CLINICAL AND FUNCTIONAL OUTCOMES AFTER TWO DIFFERENT ANTERIOR CRUCRIATE LIGAMENT RECONSTRUCTION TECHNIQUES: COMPARISON OF RIGIDFIX AND ENDOBUTTON

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ABSTRACT

Endobutton and Rigidfix are the most used fixation methods for anterior cruciate ligament reconstruction (ACLR). No studies were found investigating the superiority of these two methods to each other in terms of laxity, strength, gait and jumping. The purpose of this study is to compare laxity, tunnel enlargement, isokinetic strength, gait and jump in cases who had ACLR with Endobutton or Rigidfix techniques. The study consisted of cases who received ACLR with Endobutton (n=13) and Rigidfix techniques (n=13). Bone tunnel enlargement was assessed on CT serial sections and anterior knee laxity was evaluated using an arthrometer. Quadriceps and Hamstring muscle strengths were measured using isokinetic system. BTS G-walk was used for gait analysis and jumping. There was no statistically significant difference in anterior knee laxity, tunnel enlargement, isokinetic muscle strength and jump height between two groups (p>0.05). In gait analysis, only uninvolved side stride length and pelvic tilt symmetry index were significantly different between groups (p=0.045; p=0.038 respectively). In patients with ACLR, whichever type of fixation method was used; all of parameter values were similar. According to the results of this study, it was observed that the two techniques did not have superiority over each other in terms of laxity, tunnel enlargement, strength, and jump performance, but they can differ minimally during a functional activity such as walking. Furthermore, even after two years of surgery, functional differences were detected between the surgical and uninvolved sides. Also, statistically significant tunnel enlargement was found in both techniques. It was concluded that the recovery after ACLR is not fully achieved, regardless of the fixation technique. It can be stated that this situation may cause problems in terms of the structure of the ligament and joint kinematics over time.

Anahtar Kelimeler: anterior cruciate ligament reconstruction; endobutton; rigidfix; function

İKİ FARKLI ÖN ÇAPRAZ BAĞ REKONSTRÜKSİYON TEKNİĞİ SONRASI KLİNİK VE FONKSİYONEL SONUÇLAR: RIGIDFIX VE ENDOBUTTON KARŞILAŞTIRILMASI

ÖZ

Endobutton ve Rigidfix ön çapraz bağ rekonstrüksiyonu (ÖÇBR) için en çok kullanılan tespit yöntemleridir. Laksite, kuvvet, yürüme ve sıçrama açısından bu iki yöntemin birbirine üstünlüğünü araştıran herhangi bir çalışmaya rastlanmamıştır. Bu çalışmanın amacı ÖÇBR olan olgularda Endobutton veya Rigidfix teknikleri ile laksite, tünel genişliği, izokinetik kuvvet, yürüme ve sıçramanın karşılaştırılmasıdır. Çalışmaya Endobutton (n=13) ve Rigidfix teknikleri (n=13) ile ÖÇBR uygulanan olgular dahil edildi. Kemik tünel genişlemesi BT seri kesitlerinde değerlendirildi ve ön diz laksitesi artrometre kullanılarak değerlendirildi. Quadriseps ve Hamstring kas kuvvetleri izokinetik sistem kullanılarak ölçüldü. Yürüyüş analizi ve sıçrama için BTS G-walk kullanıldı. İki grup arasında ön diz laksitesi, tünel genişlemesi, izokinetik kas kuvveti ve sıçrama yüksekliği açısından istatistiksel olarak anlamlı bir fark yoktu (p>0.05). Yürüyüş analizinde, sadece etkilenmemiş taraf adım uzunluğu ve pelvik tilt simetri indeksi gruplar arasında anlamlı olarak farklıydı (sırasıyla p=0.045; p=0.038). ÖÇBR'li hastalarda hangi tip tespit yöntemi kullanılırsa kullanılsın; tüm parametre değerleri benzerdi. Bu çalışmanın sonuçlarına göre iki tekniğin laksite, tünel genişlemesi, kuvvet ve sıçrama performansı bakımından birbirlerine üstünlüklerinin olmadığı ancak yürüyüş gibi fonksiyonel bir aktivite sırasında minimal düzeyde farklılık olabileceği görüldü. Ayrıca, ameliyattan iki yıl sonra bile, cerrahi geçiren ve etkilenmeyen taraflar arasında fonksiyonel farklılıklar tespit edildi. Ek olarak, her iki teknikte de istatistiksel olarak anlamlı tünel genişlemesi bulundu. Fiksasyon tekniğine bakılmaksızın ÖÇBR sonrası iyileşmenin tam olarak sağlanamadığı sonucuna varıldı. Bu durumun zamanla bağın yapısı ve eklem kinematiği açısından sorunlara yol açabileceği ifade edilebilir.

Key words: ön çapraz bağ rekonstrüksiyonu; endobutton; rigidfix; fonksiyon

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INTRODUCTION

Anterior cruciate ligament (ACL) reconstruction is a very common and popular method used in knee treatment in young athletic and symptomatic individuals with ACL deficiency(1). The reconstruction of the ruptured ACL is recommended as the first option for an active patient, since ACL reconstruction prevents any knee instability, re-injuries, early osteoarthritis, and meniscal damage (2). There are several options for femoral-sided graft fixation in ACL reconstruction. These can be divided into two main categories: intratunnel fixation (interference screw) and extratunnel fixation (cortical fixation devices or femoral loops). Fixation of soft tissue grafts is generally considered as a weak spot in the postoperative period after ACL reconstruction. Thus, several different devices were developed for soft tissue femoral fixation. Although there are numerous options, the gold standard for femoral fixation has not yet been defined (3). The method used for ACL graft fixation should be strong enough to maintain knee stability. It should also be strong enough to prevent collapses during knee movements (4). Graft loss and re-rupture can be prevented with a strong and firm fixation as long as the bio fusion between the graft and bone is in the correct place (5). Furthermore, weak primary fixation can affect graft healing because stresses can cause micro-movement of the graft, thus, delaying its attachment to the bone tunnels (6, 7).

The success of ACL reconstruction is related to various preoperative, transoperative, and postoperative factors. The positioning of the bone tunnels and thus the positioning of the tendon graft is considered as one of the most important factors among these. Recent studies indicate that when the femoral tunnel ACL is positioned more anatomically than the femoral placement, better knee rotation control and better knee mobility are provided (8). Endobutton (36%) and Rigidfix (31%) techniques used in the femur for these purposes are among the most popular approaches used for ACL reconstruction (9). In the Rigidfix technique, the tendon graft is fixed in a horizontal position in the femoral tunnel, close to, but not in contact with the joint. On the other hand, Endobutton is a method that hangs the tendon graft in the tunnel with a mersilene bond attached to the metallic material placed in the anterolateral cortex of the femur (10).

The most significant difficulty encountered following ACL reconstruction, regardless of the used technique, is to determine when and whether it is safe to return to strenuous physical activities. Post-operative evaluations often include the assessments of laxity, flexibility, strength, and functional tests in order to determine this (11). Therefore, these parameters are used in determining which surgical technique is superior.

Although there are many studies comparing the techniques used during ACL reconstruction, these studies have generally focused on the evaluations of tunnel enlargement, laxity, or have implemented questionnaires (2, 7, 10, 12-14). There were not any studies comparing Endobutton and Rigidfix techniques in terms of isokinetic strength and gait parameters and jump performance in the literature. Thus, the present study aimed to compare cases who received ACL reconstruction with Rigidfix and Endobutton techniques in terms of laxity, tunnel enlargement, isokinetic strength, gait and jump performance. Furthermore, the secondary aim of the present study is to determine whether there is a difference between the surgical sides and the uninvolved sides in both techniques.

1. Material and Method

1.1.Participants

The study consisted of 82 subjects aged 18-45 years who had no injuries in either extremity for at least 6 months and who underwent Endobutton or Rigidfix techniques for ACL reconstruction using a hamstring tendon graft at least 6 months ago. Those with concomitant posterior cruciate ligament, meniscus, lateral collateral ligament or medial collateral ligament injuries, those who underwent ACL reconstruction with patellar tendon graft, those who underwent lower extremity surgery or revision surgery, or those who had any systemic or neurological problems were not included in the study. Accordingly, 14 cases who had revision surgery, 33 cases with concomitant meniscal pathology, 5 cases with multiple ligament injuries, and 4 cases who did not agree to participate in the study were excluded from the study. As a result, 26 male cases (13 Rigidfix, 13 Endobutton) were included in the study (Figure 1). The reconstruction operations were performed by a single surgeon. The required ethics commission permission was obtained for the study (Date: 11.09.2018, No: 77082166-604.01.02). The demographic data of the individuals (age, height, body weight, body mass index (BMI), dominant and surgical side, post-operation duration, received treatments) were recorded. Tunnel enlargement measurement was performed by an orthopedist and all other evaluations were performed by a physiotherapist who did not know what surgical technique the individual underwent.

1.2.*Surgical Method:*

Transfemoral Rigidfix**:** The cases were operated arthroscopically following the pneumatic tourniquet application with a single dose of antibiotic prophylaxis 1g cefazolin in supine position under spinal anesthesia. The tibial upper-end anteromedial incision and semitendinous and gracilis tendons were taken. The graft diameter was measured. From the arthroscopically remote anteromedial portal, the guidewire was sent to the adherence part of the ACL at an angle appropriate to the rear section of the posterior with at least 2mm intact bone. The femoral tunnel was drilled up to 30 mm with a reamer with the size of the graft diameter. The tunnel opened with the Rigidfix Curve frame system was opened for the 2 pins from medial to lateral. It was paid attention to not to exceed the pins from the lateral cortex. At this stage, it was checked whether the pins were located in the center of the femoral tunnel, in other words, inside the graft. The graft was fixed in the femoral tunnel with bioabsorbable cross pinsand was fixed in the tibial tunnel with an Intrafix screw (DePuy Mitek) (2).

Transfemoral Endobutton: The cases were operated arthroscopically following the pneumatic tourniquet application with a single dose of antibiotic prophylaxis 1g cefazolin in supine position under spinal anesthesia. The tibial upper-end anteromedial incision and semitendinous and gracilis tendons were taken. From the arthroscopically remote anteromedial portal, the guidewire was sent to the adherence part of the ACL at an angle appropriate to the rear section of the posterior with at least 2mm intact bone. The femoral tunnel for the EndoButton plug was drilled over the guide wire which was reamed from the anteromedial portal using a 4.5mm drill to perforate the anterior femoral cortex (2). The length of this tunnel was measured. The guidewire was placed again and a 35 mm tunnel in the size of the graft diameter was opened over it. The difference between these two tunnels was calculated. EndoButton size was calculated by adding 6 mm to this difference for the plate to cover the cortex. The graft was fixed in the femur with EndoButton and was fixed to the Tibia with an Intrafix screw (DePuy Mitek) placed in the tunnel.

1.3.Evaluations

Drill enlargements used to open the femoral tunnel during surgery were taken as the initial tunnel enlargement. In the last controls, the tunnel enlargement was evaluated with computed tomography (CT). Only the axial images of the femoral tunnels were taken at a right angle to the tunnel path and the enlargement of the tunnel was calculated from the widest part with CT. The differences between the measured tunnel enlargements and the drill enlargement recorded during surgery were calculated. The differences were divided into four groups as no enlargement (<0.5 mm), border enlargement (0.5-<2.5 mm), significant enlargement (2.5-<4.5 mm), excessive enlargement (> 4.5 mm) (6).

The laxity of the ACL was evaluated at 20 degrees knee flexion in the Lachman test position by GNRB® knee arthrometer. The measurement was made with all individuals in the supine position. The back of the operation table was adjusted with a 30-degree tilt. The sensor of the device which records the displacement of the anterior tibial tubercle relative to the femur was placed on the anterior tibial tubercle. The mean displacement of the tibial tubercle in 3 measurements for 200 N for both legs was taken. Furthermore, the difference values between the two extremities were recorded (15).

Muscle strength measurements were performed by using the isokinetic system (Cybex NORM®, Humac, CA, USA). The individuals were seated with their hips at 90 degrees of flexion for the measurements (16). The concentric strength assessment of the quadriceps femoris and hamstring muscles was performed at a speed of 60º/sec in the 0-90º knee flexion range. The tests commenced with the knee at a 90º flexion position. Three repetitions of submaximal warm-ups were performed by the cases before the test. Following a one minute rest period, five maximal test repetitions were performed (17). Eccentric muscle test was performed in 20-90º knee flexion intervals with 5 repetitions at 60º/sec. A one-minute rest period was provided after two repetitions (18). Peak torque/body weight values were recorded for hamstring and quadriceps muscles from both extremities.

Gait analysis and jump performance were measured with the BTS G-walk device. BTS G-walk (BTS SpA, Via della Croce Rossa, 11 Padova, Italy; SN: 0213-0378) allows an objective and precise analysis of movement with a wearable inertial sensor.

All data were collected using a sampling frequency of 100 Hz. The device is placed on an elastic belt and worn on the waist of the person being evaluated, with the center of the device at the fifth lumbar vertebrae. The gait speed, stride length, and cadence over a length of eight meters were evaluated with G-walk (19). The performance was evaluated during the repeated jump test. The test was first performed on the uninvolved extremity, then on the surgical side. For each jump, the individuals were asked to reach the highest possible vertical length. Three attempts were recorded and the maximum jump height was taken for analysis (20).

1.4.Statistical Analysis:

SPSS 22 program was used in the analysis of the data. The suitability of variables to normal distribution was examined using visual (histogram and probability graphs) and analytical methods (Kolmogorov-Smirnov test). Median and value intervals between quarters were calculated for the descriptive statistics. In the analysis of the difference between the extremities of individuals who received ACL reconstruction, the "Mann-Whitney U Test" was used in cases where there was no normal distribution. While comparing the difference between extremities in the group who received ACL reconstruction, the "Wilcoxon Test" was used in cases where there was no normal distribution. Cases, where p value was below 0.05, were evaluated as statistically significant results.

2. Results

The groups possessed similar features in terms of age, height, body weight, body mass index, and post-operation duration (p>0.05, Table 1).

Table 1: Demographic characteristics in Endobutton and Rigidfix groups

	Endobutton (n=13) Median (IQR)		**Rigidfix (n=13) Median (IQR)**	**p**
Age (years)	28 (23/34)		28 (24/34)	0.959
Height (cm)	175 (170/180)		178 (178/180)	0.234
Weight (kg)	82.9 (72.8/95.5)		81.4 (73.7/92.4)	0.817
BMI (kg/cm^2)	26.2 (25.3/28.8)		25.5 (25/29.2)	0.457
Time from surgery to follow-up (months)	24 (14/35)		27 (16/25)	0.504
	n (%)		**n (%)**	
Dominance	**Right**	12 (92.3)	13 (100)	
	Left	1 (7.7)	0	
Surgical side	**Right**	7 (53.8)	6 (46.2)	
	Left	6 (46.2)	7 (53.8)	
Physiotherapy (session)	**Yes**	4 (30.8)	8 (61.5)	
	No	9 (69.2)	5 (38.5)	

IQR: Interquartile range BMI: Body Weight Index

There was no statistically significant difference between the groups in terms of laxity, tunnel enlargement, isokinetic strength ($p>0.05$, Table 2). Both groups possessed similar features in terms of these parameters.

Table 2: Comparison of laxity, tunnel expansion and strength of patients who underwent ACL reconstruction with Endobutton and Rigidfix techniques

	Endobutton (n=13) Median (IQR)	Rigidfix (n=13) Median (IQR)	p
Surgical Side Laxity (mm)	6.1 (5,4 / 9,7)	6.1 (4.2 / 8.1)	0.397
Laxity Difference	1.4 (0.5 / 2.5)	0.95 (0.4 / 1.6)	0.426
Tunnel Enlargement (mm)	3.3 (2.8 / 4.1)	3.2 (2.9 / 4.1)	0.758
Surgical Side Con Q PT/BW (N/Kg)	140 (113 / 188)	176 (161/ 203)	0.144
Surgical Side Con H PT/BW (N/Kg)	77 (51 / 113)	89 (77/ 104)	0.700
Surgical Side Ecc Q PT/BW (N/Kg)	200 (137 / 232)	215 (188 / 253)	0.259
Surgical Side Ecc H PT/BW (N/Kg)	107 (64 / 128)	122 (104/ 137)	0.209

Q: Quadriceps, H: Hamstring, Con: Concentric, Ecc: Eccentric, IQR: Interquartile range, PT/BW: Peak Torque/ Body Weight

When compared in terms of gait and jumping performance, it was observed that while there was a difference between the two groups in terms of stride length percentage and pelvic tilt symmetry index ($p<0.05$, Table 3) in uninvolved sides, there was no difference in other parameters ($p>0.05$, Table 3). While the percentage of stride length was lower in the Endobutton group than the Rigidfix group, the pelvic tilt symmetry index was lower in the Rigidfix group.

Surgical and uninvolved side comparisons of patients who received ACL reconstruction with Endobutton and Rigidfix techniques are shown in Table 4. In the Endobutton group, while there was a difference between the surgical and uninvolved side in terms of laxity, concentric quadriceps-hamstring strength, eccentric hamstring strength and stride length ($p<0.05$, Table 4), there was no difference in other parameters ($p>0.05$, Table 4). In this group, it was determined that laxity and muscle strength were higher on the uninvolved side than the surgical side. It was also determined that the stride length was higher on the uninvolved side. In the Rigidifix group, while there was a difference between the uninvolved side and the surgical side in terms of laxity, concentric-eccentric quadriceps-hamstring strength and jump height ($p<0.05$, Table 4) there was no difference in other parameters ($p>0.05$, Table 4). In this group, it was also determined that laxity, jump height, and muscle strength were higher on the uninvolved side than the surgical side.

Table 3: Comparison of gait parameters and jumping performances of patients who underwent ACLR with Endobutton and Rigidfix techniques

	Side	**Endobutton (n=13) Median (IQR)**	**Rigidfix (n=13) Median (IQR)**	**p**
Analysis duration		26.1 (23 / 27.4)	25.6 (23.2 / 30.2)	0.959
Cadence		107.7 (102.1 / 113.2)	110.3 (108.6 / 115.3)	0.270
Speed		1.13 (1.04 / 1.33)	1.13 (1.02 /1.29)	0,797
Gait cycle duration	**Uninvolved**	1.13 (1.09 / 1.18)	1.09 (1.04 / 1.13)	0.292
	Surgical	1.13 (1.07 / 1.18)	1.09 (1.03 / 1.12)	0.182
Stride length	**Uninvolved**	1.3 (1.21 / 1.41)	1.26 (1.06 / 1.43)	0.590
	Surgical	1.3 (1.21 / 1.42)	1.25 (1.05 / 1.43)	0.473
% stride length	**Uninvolved**	72.5 (68.3 / 80)	84 (70.8 / 96.1)	**0.045***
	Surgical	76.3 (71 / 84.3)	83.4 (70.5 / 95)	0.228
Step length	**Uninvolved**	51.3 (50.7 / 52.2)	50.2 (49.4 / 51.5)	0.292
	Surgical	48.7 (47.8 / 49.3)	49.8 (48.5 / 50.6)	0.292
Stance phase	**Uninvolved**	60.1 (58.6 / 62.1)	58.4 (57.2 / 59.9)	0.174
	Surgical	60 (58.8 / 60.6)	58.6 (57.9 / 59.1)	0.259
Swing phase	**Uninvolved**	39.9 (37.9 / 41.4)	41.6 (40.1 / 42.8)	0.174
	Surgical	40 (39.4 / 41.2)	41.4 (40.9 / 42.1)	0.259
First double support phase	**Uninvolved**	9.6 (8.5 / 10.4)	8.4 (7.4 / 10.6)	0.537
	Surgical	10.4 (8.4 / 11.2)	8.7 (7.6 / 9.7)	0.112
Single support phase	**Uninvolved**	40.1 (39.3 / 41.4)	41.2 (40.6 / 42.2)	0.329
	Surgical	39.9 (37.5 / 41.4)	41.5 (40.6 / 42.3)	0.124
Gait cycle symetry index		96.4 (95.2 / 98)	97 (95 / 98,2)	0.837
Pelvic tilt symmetry index		77.8 (54.5 / 89.1)	50.8 (40 / 73.1)	**0.038***
Pelvic obliquity symmetry index		97.7 (97 / 98.7)	98.6 (97.6 / 98.8)	0.410
Pelvic rotation symmetry index		98.6 (97.1 / 98.9)	98.8 (97.9 / 99.1)	0.207
Jump height (cm)	**Double limb**	25.9 (19.6 / 29.4)	22.7 (21.6 / 25.9)	0.623
	Uninvolved	10.3 (8.3 / 14.2)	11.8 (11 / 13.4)	0.171
	Surgical	10.3 (7.7 / 10.3)	11 (9.6 / 11)	0.472

IQR: Interquartile range, *p<0.05

Table 4: Comparison of the surgical with the healthy sides of the patients who underwent ACL reconstruction with Endobutton and Rigidfix techniques

	Endobutton (n=13) Median (IQR)		p	Rigidfix (n=13) Median (IQR)		p
	Uninvolved	**Surgical**		**Uninvolved**	**Surgical**	
Laxity	5.15 (4.2 / 5.9)	6.1 (5.4 / 9.7)	**0.006***	5.15 (3.7/ 6.5)	6.1 (4.2/ 8.1)	**0.019***
Con Q PT/BW	209 (173 / 244)	140 (113 / 188)	**0.001***	244 (206/ 271)	176 (161/ 203)	**0.001***
Con H PT/BW	104 (69 / 116)	77 (51 / 113)	**0.012***	104 (89/ 125)	89 (77/ 104)	**0.008***
Ecc Q PT/BW	226 (188 / 271)	200 (137 / 232)	0.552	250 (232/ 274)	215 (188/ 253)	**0.036***
Ecc H PT/BW	128 (107 / 149)	107 (64 / 128)	**0.015***	146 (131/ 152)	122 (104/ 137)	**0.014***
Cycle duration	1.13 (1.09 / 1.18)	1.13 (1.07 / 1.18)	0.531	1.09 (1.04/ 1.13)	1.09 (1.03 / 1.12)	0.236
Stride length	1.3 (1.21 / 1.41)	1.3 (1.21 / 1.42)	0.865	1.26 (1.06/ 1.43)	1.25 (1.05 / 1.43)	0.763
% stride length	72.5 (68.3 / 80)	76.3 (71 / 84.3)	0.700	84 (70.8 / 96.1)	83.4 (70.5 / 95)	0.609
Step length	51.3 (50.7 / 52.2)	48.7 (47.8 / 49.3)	**0.030***	50.2 (49.4 / 51.5)	49.8 (48.5 / 50.6)	0.286
Stance phase	60.1 (58.6 / 62.1)	60 (58.8 / 60.6)	0.132	58.4 (57.2 / 59.9)	58.6 (57.9 / 59.1)	0.834
Swing phase	39.9 (37.9 / 41.4)	40 (39.4 / 41.2)	0.115	41.6 (40.1 / 42.8)	41.4 (40.9 / 42.1)	0.834
First double support phase	9.6 (8.5 / 10.4)	10.4 (8.4 / 11.2)	0.311	8.4 (7.4 / 10.6)	8.7 (7.6 / 9.7)	1
Single support phase	40.1 (39.3 / 41.4)	39.9 (37.5 / 41.4)	0.249	41.2 (40.6 / 42.2)	41.5 (40.6 / 42.3)	0.506
Jump height	10.3 (8.3 / 14.2)	10.3 (7.7 / 10.3)	0.230	11.8 (11 / 13.4)	11 (9.6 / 11)	**0.026***

Q: Quadriceps, H: Hamstring, Con: Concentric, Ecc: Eccentric, IQR: Interquartile range, PT/BW: Peak Torque/ Body Weight, *p<0.05

3. Discussion

The present study is the first study in the literature evaluating patients after ACL reconstruction by using the Endobutton and Rigidfix surgical techniques in terms of functional performance. As a result of this study, it could be stated that in patients with ACL reconstruction, whichever type of fixation method was used; Endobutton or Rigidfix, laxity, tunnel enlargement, strength, gait characteristics and jump height values were similar. Furthermore, although it has been two years since the operation performed with both techniques, it was determined that there were still differences in parameters such as strength, laxity, gait characteristics and jump performance between the uninvolved side and the surgical side.

ACL reconstruction is one of the most common treatments for sports injuries (21). The selection of the appropriate graft for fixation plays a key role in returning the patient to daily activities and sports (22). The applied graft is related to the preference of the surgeon and the existing tissues (23). Many clinical studies comparing different fixation techniques during ACL reconstruction revealed conflicting, objective or subjective results (2, 7, 10, 13, 14). There is no precise recommendation about the best fixation technique, and it is possible that the surgeon's preference for fixation is influenced by personal experience, local traditions, and marketing (9). In a multicenter study conducted in Scandinavian countries in 2018, it was determined that the risk rate for revision decreased by 30% when using Transfemoral fixation with Rigidfix or Transfix compared to cortical fixation with Endobutton regardless of the used tibial fixation (9). It is also known that the Endobutton technique is cheaper than Rigidfix (2). There is no consensus on which of these two techniques, which possess advantages and disadvantages, is better. Therefore, the number and importance of the studies comparing these techniques are increasing day by day. There are a few biomechanical studies in the literature regarding these techniques (2, 7, 10, 13, 14). Biomechanical studies frequently examine the graft fixation complex rigidity, pulling strength, or graft fixation complex elongation after cycling loading. Graft fixation complex laxity and graft tunnel movement may impair the biological involvement of the graft in the bone tunnel (24) and result in a weaker reconstruction. In the cadaver model measuring the graft fixation complex stiffness in double-layer semitendinosus grafts, it was stated that the stiffness of the graft and fixation complex is related to the fixation method rather than the graft (25). It is intriguing to compare different fixation techniques biomechanically and functionally due to the importance of which technique the graft is fixed.

Ligamentization of the ACL graft with the composition of collagen fibers keep developing during the maturation phase of healing, which can last one year after surgery (26-28). Laxity is a parameter that frequently used to compare the success of different techniques after ACL reconstruction (10, 12, 14, 29). Eajazi et al. compared Aperfix, Endobutton and Rigidfix techniques and found that there was no difference between groups in terms of laxity (12). Ghaffari et al. stated that the Endobutton and Rigidfix techniques had similar rotator and anteroposterior stability, and that both methods resulted in a stable knee (30). Cınar et al. compared the cases who had a ACL reconstruction with Endobutton or Rigidfix techniques and concluded that the ligament relaxation was higher in the Rigidfix technique (10). In contrast, İbrahim et al. investigated the difference in the laxity and functionality of the individuals reconstructed with the Endobutton or Rigidfix techniques and reported that the laxity was higher in the Endobutton group (14). In addition to these studies, there are also studies in the literature indicating that Endobutton is looser or more rigid than Rigidfix and therefore these results suggests that there is no consensus between the two techniques in terms of laxity (10, 14, 29). In present study, laxity parameters were similar in both fixation techniques, however, on the surgical side, laxity was higher in both techniques compared to the uninvolved side. With this result, it can be said that functional stability is not fully restored even 2 years after surgery, regardless of the fixation technique.

One of the most common complications observed following ACL reconstruction with hamstring tendon graft is bone tunnel enlargement (10, 31). Exact etiology of tunnel enlargement is still unknown, however, it was stated that it can be related to the several mechanical and biological factors with tunnel enlargement in ACL reconstruction (13). One of the possible causes of tunnel enlargement include inappropriate graft fixation (3). It was suggested that different mechanical effects of fixation methods would affect tunnel enlargement differently (10, 24, 32). Lopes et al. reported that the cases with Rigidfix fixation possessed the widest femoral tunnel enlargement. Lilian et al. found that Endobutton fixation was more likely to cause bone tunnel expansion when compared to Rigidfix at the end of one year (33). However, in the study conducted by Cinar et al., individuals operated with Endobutton/Rigidfix techniques were compared and it was found that there was no difference between the two methods in terms of tunnel enlargement, however, both groups had an excessively enlarged tunnel (10). Similarly, because of the present study, it was observed that there was no difference between the two techniques, but, after both surgical applications, it was observed that there was a significant tunnel enlargement. The reason for the tunnel enlargement observed in both techniques may be caused by insufficient and ineffective rehabilitation and the timing of return to performing sports or daily life activities.

Functional tests including muscle strength, power, and neuromuscular control are suggested for the assessment of function following ACL reconstruction. (34). Although certain studies compare the functionality after different fixation techniques, only questionnaires were used for function assessment and it was reported that there was no difference in terms of functionality (10, 14). Similarly, results of these studies support our results. However, in our study, instead of using questionnaires, we preferred to use the isokinetic system for strength assessment and G-walk device for gait analysis and jump performance in order increase objectivity. When the results of these evaluations are examined, it was observed that the two techniques were similar in terms of isokinetic strength, however, a minimal difference was determined in gait parameters. The fact that the step length percentage of the uninvolved side is lower in the Endobutton group than the Rigidfix group suggests that there may still be weight transfer deficits in this group. Weight transfer deficit also may lead changes pelvic tilt symmetry index.

In the comparisons within the two techniques and in terms of surgical and uninvolved sides, it was observed that the deficits were still present (in addition to observing deficits in different parameters for the techniques) even after an average of 24 months. When the differences between the two extremities were analyzed thoroughly, it was determined that the uninvolved side was better in terms of laxity, concentric quadriceps-hamstring strength, eccentric hamstring strength, and stride length in the Endobutton group. In the Rigidfix group, the laxity, concentric-eccentric quadriceps-hamstring strength, and jump performance were higher in the uninvolved side than the surgical side. The reason why there were still deficits although two years have passed since the operation may derive from the fact that a sufficient and well-planned rehabilitation program was not provided to the cases. The reason that the jump performance in the Rigidfix group was lower than the uninvolved side in the surgical side and not in the Endobutton group may originate from the fact that eccentric quadriceps strength on the surgical side of the Rigidfix group is also less than the uninvolved side. These evaluations are significant in terms of determining the functional value of the surgical extremity compared to the uninvolved side.

When the literature is examined, it was observed that there were studies comparing Endobutton and Rigidfix in terms of laxity and tunnel enlargement. However, there is no consistency between the results of these studies. Furthermore, to the best of our knowledge, there were no studies evaluating these two techniques in terms of strength, and gait and jump performance. These studies were generally evaluated by Lyshom, IKDC and Tegner scoring in terms of functionality, and objective measurements were not used for functional evaluations. Moreover, there were no studies in the literature evaluating these two techniques within themselves and comparing them with the uninvolved side in terms of these parameters. It is considered that the present study would contribute significantly to the literature in this aspect.

4. Limitations

This study has some limitations; the fact that more than half of the cases did not receive post-surgical rehabilitation, the individuals who received rehabilitation underwent different rehabilitation applications, and although the ACL injury rates are higher in females (35), the evaluated cases included only males can be listed as the limitations of the present study.

5. Conclusions

There is still no consensus as to which fixation technique used during the reconstruction of ACL injuries, is superior. According to the results of the present study, it was observed that Endobutton and Rigidfix techniques did not have any superiority against each other in terms of laxity, tunnel enlargement, strength, and jumping performance, however, they may differ minimally during a functional activity such as walking. It is considered that the present study contributes significantly to the literature by comparing the long-term results in terms of functionality with these two techniques.

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COI statements

The authors report no conflict of interest.

Declarations of interest

None

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Ethical approval

The study was approved by the Review Board at the University of Gazi.

Author Contributions

NK: Study Design, Manuscript Preparation, Critical Review

GC: Data Collection, Statistical Analysis, Data Interpretation, Manuscript Preparation, Literature Search

CU: Data Collection, Providing Cases

MBA: Study Design, Providing Cases

NAG: Data Interpretation, Critical Review

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