medial Meniscal Tear	3 (21.4)	4 (25.0)	1
	Lateral Meniscal Tear	6 (42.9)	5 (31.3)	
	Cartilage Damage	1 (7.1)	1 (6.3)	
	Lateral and Medial Meniscal Tear	1 (7.1)	2 (12.5)	
	None	3 (21.4)	4 (25.0)	
Additional Injury Treatment	Meniscal Repair	8 (57.1)	2 (12.5)	0.016
	Meniscectomy	2 (14.3)	9 (56.3)	
	Microfracture	1 (7.1)	0 (0.0)	
	None	3 (21.4)	5 (31.3)	

Table 4
Isokinetic Test Results.

	Anatomic femoral single tunnel		Transtibial		MW	*P*
	Mean	SD	Mean	SD		
3.month.peaktork.flex.60°/s	−30.500	18.451	−27.125	17.970	100.000	0.617
3.month.peaktork.eks.60°/s	−93.286	38.261	−61.500	33.190	60.000	0.031
3.month.peakwork.flex.60°/s	−37.000	19.323	−35.250	21.044	99.500	0.603
3.month.peakwork.eks.60°/s	−77.071	31.929	−47.500	26.905	49.000	0.009
3.month.peaktork.flex/kg.60°/s	−0.389	0.250	−0.339	0.211	106.000	0.803
3.month.peaktork.eks/kg.60°/s	−1.182	0.548	−0.773	0.475	58.000	0.025
3.month.peakwork.flex/kg.60°/s	−0.474	0.269	−0.441	0.262	106.500	0.819
3.month.peakwork.eks/kg.60°/s	−0.982	0.458	−0.604	0.383	54.000	0.016
3.month.peaktork.flex.angle.60°/s	7.500	15.170	−1.438	17.324	70.000	0.081
3.month.peaktork.eks.angle.60°/s	0.000	10.023	−2.500	7.043	76.000	0.134
3.month.peak power.flex.60°/s	−25.000	14.223	−20.688	14.160	95.000	0.478
3.month.peak power.eks.60°/s	−55.143	20.137	−33.063	19.292	48.500	0.008
3.month.peaktork.flex.180°/s	−15.000	14.401	−20.188	14.657	90.500	0.371
3.month.peaktork.eks.180°/s	−60.500	44.779	−50.063	32.176	103.000	0.708
3.month.peakwork.flex.180°/s	−19.143	15.908	−23.938	13.344	87.000	0.298
3.month.peakwork.eks.180°/s	−54.857	40.848	−41.250	30.894	91.500	0.394
3.month.peaktork.flex/kg.180°/s	−0.201	0.216	−0.254	0.184	91.500	0.394
3.month.peaktork.eks/kg.180°/s	−0.776	0.629	−0.616	0.412	105.500	0.787
3.month.peakwork.flex/kg.180°/s	−0.248	0.223	−0.296	0.161	92.500	0.417
3.month.peakwork.eks/kg.180°/s	−0.709	0.571	−0.449	0.515	84.500	0.253
3.month.peaktork.flex.angle.180°/s	2.214	10.312	0.000	15.358	94.000	0.453
3.month.peaktork.eks.angle.180°/s	2.000	7.264	−1.125	7.907	76.500	0.139
3.month.peak power.flex.180°/s	−26.071	20.838	−30.313	20.264	97.500	0.546
3.month.peak power.eks.180°/s	−86.786	51.264	−54.875	39.091	62.500	0.040
6.month.peaktork.flex.60°/s	−19.714	21.984	−23.063	16.060	100.500	0.632
6.month.peaktork.eks.60°/s	−59.571	38.594	−46.500	46.046	99.500	0.603
6.month.peakwork.flex.60°/s	−26.571	20.129	−27.250	23.394	111.000	0.967
6.month.peakwork.eks.60°/s	−51.000	36.930	−32.563	38.967	87.000	0.299
6.month.peaktork.flex/kg.60°/s	−0.236	0.284	−0.284	0.184	93.500	0.441
6.month.peaktork.eks/kg.60°/s	−0.747	0.471	−0.592	0.618	97.000	0.533
6.month.peakwork.flex/kg.60°/s	−0.330	0.263	−0.343	0.287	107.500	0.852
6.month.peakwork.eks/kg.60°/s	−0.643	0.443	−0.418	0.515	83.500	0.236
6.month.peaktork.flex.angle.60°/s	−3.143	7.931	−4.563	11.950	104.500	0.754
6.month.peaktork.eks.angle.60°/s	1.429	5.571	−5.688	7.761	45.500	0.006
6.month.peak power.flex.60°/s	−17.857	13.155	−15.438	16.112	106.000	0.803
6.month.peak power.eks.60°/s	−36.429	27.315	−27.000	25.680	93.000	0.428
6.month.peaktork.flex.180°/s	−14.286	12.952	−13.500	17.018	106.000	0.803
6.month.peaktork.eks.180°/s	−36.214	28.121	−28.813	37.075	97.500	0.546
6.month.peakwork.flex.180°/s	−15.429	10.493	−16.250	16.937	103.000	0.708
6.month.peakwork.eks.180°/s	−32.571	29.848	−22.688	34.162	96.000	0.506
6.month.peaktork.flex/kg.180°/s	−0.176	0.164	−0.165	0.199	107.000	0.835
6.month.peaktork.eks/kg.180°/s	−0.459	0.360	−0.357	0.461	96.500	0.519
6.month.peakwork.flex/kg.180°/s	−0.192	0.137	−0.203	0.202	105.500	0.787
6.month.peakwork.eks/kg.180°/s	−0.417	0.375	−0.291	0.434	98.500	0.574
6.month.peaktork.flex.angle.180°/s	−2.000	7.317	0.188	7.157	76.500	0.136
6.month.peaktork.eks.angle.180°/s	0.429	6.357	0.875	7.311	104.000	0.739
6.month.peak power.flex.180°/s	−23.929	19.456	−19.313	24.253	105.000	0.771
6.month.peak power.eks.180°/s	−53.143	49.781	−32.750	47.528	94.000	0.454
12.month.peaktork.flex.60°/s	−16.357	19.456	−23.250	19.611	88.500	0.327
12.month.peaktork.eks.60°/s	−52.786	36.897	−35.313	41.357	82.500	0.220
12.month.peakwork.flex.60°/s	−20.714	21.851	−28.688	23.891	83.000	0.228
12.month.peakwork.eks.60°/s	−43.857	35.796	−23.250	33.469	76.000	0.134
12.month.peaktork.flex/kg.60°/s	−0.208	0.238	−0.289	0.244	86.000	0.280
12.month.peaktork.eks/kg.60°/s	−0.692	0.436	−0.441	0.526	79.000	0.170
12.month.peakwork.flex/kg.60°/s	−0.266	0.276	−0.358	0.289	86.000	0.279
12.month.peakwork.eks/kg.60°/s	−0.545	0.430	−0.298	0.437	72.000	0.096
12.month.peaktork.flex.angle.60°/s	−2.357	5.826	−0.375	10.500	107.500	0.851
12.month.peaktork.eks.angle.60°/s	−3.071	6.451	−3.438	7.797	111.000	0.967
12.month.peak power.flex.60°/s	−14.357	16.118	−16.563	16.100	102.000	0.677
12.month.peak power.eks.60°/s	−31.857	23.416	−18.563	24.851	77.000	0.145
12.month.peaktork.flex.180°/s	−12.071	17.162	−7.250	16.759	95.000	0.479
12.month.peaktork.eks.180°/s	−29.143	30.145	−13.750	29.994	85.000	0.262
12.month.peakwork.flex.180°/s	−12.000	13.604	−10.563	19.329	110.000	0.934
12.month.peakwork.eks.180°/s	−28.500	31.181	−10.813	29.659	78.000	0.157
12.month.peaktork.flex/kg.180°/s	−0.161	0.220	−0.090	0.203	97.000	0.533
12.month.peaktork.eks/kg.180°/s	−0.364	0.379	−0.167	0.365	80.000	0.183
12.month.peakwork.flex/kg.180°/s	−0.155	0.180	−0.131	0.228	111.000	0.967
12.month.peakwork.eks/kg.180°/s	−0.354	0.399	−0.134	0.371	78.500	0.164
12.month.peaktork.flex.angle.180°/s	3.929	5.903	0.313	12.451	77.000	0.144
12.month.peaktork.eks.angle.180°/s	2.214	8.954	2.063	7.895	107.500	0.851
12.month.peak power.flex.180°/s	−20.314	25.136	−16.500	37.427	104.500	0.755
12.month.peak power.eks.180°/s	−45.286	47.448	−17.000	45.160	76.000	0.135

Table 5
Functional Test Results.

	Anatomic femoral single tunnel	Transtibial	MW	*P*
	Mean ± SD	Mean ± SD		
Pre-op Lysholm	58.000 ± 6.805	60.375 ± 5.830	89.000	0.333
Post-op Lysholm	96.714 ± 3.338	92.375 ± 4.395	38.500	0.002
Pre-op IKDC	43.929 ± 10.229	53.881 ± 6.974	49.000	0.009
Post-opIKDC	94.671 ± 4.651	90.025 ± 4.429	56.000	0.018

the TT group at both the angular velocity of 60°/s and 180°/s between the postoperative Lysholm score and the postoperative 12th month peak torque flexion angle ($r = -0.713$; $p = 0.002 < 0.05$ and $r = -0.778$; $p = 0.000 < 0.05$, respectively). An intermediate positive correlation was seen between the postoperative IKDC with postoperative 12th month peak torque extension angle ($r = 0.574$; $p = 0.020 < 0.05$) at the angular velocity of 60°/s in the transtibial group. There were also intermediate negative correlations between the postoperative IKDC with the postoperative 12th month peak torque flexion angle ($r = -0.517$; $p = 0.040 < 0.05$) and peak effort extension/flexion ratio ($r = -0.5$; $p = 0.049 < 0.05$) at the angular velocity of 180°/s in the transtibial group.

Discussion

The results of the this study showed that there were differences in the extensor parameters of peak torque, peak effort, peak torque/kg, peak work ext/kg, peak power, and peak torque extension angle between the 2 surgical techniques postoperatively. Varying parameters during knee extension in the isokinetic tests were different between the 2 groups, particularly the tests performed 3 months after ACL surgery. This difference may reflect some patients inability to adjust to exercise applied to the extensor muscles within 3 months. These early differences may also be due to the fact that 2 different surgeons performed the surgeries. Although there was no statistical difference between the groups in terms of additional injuries associated with the ACL injury, the approach of the 2 surgeons to additional injuries was different. Furthermore, the oblique nature of the graft in the knee in the AFT group and in the femoral single tunnel may have affected muscle strength during the early postoperative period.[25] However, differences in the isokinetic results in the early postoperative period were resolved as the physical therapy progressed; ultimately, the results for patients of both techniques were similar.

In our study, the results of the Lysholm and IKDC scores in the AFT group were better than those of the TT group. We found no statistically significant difference between the 2 groups in terms of the Lachman and pivot shift instability examination findings. In addition to peak torque, peak effort, and peak power parameters, we also investigated parameters that have seldom been evaluated in literature: peak torque extension and flexion angle, and the ratio of the peak torque and peak effort to the patient's weight. In our literature review, we did not find any study evaluating the peak torque angle of flexion and extension. We believe that these parameters are much more specific to body weight than peak torque and peak effort values. As a result, we also included the ratio of these parameters to the patient's weight in addition to the peak torque and peak effort parameters. Isokinetic testing carried out 3 months after surgery at the speed of 60°/s indicated that the measures of ratio of peak torque and peak effort to weight were better in the TT group than in the AFT group. In the isokinetic testing performed 6 months after surgery at the speed of 60°/s, the joint angle at which peak torque was achieved was better in the AFT group than in the TT group. Other measurements did not differ between the 2 techniques. Physical therapy standards have been established and both groups were approached in the same way; however, differences in the application of the patients and their valuation of the importance of physical therapy may have also contributed to differences in the isokinetic test results between the 2 groups in the first postoperative period. Nonetheless, as the patients recovered their hamstring and quadricep strength during the process, the differences between the 2 groups in isokinetic power disappeared.

There are several ACL reconstruction techniques demonstrated in the literature. In order to compare the outcomes of the different techniques, isokinetic and functional tests were used in this study. Koutras et al[5] investigated a total of 51 patients who underwent ACL surgery with a hamstring autograft using TT on 36 patients and single-tunnel AFT technique on 15 patients. The mean follow-up period was 6 months. Isokinetic tests were performed at the postoperative third and sixth months at a speed of 60°/s and 180°/s. The tests were conducted on both on the healthy limb and that with the repaired ACL. The flexion and extension peak torque values of the isokinetic tests were evaluated. Time is considered an important factor in the evaluation of isokinetic peak torque values. There was no significant difference between the 2 groups with regard to isokinetic properties or Lysholm score at the postoperative sixth month, but the AFT group had a better Lysholm score at the postoperative third month. The follow-up period was longer and the distribution between the groups was more homogenous in our research. The mean duration of follow-up was 17.1 months in our study. We found that TT produced better postoperative third month isokinetic results, while AFT patients had better results at the postoperative sixth month. There was no significant difference between the 2 groups in the last isokinetic test at the 12th month and we found a correlation between the IKDC and Lysholm scores and the isokinetic test results.

The IKDC and Lysholm scores of the AFT group were better than those of the TT group in the final postoperative follow-up. The AFT technique may provide better stability for the knee during high activity, as the graft position is closer to the anatomical location and course of the ACL compared with TT. This may explain the difference in the final postoperative IKDC and Lysholm test results.

In the literature, additional injuries in ACL injury cases are most often related to the mechanism of injury. Although there was no significant difference between the 2 groups in our study in terms of additional injuries, there were statistical differences between the groups in terms of the treatment of these injuries. This is a limitation of our research. A standard could be established for the treatment of additional injuries; however, 2 surgeons applied their own treatment methods in this study. There were also differences in the means of femoral fixation between the 2 groups, but according to the literature, different femoral fixation methods have no effect on isokinetic and clinical outcomes. Isokinetic test results of Endobutton and Transfix fixation methods used in ACL surgery demonstrated that there was no statistically significant difference between the 2 groups.[26] In a study conducted by Aydın et al, anterior drawer tests, Lachman tests, and scores from the IKDC and

Lysholm tests were compared after Endobutton, Transfix and Aperfix fixation in ACL surgery. No statistically significant difference was found between the groups in the evaluated parameters.[27] One other limitation of our study was that it consisted of a limited cohort. Although single-tunnel AFT and TT groups had a homogenous distribution, a larger cohort with more patients and longer follow-up could give us more reliable results.

There are many methods to evaluate ACL reconstruction, but these methods are mostly subjective. We suggest that in the future, isokinetic tests are going to have an important place in the discussion of controversial issues related to ACL surgery because they can provide a more accurate and objective assessments of a patient's clinical condition. Comprehensive, long-term studies are needed to provide more reliable means of outcome evaluation after reconstructive ACL surgery.

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