

Is anterior cruciate ligament surgery technique important in rehabilitation and activity scores?

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To compare the two different anterior cruciate ligament surgery techniques' effect in rehabilitation and activity performance. Fifty-five patients were evaluated. Twenty-seven patients with transtibial technique (TT), 28 with anatomic single-bundle technique (AT) included. Tegner Activity Scale (TAS) was performed at preoperation and follow-up. The returning time of the sport and work was evaluated at follow-up. Single-leg hop test was performed at follow-up. Outcomes were compared between the two groups. The determined length difference between the operated knee and the intact knee was compared between the two groups. Average age of TT and AT was 27.9 ± 6.4 yr, 28.3 ± 6 yr, respectively. There was a significant difference between the two groups in duration of returning to sport. TT group had higher duration to return to sport ($P < 0.01$). No difference between the two groups in duration of returning to work ($P > 0.05$). There was a significant difference between

the two groups. TT group had significantly higher values than AT group ($P < 0.01$). No difference in TAS between the two techniques at preoperation and at last follow-up ($P > 0.05$). The increase of TAS in patients who had AT was higher than the patients who had TT ($P > 0.05$). No difference in single-leg hop test at 55%–65%, 65%–75%, and 85%–95% level ($P > 0.05$). In this test at 75%–85% TT group had higher values than AT group ($P < 0.05$), AT group had higher values at 95%–105% level ($P < 0.05$). Good short and long-term knee outcome scores depend on rehabilitation protocol after surgery. Surgery technique should provide the adequate stability in rehabilitation period. AT obtains better outcomes in rehabilitation.

Keywords: Anterior cruciate ligament, Anatomic single-bundle, Transtibial, Anterior cruciate ligament rehabilitation, Single-leg hop test

INTRODUCTION

The anterior cruciate ligament (ACL) is a key knee stabilizer and its main function is to prevent anterior translation of the tibia on the femur. ACL injuries remain high in the athletic arena. Orthopaedic Sports Medicine has identified it as the single largest problem affecting the athletes (Woo et al., 2006). The anterior cruciate-deficient knee in many patients prevents successful return to sports and their best chance of doing so is by undergoing primary ACL reconstruction.

A study conducted by the National Football League during a 4-year period (1994–1998) indicates that an averaging 2,100 in-

juries were reported per year with knee injuries accounting for 20% of all injuries of which 2% were ACL injuries (Woo et al., 2006). ACL injury is a noncontact event which occurs more frequent in females than male athletes (Arendt and Dick, 1995; Hurd et al., 2008; Hutchinson and Ireland, 1995; Ireland, 1999).

The incidence of ACL injuries in sports is significantly higher during competition than training and this finding is consistent among all sports (Prodromos et al., 2007).

The main goals of ACL reconstruction are the reduction or elimination of knee instability, the restoration function lose, achieving the activity status before the injury and the prevention of long-term joint degeneration.

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The localization of the femoral tunnel is particularly important in terms of isometric placement of the graft.

This study was done to compare the two different ACL surgery techniques' effect in rehabilitation and activity performance.

MATERIALS AND METHODS

Ethical approval was obtained from the Institutional Review Board of Sisli Etfal Training and Research Hospital (approval number: 08/04/2014-630). Informed consent was obtained from all patients prior to participation in the study.

Taking into consideration of instability findings detected on physical examination, direct and indirect ACL insufficiency in magnetic resonance imaging, prior trauma activity level and desired future activity level, factors such as the presence of additional pathologies apart from ACL in the preoperative evaluation of the patients, reconstruction was decided. While deciding about the surgery time of patients who were applied early after the injury, edema in the knee and range of motion of the knee were evaluated in the first place. Furthermore, the social structure of the patient, activity level, occupation, the presence of inflammation, the adequacy of muscle strength were also considered.

In the study patients were advised to return to sports after having adequate hamstring and quadriceps strength, knee range of motion, stability and function as compared to the opposite unaffected knee and after successfully undergoing a phase of sports-specific training.

In our study, 55 patients who were applied ACL reconstruction surgery were evaluated. Among these patients who were applied arthroscopic ACL reconstruction surgery using the transtibial technique 27 patients with adequate follow-up of at least 12 months were enrolled in the study. On the other hand, patients who were performed arthroscopic ACL reconstruction surgery using anatomical single-bundle technique, 28 patients with adequate follow-up of at least 12 months were enrolled in the study.

The Tegner Activity Scale (TAS) is a subjective rating scale, which assessed the patient's activity level before and after surgery. It comprises of eight knee symptoms of which each symptom has a range of function which the patient matches to their level of activity if the symptom occurred. The total score is graded as poor (< 66), fair (66–83), good (84–90) and excellent (> 90).

TAS was performed to the patients before the surgery and at last follow-up. The returning time of the sport and work was evaluated after surgery. Single-leg hop test was performed at last follow-up. Outcomes were compared between the two groups.

Each patient was laid in the supine position, knees at full extension and relaxed position prior to measurement of the circumference of the thigh muscles. Both thigh circumference were measured and recorded from 15 cm proximal to the upper limit of the patella for measuring. The determined length difference between there operated knee and the intact knee was recorded. Results were compared between the two groups.

Patients with combined ligament and meniscal injuries were excluded from the study. Same rehabilitation protocol was applied to all patients in the study.

NCSS 2007 and PASS 2008 Statistical Software (Kaysville, UT, USA) were used for statistical analysis. Data was analyzed by using descriptive statistical methods (mean, standard deviation, median, frequency, ratio, range) and for comparing quantitative data Student *t*-test was used for two group comparisons of parameters with normal distribution, while Mann–Whitney *U*-test was used for two group comparisons of parameters without normal distribution. In the comparison of qualitative data Pearson chi-square test, Fisher–Freeman–Halton test, Fisher exact test, and Yates Continuity Correction test (Yates adjusted chi-square) were used. Spearman 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 $P < 0.05$.

RESULTS

All of the patients who had ACL reconstruction with TT were male. Thirteen of these patients (48.1%) had left knee, and 14 of them (51.9%) had right knee ACL reconstruction surgery. The average age was 27.9 ± 6.4 yr in TT group (range, 18–40 yr). Average time between ACL rupture and the time of surgery was 10.1 months (range, 1–36 months). The average follow-up period was 26.6 months (range, 12–42 months). Twenty-eight of the patients (96.4%) who had arthroscopic ACL reconstruction with AT were male and one (3.6%) was female. Fifteen of these patients (53.5%) had right knee, and 13 of them (46.5%) had left knee ACL reconstruction. The average age of the patients who had AT was 28.3 ± 6 yr (range, 17–38 yr). Average time between ACL rupture and the time of surgery was 9.65 months (range, 1–36 months). The average follow-up period was 19.1 months (range, 9–36 months) (Tables 1, 2).

In TT group, the average duration to start postoperative sport activities was 6.37 ± 1.96 months (range, 3–10 months), and the average duration to return to work was 1.89 ± 0.58 months (range,

Table 1. Assessment of age, follow-up duration

Variable	Transtibial (n=27)	Anatomic (n=28)
Age (yr)	27.96±6.47	28.39±6.06
Follow-up duration (mo)	27.11±9.02	19.21±7.41

Values are presented as mean ± standard deviation.

Table 2. Assessment of side and surgery technique

Variable	No. (%)
Side	
Left	24 (43.6)
Right	31 (56.4)
Surgery technique	
Transtibial	27 (49.1)
Anatomic	28 (50.9)

Table 3. Assessment of thigh diameter difference, return to sport and work according to the technique

Variable	Thigh diameter difference (cm)	Duration (mo)	
		Return to sport	Return to work
Total			
Mean±SD	1.33±1.32	5.60±1.72	1.87±0.49
Range	0–4	3–10	1–3
Median	1.00	5.00	2.00
Transtibial (n=27)			
Mean±SD	1.89±1.40	6.37±1.96	1.89±0.58
Range	0–4	3–10	1–3
Median	2.00	6.00	2.00
Anatomic (n=28)			
Mean±SD	0.79±0.99	4.86±1.01	1.86±0.40
Range	0–4	3–7	1–3
Median	0.50	5.00	2.00
P-value	0.002**	0.003**	0.842

SD, standard deviation.

Mann–Whitney U-test.

**P<0.01.

1–3 months) (Table 3). In the AT group, the average duration to start postoperative sport activities was 4.86±1.01 months (range, 3–7 months), and the average duration to return to work was 1.86±0.40 months (range, 1–3 months) (Table 3). There was a statistically difference between the two groups in duration of returning to sport. TT group had higher duration to return to sport (P<0.01) (Table 3). There was no difference between the two groups in duration of returning to work (P>0.05) (Table 3).

The average thigh difference was 1.89±1.40 cm and 0.79±0.99 cm in TT and AT, respectively. There was a statistically significant difference between the two groups. TT group had significantly higher values than AT group (P<0.01) (Table 3).

The TAS difference between preoperation and last follow-up in

Table 4. Assessment of Tegner Activity Scale according to the technique

Variable	Tegner		P-value ^{b)}	Difference (point) Preoperative & F/U
	Preoperative	Postoperative		
Total				
Mean±SD	3.93±1.96	6.42±1.75		2.49±3.15
Range	1–9	3–9		-4 to 8
Median	3.00	7.00		3.00
Transtibial (n=27)				
Mean±SD	4.33±2.11	6.15±1.63	0.008**	1.81±3.16
Range	2–9	3–9		-4 to 6
Median	4.00	7.00		3.00
Anatomic (n=28)				
Mean±SD	3.54±1.75	6.68±1.85	0.001**	3.14±3.06
Range	1–7	3–9		-4 to 8
Median	3.00	7.00		4.00
P-value ^{a)}	0.118	0.148		0.082

F/U, follow-up; SD, standard deviation.

^{a)}Mann–Whitney U-test. ^{b)}Wilcoxon signed ranks test. **P<0.01.

Table 5. Assessment of single-leg hop test according to the technique

Single-leg hop test level	Transtibial (n=27)	Anatomic (n=28)	P-value
55%–65%	2 (7.4)	0 (0)	0.236 ^{a)}
65%–75%	5 (18.5)	5 (17.9)	1.000 ^{b)}
75%–85%	6 (22.2)	0 (0)	0.010* ^{a)}
85%–95%	9 (33.3)	9 (32.1)	1.000 ^{b)}
95%–105%	5 (18.5)	14 (50.0)	0.030* ^{a, b)}

Values are presented as number (%).

^{a)}Fisher exact test. ^{b)}Yates continuity correction test. *P<0.05.

TT group was 1.81±3.16 points, and in AT group was 3.14±3.06 points. There was no difference in TAS between the two techniques at preoperation and at last follow-up (P>0.05). The increase of TAS in patients who had AT was higher than the patients who had TT (P>0.05) (Table 4).

There was no difference in single-leg hop test at 55%–65%, 65%–75%, and 85%–95% level (P>0.05). In this test at 75%–85% TT group had higher values than AT group (P<0.05), AT group had higher values at 95%–105% level (P<0.05) (Table 5).

DISCUSSION

An ACL tear is a common injury, accounting for 40% to 50% of all ligamentous knee injuries, especially in young patients involved in sporting activities (Gianotti et al., 2009). Its incidence in the general population ranges from 1 in 3,500 patients in the United States to 34, 38, and 32 per 100,000 inhabitants in Norway, Denmark, and Sweden, respectively (Albright et al., 1999; Gordon and Steiner, 2004; Granan et al., 2009). At the Universi-

ty Hospital of the West Indies the first open procedure was done in 1994. By 1998 arthroscopic-assisted techniques were introduced and remain today as the gold standard.

The patient's ability to return to a sport as well as the type of sport(s) played was documented. A sport was defined as all forms of physical activity which, through participation, aim at expressing or improving physical fitness and mental well-being, forming social relationships or obtaining results in competition at all levels (Council of Europe, 1993).

Reconstruction and rehabilitation rather than rehabilitation alone is more effective in achieving this goal (Kessler et al., 2008; Muaidi et al., 2007). Also by performing surgery the risk for further injury of the menisci and cartilage is decreased. Patients opting for rehabilitation alone have up to three year return to preinjury level (Noyes et al., 1983).

The definition of "return to sport" varies widely. A meta-analysis with 5,770 participants from 48 studies showed that, noted this definition referred to return-to-any-sport or return-to-preinjury level or return-to-competitive-sport (Ardern et al., 2011). Our show that most persons are able to return to sports after surgery, but are less likely to return to their preinjury level of participation in TT surgery group. We showed that TT group had lower values in term of the evaluation of activity after the surgery.

One of the major complaints of patients with chronic anterior cruciate-deficient knees is recurrent episodes of giving away and this causes significant restriction in players' ability to perform sports that require many cutting and pivoting maneuvers (Noyes et al., 1983). As a result only 19%–82% of these athletes reported to return to their preinjury activity level and in some ended their sporting career (Myklebust et al., 2003; Roos et al., 1995). Rehabilitation alone is only supported in those patients who are willing to modify their activity level and avoid pivoting sports (Kostogiannis et al., 2008).

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 (Ekdahl et al., 2009; Friedman and Feagin Jr, 1994; Morgan et al., 1995; Topliss and Webb, 2001; Van der Bracht et al., 2014). 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 (Sinha et al., 2015; Steiner et al., 2009; Zantop et al., 2008). AT surgery technique provides better relocation of the graft in terms of kinematics of the knee. Therefore, this technique with combined good

rehabilitation has better activity outcomes in terms of sport and regular life vs TT technique.

A clinical study concluded that the use of the anatomic replacement of the ACL resulted in greater knee stability and range of motion values and an earlier return to running compared to the TT (Alentorn-Geli et al., 2010).

It is shown that anatomical approach brought the tunnel 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 (Kilinc et al., 2016; Miller et al., 2011; Scopp et al., 2004; Seon et al., 2011).

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 preinjury 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 nonanatomic surgery results. By ensuring a better knee kinematics, patients increase their activity level, adaptation to the rehabilitation protocol, and the muscle strength. That should be considered to get remarkable outcomes with applied rehabilitation protocol also depending on surgery technique. Theoretically, anatomic reconstruction of the ACL can provide better knee kinematics and that provide better compliant to rehabilitation protocol. Anatomic ACL reconstruction will increase the better outcomes of patient rehabilitation in short and the long term.

Reconstruction of ACL is the management of choice for patients who sustain an ACL tear and wish to return to sports. Good-short and long-term knee outcome scores depend on rehabilitation protocol after surgery. Surgery technique should provide the adequate stability in rehabilitation period. Patients who had anatomic single-bundle ACL reconstruction obtain better adaptation and have better outcomes in rehabilitation.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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