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Transtibial vs anatomical single bundle technique for anterior cruciate ligament reconstruction: A Retrospective Cohort Study

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HIGHLIGHTS

- Transtibial ACL reconstruction applications which are assessed as traditional methods will be diminished.
- Anatomical single-bundle technique compared to the transtibial has better rotational and anterior translational stability.
- Anatomical single-bundle ACL reconstruction reduces complications.
- Anatomical single-bundle ACL reconstruction is more effective on the returning to normal knee functions after surgery.

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ABSTRACT

Introduction: Most of the ACL reconstruction is done with isometric single-bundle technique. Traditionally, surgeons were trained to use the transtibial technique (TT) for drilling the femoral tunnel. Our study compared the early postoperative period functional and clinical outcomes of patients who had ACL reconstruction with TT and patients who had ACL reconstruction with anatomical single-bundle technique (AT).

Material method: Fifty-five patients who had ACL reconstruction and adequate follow-up between January 2010–December 2013 were included the study. Patients were grouped by their surgery technique. 28 patients included into anatomical single-bundle ACL reconstruction surgery group (group 1) and 27 patients were included into transtibial AC reconstruction group (group 2). Average age of patients in group 1 and group 2 was 28.3 ± 6, and 27.9 ± 6.4, respectively. Lachman and Pivot-shift tests were performed to patients. Laxity was measured by KT-1000 arthrometer test with 15, 20 and 30 pound power. All patients' muscle strength between both extremities were evaluated with Cybex II (Humac) at 60°/sec, 240°/sec frequencies with flexion and extension peak torque. The maximum force values of non-operated knee and the operated knee were compared to each other. Groups were evaluated by using International Knee Documentation Committee (IKDC) knee ligament healing Standard form, IKDC activity scale, modified Lysholm and Cincinnati evaluation forms. Return to work and exercise time of patients were compared. Functional and clinical outcomes of two groups were compared. NCSS 2007 and PASS 2008 Statistical Software programs were used for statistical analysis.

Result: There was no statistically significant difference between Lachman and Pivot-shift results ($p > 0.01$). Positive value of Pivot-shift test and incidence of anterior translation in Lachman test were higher in the patients who had TT. Lysholm activity level of patients who had TT, 33.3% (n = 9) were excellent, 51.9% (n = 14) were good and 14.8% (n = 4) were moderate; patients who had AT, 57.1% (n = 16) were excellent, 39.3% (n = 11) were good and 3.6% (n = 1) was good level. There was no statistically significant difference between Lysholm Activity level of the patients ($p < 0.01$). Lysholm Activity

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level of patients who had AT significantly higher than TT. There was no statistically significant difference between Modified Cincinnati activity level of the patients ($p < 0.05$). Modified Cincinnati activity level of patients who had AT were significantly higher than those had TT. There was no statistically significant difference between two groups with post treatment IKDC activity level ($p < 0.01$). Intense activity after treatment rate of patient who had AT was significantly higher than those had TT. There was statistically significant difference between Cybex extension-flexion 60 measurement and extension 240 measurement of the patients ($p < 0.01$). KT-1000 arthrometer test results with AT was better than the TT in antero-posterior translation of the knee kinematics at 20 and 30 pound of forces. Return to exercise time of patients who had TT was significantly higher than those had AT ($p < 0.01$). There was no statistically significant difference between return to work time of patients ($p > 0.05$).

Conclusion: Single-bundle anatomic ACL reconstruction was better than the TT in term of clinical, functional, and laboratory results. We believe that AT ACL reconstruction will increase in use and traditional method which is TT ACL reconstruction surgery will decrease in the long term. Theoretically, anatomic relocation of the ACL can provide better knee kinematics.

1. Introduction

The main goals of anterior cruciate ligament (ACL) reconstruction are the reduction or elimination of knee instability, the restoration function lose, and the prevention of long term joint degeneration. Most of the ACL reconstruction is done with isometric single-bundle technique. Traditionally, surgeons were trained to use the transtibial technique (TT) for drilling the femoral tunnel [1,2]. However, several studies have suggested that the TT might not be able to center the graft near the anatomic center of the ACL [3,4]. The localization of the femoral tunnel is particularly important in terms of isometric placement of the graft. In some studies femoral fixation appears to be rebuilt located further ahead in 62% of revised cases and this is indicated as the most important cause of graft failure [5].

Conventional single-bundle ACL reconstruction with TT is widely used all over the world. Femoral tunnel created with transtibial approach leads to drop out of ACL natural binding sites and it fails to provide sufficient resistance to rotational and translational forces [6,7]. For these reasons, a femoral disposition is formed to provide enhanced rotational stability and sufficient antero-posterior stability. As a result, the importance of anatomic tunnel placement in a single bundle ACL reconstruction is realized [8,9]. Anatomic approach brings the tunnel placement to more horizontal location. Biomechanical studies showed that it provides better antero-posterior and internal rotational stability in the coronal plane [10]. Several studies have demonstrated that drilling the ACL femoral tunnel using a transtibial surgical technique often results in a vertical femoral tunnel, which produces a vertical ACL graft orientation, resulting in inferior rotational control and inferior clinical outcomes [11–13].

Our study compared the early postoperative period functional and clinical outcomes of patients who had ACL reconstruction with TT and patients who had ACL reconstruction with anatomical single-bundle technique (AT).

2. Material Methods

In our study, 138 patients who had ACL reconstruction surgery were evaluated between January 2010 and December 2013 retrospectively. Fifty-three patients who had arthroscopic ACL reconstruction surgery with the TT, and 27 patients who had at least 12 month follow-up with isolated ACL tear (group 1) were included to the study. Eighty-five patients who had arthroscopic ACL reconstruction surgery with the AT, and 28 patients who had at least 12 month follow-up with isolated ACL tear (group 2) were included to the study. Patients with combined ligament and meniscal injuries were excluded from the study. Same rehabilitation protocol was applied to all patients in the study.

Our study was approved with the file number of 2014/630 at the meeting on the date of 08.04.2014 by Sisli Etfal Training and Research Hospital Ethical Committee.

Postoperatively all patients were assessed Lachman and Pivot-shift tests. Lachman and Pivot-shift tests were graded as negative, 1 (+) 2 (+) and 3 (+). Laxity measurements were performed to patients by using KT-1000 arthrometer testing of 15, 20 to 30 pounds. Power measurement of the quadriceps and hamstring muscle groups in the patients' operated and non-operated extremities were performed using Cybex II isokinetic dynamometer (HUMAC). Peak torque values at flexion and extension positions were determined at 60°/sec and 240°/sec frequency during measurements. International Knee Documentation Committee (IKDC) knee ligament healing standard form, IKDC activity scale, Lysholm and Modified Cincinnati evaluation forms were used to compare findings of both patient groups. Functional and clinical outcomes of two groups were compared.

NCSS (Number Cruncher Statistical System) 2007 and PASS (Power Analysis and Sample Size) 2008 Statistical Software (Utah, USA) were used for statistical analysis. Data was analyzed by using descriptive statistical methods (mean, standard deviation, median, frequency, ratio, minimum, maximum) and for comparing quantitative data Student's t-test was used for two group comparison of parameters with normal distribution, while Mann-Whitney U test was used for two group comparison of parameters without normal distribution. In the comparison of qualitative data Pearson Chi-square test, Fisher–Freeman–Halton test, Fisher's exact test, and Yates Continuity Correction test (Yates adjusted Chi-square) were used. Spearman's correlation analysis was used for the evaluation of the relation between parameters. Wilcoxon Signed Ranks test was used for within group comparison of parameters without normal distribution. Significance was evaluated in $p < 0.01$ and $p < 0.05$.

3. Results

All of the patients who had ACL reconstruction with TT were male. Thirteen of these patients (48.1%) had left knee, and 14 (51.9%) of them had right knee ACL reconstruction surgery. The mean age was 27.9 ± 6.4 in our study (range 18–40). Average time between ACL rupture and the time of surgery was 10.1 month (range 1–36). The mean follow-up period was 26.6 month (range 12–42). The average duration to start postoperative sport activities

was 6.5 month (range 3–11). Twenty-seven (96.4%) of the patients who had arthroscopic ACL reconstruction with AT were male and 1 (3.6%) was female. Fifteen (53.5%) of these patients had right knee, and 13 (46.5%) of them had left knee ACL reconstruction. The average age of the patients who had AT was 28.3 ± 6 (range 17–38). Average time between ACL rupture and the time of surgery was 9.65 month (range 1–36). The mean follow-up period was 19.1 month (range 9–36). The average duration to start postoperative sport activities was 5.1 month (range 3–8) (Tables 1 and 2).

There was no statistically significant difference between Lachman and Pivot-shift test results. It was remarkable that positivity in Pivot-shift test and high incidence of anterior translation in the Lachman test in TT group were higher than AT group ($p > 0.01$) (Table 3).

Lysholm activity level of 33.3% ($n = 9$) of patients with TT was excellent, 51.9% ($n = 14$) was good and the 14.8% ($n = 4$) was at medium level; 57.1% ($n = 16$) of patients with AT was excellent, 39.3% ($n = 11$) was good and the 3.6% ($n = 1$) was at medium level. There was statistically significant difference in the advanced level between Lysholm activity level of the cases according to the technique ($p < 0.01$). Lysholm activity level of patients with AT was significantly higher than TT (Table 4, Fig. 1). Modified Cincinnati activity level of 74.1% ($n = 20$) of the patients with TT was excellent, and 25.9% ($n = 7$) was at good level; 85.7% of patients ($n = 24$) with AT was excellent, 14.3% ($n = 4$) was at good level. There was statistically significant difference between the Modified Cincinnati activity level of the cases according to the technique. Modified Cincinnati activity level of patients with AT was significantly higher than TT ($p < 0.05$) (Table 4, Fig. 2).

Activity status during the final examination before trauma and post-treatment of patients who had arthroscopic ACL reconstruction with TT were evaluated according to IKDC activity scale. Twenty-seven patients (100%) were at level I and II before trauma, and 15 patients (55.5%) were at the same level during the final follow-up (Table 5, Fig. 3). Twenty-eight patients (100%) were at level I and II before trauma, and 27 patients (96.5%) were at the same level during the final follow-up in AT group (Table 5, Fig. 3).

There was statistically significant difference between post-treatment IKDC activity level of the patients according to the technique. The incidence of post-treatment intense activity of patients who had AT was significantly higher than the patients who had TT ($p < 0.01$).

There was a statistically significant difference between Cybex Extension 60% measurement of the cases according to the technique ($p < 0.01$). Cybex Extension 60% measurement of the patients who had AT was significantly higher than the patients who had TT. There was statistically significant difference between Cybex Extension 240% measurements of the cases according to the technique ($p < 0.05$). Cybex Extension 240% measurement of the patients who had AT was significantly higher than the patients who had TT. There was statistically significant difference between Cybex Flexion 60% measurements of the cases according to the technique ($p < 0.01$). Cybex Flexion 60% measurement of the patients who had AT was significantly higher than the patients who had TT. There was no statistically significant difference between Cybex Flexion 240% measurements of the cases according to the technique ($p > 0.05$) (Table 6). Measurement values between operated and non-operated extremities were compared (Table 7, Fig. 4). Values 80% and above were considered normal.

Average laxity values for patients who had arthroscopic ACL reconstruction by TT was 0.85 mm for 15 pound force; 1.28 mm for 20 pound force and 1.33 mm for 30 pound force. Average laxity values for patients who had arthroscopic ACL reconstruction by AT was 0.61 mm for 15 pound force; 0.75 mm for 20 pound force and 0.96 mm for 30 pound force (Table 8, Fig. 5). There was no statistically significant difference between operated side and non-operated side of patients under 15 pound KT-1000 device power ($p > 0.05$). There was statistically significant difference between operated side and non-operated side of the patients under 20 pound KT-1000 device power ($p < 0.01$). Anterior translational difference between the operated side and non-operated side was significantly lower in patients who had anatomical single-bundle ACL reconstruction than those who had transtibial ACL reconstruction. There was statistically significant difference between operated side and non-operated side of patients under 30 pound KT-1000 device power ($p < 0.05$). Anterior translational difference between the operated side and non-operated side was significantly lower in the patients who had anatomical single-bundle ACL reconstruction than those who had transtibial ACL reconstruction.

Table 1
Assessment of age, follow-up duration and trauma duration.

	Transtibial (n = 27)	Anatomic (n = 28)
	Mean ± SD	Mean ± SD
Age (year)	27.96 ± 6.47	28.39 ± 6.06
Follow-up duration (month)	27.11 ± 9.02	19.21 ± 7.41
Trauma duration (month)	9.67 ± 11.35	10.64 ± 10.61

Table 2
Assessment of side and surgical technique.

Side	Left	24	%43.6
	Right	31	%56.4
Surgical technique	Transtibial	27	%49.1
	Anatomic	28	%50.9

4. Discussion

The present study demonstrated that the anatomical single-bundle ACL reconstruction provides better initial stability when compared to the non-anatomical single-bundle ACL reconstruction with the combined anterior and internal rotatory forces. Several studies have extensively examined tunnel position in ACL reconstruction and found that inappropriate graft placement had significant adverse effect on graft incorporation and knee function [11,14–17]. According to the radiographic analysis, the femoral insertion of the anteromedial bundle is located at 66.5% of the intercondylar depth and at 27.6% of the intercondylar height. This indicates that the location of the femoral tunnel in this series was marginally too deep, whereas most previous anatomic studies identified the femoral ACL footprint center at an average intercondylar depth of 71% and the anteromedial bundle center at an average intercondylar depth of 75.5% [18–22]. Anatomic ACL graft positioning is considered a key factor for proper postoperative knee function and restoration of the physiological kinematics of the femorotibial joint in ACL reconstruction [23–25]. The suggestion is to leave at least 2 mm bone stock in posterior wall while creating a femoral tunnel. The reconstructed graft should not be jammed at the intercondylar notch, tunnel's intra-articular exit point should be arranged long enough not to force the graft to tear apart and should be placed at sufficient angle to store ideal location.

Conventional single-bundle ACL reconstruction with TT is widely used all over the world. Femoral tunnel created by transtibial approach will cause ACL to spread outside of the natural adhesion areas and lead to abnormal knee kinematics [6,7,26]. In the long-term follow-up results of the patients who had ACL reconstruction with TT showed that the TT reduces the anterior tibial translation of the patients as assessed by Lachman test and

Table 3
ACL stability test results of the patients according to the applied technique.

		Transtibial (n = 27)	Anatomic (n = 28)
		n (%)	n (%)
Lachman (mm)	1–2 Normal	12 (%44.4)	16 (%57.1)
	3–5 Less than normal	13 (%48.1)	10 (%35.7)
	6–10 Abnormal	2 (%7.4)	2 (%7.1)
Pivot shift	Negative	16 (%59.3)	24 (%85.7)
	Positive	11 (%40.7)	4 (%14.3)

Table 4
Modified Cincinnati and Lysholm scoring results of the patients according to the technique.

		Transtibial (n = 27)	Anatomic (n = 28)
		n (%)	n (%)
Modified Cincinnati	Excellent	20 (%74.1)	24 (%85.7)
	Good	7 (%25.9)	4 (%14.3)
Lysholm	Excellent	9 (%33.3)	16 (%57.1)
	Good	14 (%51.9)	11 (%39.3)
	Medium	4 (%14.8)	1 (%3.6)

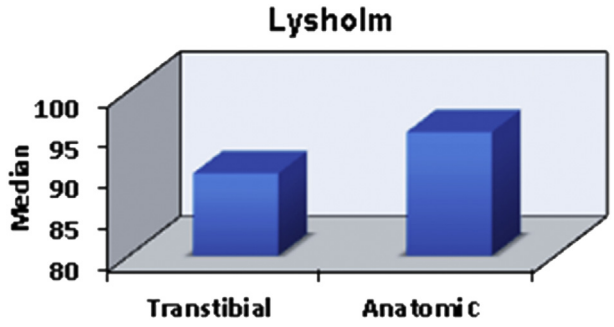

Fig. 1. Lysholm activity level changes according to the technique.

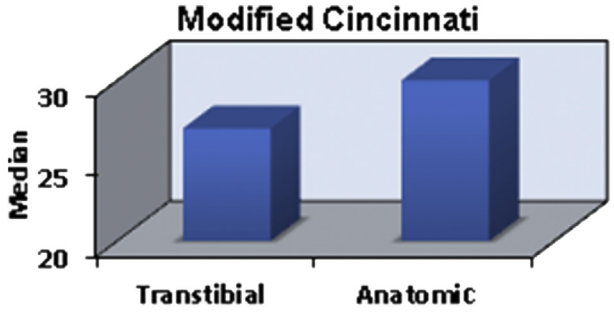

Fig. 2. Modified Cincinnati activity level changes according to technique.

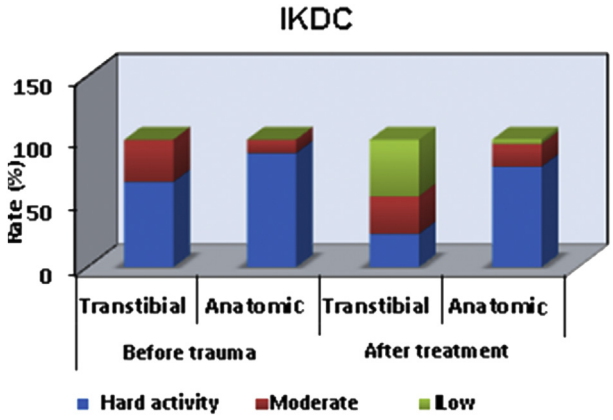

Fig. 3. Pre- and post-trauma treatment IKDC activity level changes according to the technique.

indicated that an increase in rotational instability when the graft is positioned more vertically [27–29]. Because of these reasons, to increase rotational stability and to provide adequate antero-posterior stability, there is an increasing clinical trend towards to form the femoral tunnel to intercondylar notch at ACL's anatomic foot print. The importance of anatomic tunnel placement in a single-bundle ACL reconstruction has emerged as a result of those factors [8,9]. A clinical study concluded that the use of the anatomic

Table 5
Two time points of the rate of patients by IKDC activity scale according to technique.

IKDC		Transtibial (n = 27)	Anatomic (n = 28)
		n (%)	n (%)
Pre-trauma	Intense activity	18 (%66.7)	25 (%89.3)
	Moderate activity	9 (%33.3)	3 (%10.7)
Post-treatment	Intense activity	7 (%25.9)	22 (%78.6)
	Moderate activity	8 (%29.6)	5 (%17.9)
	Low activity	12 (%44.4)	1 (%3.6)

KT-1000 arthrometer testing. However, it can not prevent axial instability in the knee kinematics [8]. Other in vitro studies replacement of the ACL resulted in greater knee stability and range of motion values and an earlier return to running compared to the

Table 6
Extension and flexion cybex measurement distribution according to the technique.

		Transtibial (n = 27)	Anatomic (n = 28)
		Mean ± SD	Mean ± SD
Cybex extension 60	Operated	181.89 ± 39.84	202.68 ± 53.74
	Intact	214.70 ± 28.87	223.68 ± 36.45
Cybex extension 240	Operated	89.59 ± 18.22	98.32 ± 27.98
	Intact	107.89 ± 14.53	105.68 ± 20.13
Cybex flexion 60	Operated	131.89 ± 22.45	153 ± 36.22
	Intact	146.04 ± 18.79	155.29 ± 29.47
Cybex flexion 240	Operated	76.85 ± 16.48	81.32 ± 25.08
	Intact	87.52 ± 16.31	88.04 ± 22.09

Table 7
Evaluation of the isokinetic muscle strength of both lower extremities of the patients who underwent arthroscopic ACL reconstruction with transtibial and anatomic single-band technique.

	Transtibial (n = 27)	Anatomic (n = 28)
	Mean ± SD (median)	Mean ± SD (median)
Cybex extension 60	84.65 ± 13.69 (86.3)	92.55 ± 25.30 (97.3)
Cybex extension 240	83.73 ± 16.61 (83.1)	92.58 ± 20.79 (94.3)
Cybex flexion 60	90.46 ± 10.55 (88.,5)	99.69 ± 18.62 (104.7)
Cybex flexion 240	89.59 ± 21.64 (85.3)	96.78 ± 40.08 (94.6)

layout to a more horizontal position and thus biomechanical studies have shown that in the coronal plane, it provides the anterior-posterior and the internal rotational stability better [10,31,32].

Tunnel position is one of the most important factors determining the outcome of ACL reconstruction. It has been shown that failure of the ACL reconstruction surgery with persistent knee laxity or constrained knee motion correlated with improper graft placement; and placement of the femoral bone tunnel more towards to the medial wall of the lateral condyle in a 10 o'clock position more

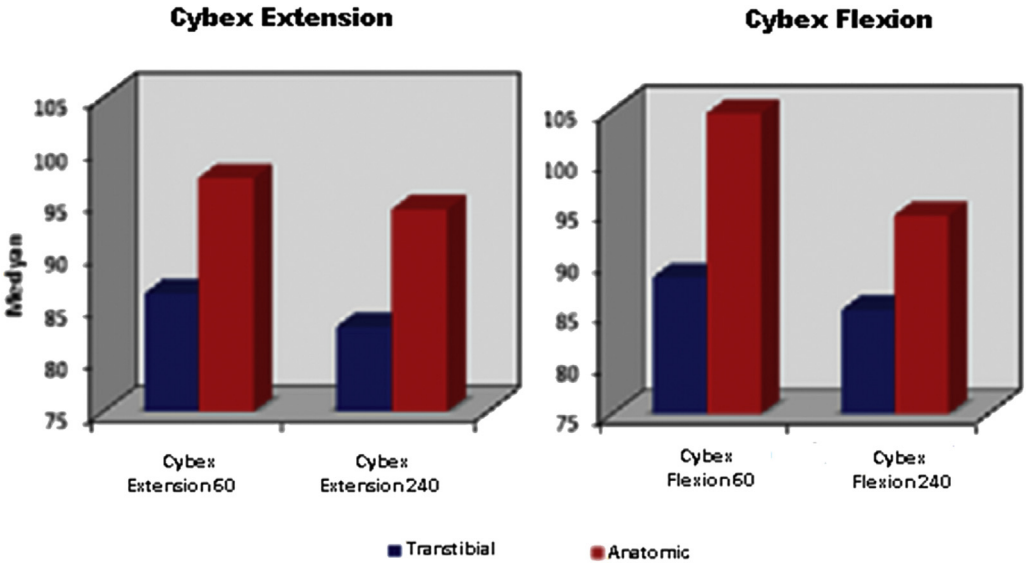

Fig. 4. Cybex II Isokinetic Dynamometer value distribution according to the technique.

Table 8
Assessments on KT 1000 device according to technique.

KT-1000		Transtibial (n = 27)		Anatomic (n = 28)	
		Min–max (median)	Mean ± SD	Min–max (median)	Mean ± SD
15 Pound	Operated	2–8 (5)	5.04 ± 1.60	3–7 (5)	5.00 ± 1.22
	Intact	2–7 (4)	4.19 ± 1.44	2–7 (4)	4.39 ± 1.42
	Difference	0–2 (1)	0.85 ± 0.72	0–2 (1)	0.61 ± 0.63
20 Pound	Operated	4–9 (7)	6.83 ± 1.26	5–9 (7)	6.93 ± 1.15
	Intact	3–8 (6)	5.56 ± 1.25	4–8 (6)	6.18 ± 1.09
	Difference	0–2.5 (1)	1.28 ± 0.74	0–2 (1)	0.75 ± 0.52
30 Pound	Operated	6–13 (9)	8.59 ± 2.04	8–11 (9)	9.29 ± 0.94
	Intact	5–12 (7)	7.26 ± 2.05	6–10 (8)	8.32 ± 1.06
	Difference	1–2 (1)	1.33 ± 0.48	0–2 (1)	0.96 ± 0.58

TT [30]. It is shown that anatomical approach brought the tunnel effectively resists rotator loads when compared with tunnel

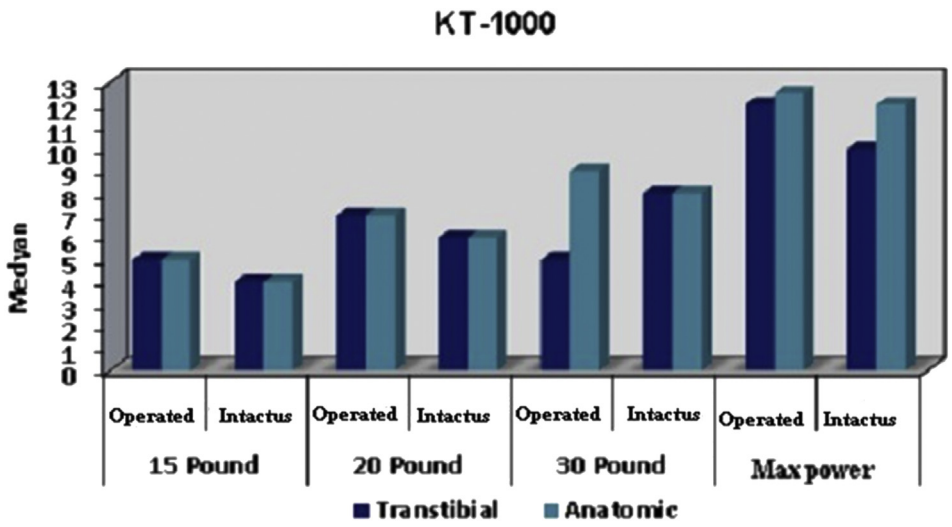

Fig. 5. Distributions of the KT 1000 device measurement according to the technique.

placement close to the roof of the intercondylar notch [33].

Various methods have been suggested to measure ACL tunnel placement intraoperatively. Fluoroscopy has been favored by some authors as a practical real-time method to verify correct ACL tunnel positions ([34–36]). The femoral tunnel that was opened independently from the tibial tunnel with the help of anteromedial portals, was found to increase the rotational stability and obliquity of the femoral tunnel in a study of 20 cadavers [31]. After the study on comparison of transtibial and anatomical femoral tunnel opening, more horizontal graft location provides better rotational control in addition to anterior-posterior translational stability [32]. Anterior-posterior and rotational stability after transtibial and anatomical techniques were compared in one study. Sufficient stability in anteroposterior translational and rotational force has not been achieved in patients who had reconstruction transtibially. Anatomical repair was found to perform more stable against anterior and internal rotational force. It was shown that non-anatomical graft placement had an opposite effect on graft alignment and the knee functions [14,17]. Anatomical tunnel placement in ACL reconstruction was emphasized as a strategic approach to reduce rotational instability and ACL reconstruction complications such as arthritis [37].

KT-1000 arthrometer testing and measurements made in the knee joint are objective measurements to demonstrate tibia's forward displacement at anterior-posterior plan with regard to the femur, in other words, they are objective measurements to demonstrate the laxity of the knee joint. Studies showed that KT-1000 arthrometer testing can reliably determine the knee joint laxity and clinical use of this device was successful [38,39]. Some studies showed that instrumented laxity measurement testing using a rolimeter, patients treated with anatomical ACL reconstruction had more stability in antero-posterior examination [40,41]. We compared the antero-posterior translational differences between the operated and non-operated side with the KT-1000 arthrometer measurement with 15, 20 and 30 pounds power to evaluate the antero-posterior stability objectively. We found that anterior translational difference between the ACL intact side and operation side under 20 and 30 pounds forces were significantly lower in the patients who had anatomical single-bundle ACL reconstruction than those had transtibial ACL reconstruction. In according to our study, we found that increase in anterior translation amounts under the 20 and 30 pounds of power were statistically significant in patients who had ACL reconstruction with TT than ACL reconstruction with AT. Although we saw that anterior-posterior translation was higher at the knee with TT in KT-1000 arthrometer testing value under 15 pounds, but there was no statistically significant. Under these findings we found that AT was more stable than the reconstruction with the TT in anterior-posterior translation of the knee kinematics. We attribute our better clinical results in the AT reconstruction group to the more distal position of the femoral tunnels in this group.

In the follow-up of the patients there was no statistical significant difference between the Lachman and Pivot-shift test levels of the patients according to the technique. However, Pivot-shift and Lachman test levels of patients who had TT was higher than those had AT. Excess incidence of internal rotation and anterior translation in Lachman test and Pivot-shift test levels were also higher than those had AT. We found more consistent results on the knee kinematics of the patients who had AT ACL reconstruction than those who had TT ACL reconstruction.

In the literature, reconstruction with hamstring tendon graft was taken from the same side was applied to ACL patients with chronic lesions, there was no difference in dynamometric measurements made between the operated knees and non-operated knees [42]. Highest extension and flexion strength values of operated knee and non-operated knee were compared to each other, the results that is 80% and more considered normal. In result, more than 20% the power loss was detected in the average value of both groups based on the technique. In our study, functional activity scale with AT ACL reconstruction results were better than the TT ACL reconstruction results. There was no publication in the literature regarding the impact of the surgical technique in ACL reconstruction on the thigh muscle strength. We believe that post-operative rehabilitation process compliance increases with better knee kinematics. AT provides better knee stability, therefore patients have more compliance with rehabilitation protocol and exercise level. All of those contribute to thigh muscle strength in the knee.

Taking into consideration of instability findings detected on physical exam, direct and indirect ACL insufficiency at MRI, prior trauma activity level and desired future activity level, factors such as the presence of additional problems apart from ACL in the pre-operative evaluation of the patients, reconstruction has to be decided. Furthermore, activity level, occupation of the patients, the presence of inflammation and the adequacy of muscle strength also has to be considered. We recommend surgery for young and active

patients who feel instability in their daily activities and in their exercise capacity. The main aim is to bring activity level of patients who have ACL tear, close to or same to their pre-injury level. Otherwise, patients with ACL tear determine an activity level according to their current state, reduce their previous activity levels. In our study, AT ACL reconstruction surgery results were better than the non-anatomic surgery results. By ensuring a better knee kinematics, patients increase their activity level, adaptation to the rehabilitation protocol, and the muscle strength.

5. Conclusion

As a conclusion of our study, we obtained better results in functional and exercise capacity scale in the early follow-up results of our patients who had ACL reconstruction with AT. Furthermore, single-bundle anatomic ACL reconstruction is a better technique compared to the transtibial ACL reconstruction based on physical examination to assess the knee kinematics and KT-1000 device results. Our study is compatible with literature data and AT ACL reconstruction compared to the TT ACL reconstruction provides better rotational and anterior translational stability control, decreased complications and more effective for returning to normal function after the surgery. AT ACL reconstruction was found to be better than the TT in term of clinical, functional, and laboratory results. We believe that single-bundle anatomic ACL reconstruction will increase in use and traditional method which is transtibial ACL reconstruction surgery will decrease in the long term. Theoretically, anatomic relocation of the ACL can provide better knee kinematics.

Ethical approval

Yes.

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Author contribution

Bekir Eray Kilinc-study design, data collections, writing, Final corrections.

Adnan Kara - study design, data analysis, writing, Final corrections.

Haluk Celik-data analysis, writing.

Yunus Oc-data collections, data analysis.

Savas Camur-data collections, data analysis.

Emre Bilgin-data collections, data analysis.

Yunus Turgay Erten-data collections, data analysis.

Turker Sahinkaya-data collections, data analysis.

Osman Tugrul Eren-study design, data analysis, Final corrections.

All authors approve final version of paper for submission.

Conflict of interest

The authors declare that they have no conflict of interest.

Guarantor

Bekir Eray Kilinc, Adnan Kara.

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