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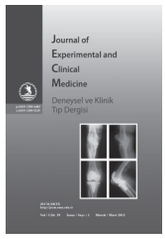

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Evaluation of knee muscles in patients undergoing anterior cruciate ligament reconstruction with hamstring tendon graft

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ABSTRACT

The objective of this study is to determine whether muscle strength loss in the knee muscles develops or not due to the hamstring tendons used for anterior cruciate ligament (ACL) reconstruction with some clinical and functional measures. 25 patients undergoing autogenous hamstring tendon graft with arthroscopic endbutton cruciate ligament (CL) due to ACL tear were evaluated in this paper. Operated knees of patients were compared those healthy. As femoral fixation, endbutton CL was selected while as tibia fixation, bio absorbable screw was selected. The patients were involved in the study in the 9th month at least. During 9 months, the patients were subject to specific exercise program. During the evaluation, dynamometric measurement of knee muscle strength, single and triple leg hop test for distance, crossover hop test, Lysholm II score and Cincinnati knee score were used. In the dynamometric measurements implemented following the surgical evaluation, no significant differences were detected between the site on which ACL repair was performed and the one on which ACL repair was not performed in the end of 9th month ($p>0.005$). Upon the evaluation of leg symmetry index with single and triple leg hop test for distance, crossover hop test, no significant differences were detected between the knee which was exposed to ACL repair and the other one which was not exposed to ACL repair ($p>0.05$). It was showed that no loss of knee muscles was detected following the ACL repair performed with the use of arthroscopic endobutton CL and hamstring tendon graft. Both functional recovery and high satisfaction rates were acquired in the patients.
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1. Introduction

Knee joint is of great importance both in daily and sportive activates. Due to the fact that traffic accidents and high performance sport activities have recently enhanced, the possible knee joint injuries have increased, as well. Knee joint is the most commonly injured site in sport activities with a frequency of 32.9 % (Yılmaz, 2005).

In cases of acute or chronic failure of anterior cruciate ligament (ACL), anterior instability develops. Clinically detected or felt during the daily activities of the patient, functional instability progressively leads to degenerations in joint cartilage and meniscus (Bray et al., 1989; Akgün, 1999; Jomha et al., 1999).

The major objective of numerous treatment methods of ACL failure is to rule out the instability of knees; to make the patient acquired the normal activity early, without pain and stabilized as soon as possible, and to prevent the secondary pathologies to be formed in the joint (cartilage damage, meniscus lesion etc.).

Auto grafts, allografts and synthetic grafts are most frequently used in the ACL reconstruction. Despite the fact that auto grafts are relatively more used, no consensus upon which auto graft is most appropriate (Ellison and Berg, 1985; Tandoğan, 1996; Tandoğan and Alpaslan, 1996; Aglietti, et al., 2004; Insall-Scott, 2005; Miller –Cole, 2006).

In the repair of ACL as well as surgical procedures hamstring tendons, patellar tendon and central quadriceps tendons are used as auto graft (Ellison and Berg, 1985; Tandoğan and Alpaslan, 1996; Tandoğan, 1999; Aglietti et al., 2004; Insall-Scott, 2005; Miller –Cole, 2006).

The purpose of this study is to determine whether or not muscle strength loss develops in the knee periphery muscles due to the hamstring tendons used for ACL reconstruction with clinical and functional tests.

2. Materials and methods

Twenty five patients undergoing reconstruction with arthroscopic endbutton cruciate ligament (CL) and hamstring

tendon graft due to anterior cruciate ligament tear diagnosed in Department of Orthopedics and Traumatology of Ondokuz Mayıs University School of Medicine between January 2008 and December 2009 participated in our study. Twenty three of the patients were male. Mean age of the patients was found to be 23.2±4.6. Dominant extremities of 22 patients were right while 3 were left sided.

Preoperative evaluation

In all the patients, ACL tear diagnosis was established following the physical examination and radiological analysis. During the physical examination, in all the patients joint motional interval, lachman test, anterior drawer test, pivot shift test were applied to all the patients. Following the radiological direct graph, Magnetic Resonance Imagings (MRI) were evaluated.

Surgical technique

In order to ensure that ACL developed, under pneumatic tourniquet in the supine position under general or local anesthesia the patients were subjected to diagnostic arthroscopy. Those patients with ACL tear detected arthroscopically underwent approximately 4 cm longitudinal incision to reach the hamstring tendons from the medial of tuberositas tibia. Gracilis and semitendinosus tendons were acquired from myotendinous junction. We folded the tendons four times and measured the thickness. Femoral and tibial tunnels were perforated with the guide wires in the narrowest size for tendon entrance. Tendon was detected with endbutton CL in the proximal. The knee was tensile in the 100-200 flexions and while tendon graft was held to be tensile, bio absorbable screw from distal site was used for fixation. Following the fixation, arthroscopic tendon tensile was evaluated.

Postoperative evaluation

The functional and clinical evaluations of the patients were performed in the 9th month at least following the surgical operation. In the clinical evaluation, joint motional interval, pivot shift test, lachman test and anterior drawer test were adopted. In the functional evaluation, single and triple hop test for distance and crossover hop test, lysholm II score, Cincinnati Knee Score as well as Baseline Evaluation instruments hydraulic push pull digital dynamometry 250Ibs (=115kg) knee periphery muscle strength measurements were used.

Statistical analysis

Data acquired from this study were analyzed with the SPSS 16.0 package software. The results obtained were expressed as to be mean ± standard deviation and number (%). Normal distribution test (Shapiro Wilk test) was adopted for the statistical comparison of the groups. Due to the fact that the data did not comply with the normal distribution, they were compared with Mann-Whitney, a non-parametric test. Statistical significance level was accepted to be $p< 0.05$.

3. Results

Twenty five patients (23 males and two females) exposed to arthroscopic endbutton CL and autogenous hamstring tendon graft were included in our study. Sixteen (64%) of the patients were operated from right knee while nine (36%) underwent ACL operation. 17 (68%) of the patients were operated from their dominant foot, while eight (32%) were operated from non-dominant foot.

Mean flexion degree on the operated site of the patients undergoing anterior cruciate ligament operation was found to be 136.2±5°, while extension degree was found to be 0°. While flexion degree was found to be 138.8±5.2° on the site not exposed to surgical operation, and extension was found to be 0°.

Visual analogue scale was detected to be 6 at most and 0 at least and the average was determined to be 2.3±1.7. Leg symmetry index for crossover and triple hop test for distance on those patients exposed to ACL repair was adopted. These entire hop tests were performed twice on the patients. First hops and second hops were individually evaluated. All of the patients were subjected to quadriceps, hamstring and gastrocnemius tensile tests by the same person prior to hop tests. The hop test results belonging to those patients were illustrated in the Table1.

Table 1. Mean values of hop tests for distance

	Operated site (mean value, cm)	**Healthy site** (mean value, cm)	**P**
Single hop for distance 1	169 (90-200)	178 (85-198)	P>0.05
Single hop for distance 2	182 (92-212)	185 (97-217)	P>0.05
Triple hop for distance 1	400 (340-590)	430 (360-570)	P>0.05
Triple hop for distance 2	413 (338-598)	420 (355-575)	P>0.05
Crossover hop for distance 1	388 (330-481)	420 (350-450)	P<0.05
Crossover hop for distance 2	408 (328-490)	420 (350-450)	P>0.05

Following the surgical operation, lysholm II score of 1 patient was found to be poor, 1 was mean, 16 were good and 7 were excellent. Lysholm II score means of the cases were found to be 90.9±9.3. Following the surgical operation, Cincinnati knee score of 12 patients were good and of 13 were excellent. Cincinnati knee score was found to be 94.2±4.6 in average.

All of the patients were subject to quadriceps, hamstring and gastrocnemius tensile tests by the same person and the

Table 2. Measurement results with digital hand dynamometry

	Operated site (mean value, kg)	**Healthy site** (mean value, kg)	**P**
Dynamometry Quadriceps 1	30 (21-35)	30 (20-38)	P>0.05
Dynamometry Quadriceps 2	29 (22-37)	30 (21-38)	P>0.05
Dynamometry hamstring 1	18 (13-33)	20 (12-30)	P>0.05
Dynamometry hamstring 2	20 (13-28)	21 (15-28)	P>0.05
Dynamometry gastrocnemius 1	29 (16-36)	29 (17-36)	P<0.05
Dynamometry gastrocnemius 2	31 (18-36)	29 (18-36)	P>0.05

measurements were obtained with digital indicator hand dynamometry twice, afterwards. The muscle strength measurement results performed with digital hand dynamometry were illustrated in the Table 2.

4. Discussion

Numerous surgical methods have been adopted for the repair of anterior cruciate ligament so far. However, most of these methods have been abolished by the new techniques recently developed or have been put away due to their complications. Most frequently used techniques today include bone-tendon-bone (BTB) technique performed with patellar tendon graft, and the reconstructions performed with tendon grafts (commonly used (Endobutton CL or Transfix method), and the reconstructions performed with all graft.

Due to their additional costs, and their infection risk despite all the laboratory studies, as well as their rejection risk even if being little, allograft reconstructions are not most frequently preferred methods except revisions (Miller–Cole, 2006).

One of the most significant points in ACL reconstructions is the tunnel point determination for the graft to be placed in the tibia and femur condyls. Many criteria have been defined for the detection of both these points. Although many recent device systems have been developed for the compatibility with these criteria thereby facilitating the surgical operation, these developments have solely reduced the complications but not eradicated.

The most potential disadvantage of hamstring tendon graft use in ACL reconstructions is that no recovery is seen between tendon and bone. It has been determined in the pathology samples acquired from human knees that the tendon placed in the tunnel, its ligamentation and sharpey lifts have been realized within approximately two weeks. Therefore, a method of which ligamentation shall become durable within the tendon bone should be used for 12 weeks. We have used endbutton CL in our clinic during hamstring tendon graft use.

The greatest disadvantage of Hamstring tendon results from the current fixation method. In order for performing the rehabilitation safely, the fixation strength of graft should be higher than normal ACL strength applicability used during daily activities. It is approximately 500 N (Jansson et al., 2003). In the Endobutton CL technique, proximal graft fixation is performed outside the tunnel. Graft structural height extension is a potential disadvantage in the outside-tunnel fixation, therefore, in case of regular stresses, graft extension possibility enhances.

Aune et al. (2001) performed ACL reconstruction on 37 patients with hamstring tendon while with BTB and patellar tendon graft on 35 patients in the year 2001 and within the first six months knee extension strength was detected to be reduced in the group to which BTB was applied. This finding disappeared in the 12th and 24th months. In the end of month 24, no substantial difference in both series between two groups was detected.

Jansson et al. (2003) performed ACL reconstruction with BTB graft on 43 patients and with hamstring tendons on 46 patients, as well in the year 2003. Jansson et al. (2003) performed the clinical and functional evaluation tests and no significant statistical difference between the patients with BTB and hamstring tendon graft was detected.

Beynnon et al. (2002) determined more anterior laxity and reduction of knee flexion strength in the patients exposed to reconstruction with hamstring tendon compared to those subject to reconstruction with BTB in 2002 in study performed in two series including 28 patients.

On the other hand, Beynnon et al. (2002) determined no clinical dissatisfaction in these cases. In our study, healthy knees of 25 patients were compared with operated knee for ACL repair with hamstring tendon graft. No significant statistical difference was detected in the quadriceps muscle strengths of operated and non-operated knees of 25 patients.

This demonstrated that no loss of strength developed in the knee extension performed with anterior cruciate ligament repair using hamstring tendon. In addition, compared with flexion strength of the knees, no statistical significance was detected between the operated and non-operated site.

Many clinical researches have compared the ACL reconstruction with hamstring tendon graft and BTB. According to the prospective comparison studies, no differences between two graft groups have been detected (Beynnon et al., 1997; Aune et al., 2001).

In our study, the mean value of the first measurement of single hop test for distance of leg symmetry index was determined to be 97.2% and in the second measurement as 95.9%, and the first mean value of the triple hop test for distance as to be 96.7%, in the second measurement as to be 98.5%, and as to be 98.6% in the first measurement of crossover hop test for distance and as to be 98.5% in the second measurement. The reason why our patients had high performance could be expressed with the complete application of functional rehabilitation following the reconstruction and with the fact that 88% of the knees were dominant feet.

Since one functional test is not sufficiently reliable, at least two functional tests must be performed (Noyes et al., 1991; Phillips et al 2000; Shaw et al., 2004; Gustavsson et al 2006). Performance of one single functional test determines 50% reliability (Noyes et al., 1991; Phillips et al., 2000; Gustavsson et al., 2006). However, it has been reported that one single test is not sufficient in determining the function of a test, and that at least two functional tests have enhanced the reliability of patient evaluation in 62% ratio (Noyes et al., 1991; Phillips et al., 2000). When three functional tests have been applied, this ratio has reached to 82%, and in 4, 97% has been reached (Barber et al., 1992; Phillips et al., 2000). We therefore have evaluated our patients with 3 different functional hop tests.

In the study held by Paterno et al. (1996), the single hop test for distance values in the first measurement were detected to be 146.97 cm for the impacted site and 167.93 cm. for the site not impacted, and in the second measurement 150.88 cm. for the impacted site and 170.72 cm. for the site not impacted (Paterno and Greenberg, 1996).

In the study conducted by Hopper et al. (2002), Cincinnati knee score result was detected to be 82.1 in the 1st measurement while 82.6 in the second measurement.

The impacted site in the first measurement of crossover hop test for distance was 4.0±1 m. while the site not impacted was 4.4±0.9 m., and in the second measurement for the impacted site it was 4.2±1.2 m. while the site not impacted was 4.7±1 m (Hopper et al., 2002).

In the study held by Gustavsson et al. (2006), the single hop test for distance result in the patient undergoing ACL OP was 128±28 cm. in the first measurement in average for the site impacted while it was 148±23 cm. in average for the site not impacted (Gustavsson et al., 2006).

In the study conducted by Reid et. (2007), the patients undergoing ACL operation were evaluated in the week 22. While the mean distance measured with the single hop test for distance was 141.4±28.1 cm. for the leg impacted, 160±26 cm. for the site not impacted and leg symmetry index was measured to be 88.2±9.5 in average. Likewise, while the mean distance measured with the triple hop test for distance was 393±88.9 cm. for the leg impacted, 450.6±99.4 cm. for the site not impacted and leg symmetry index was measured to be 87.7±10.2 in average. On the other hand while the mean distance measured with the crossover hop test for distance was 358.6±89.3 cm. for the leg impacted, 405.6±89.8 cm. for the site not impacted and leg symmetry index was measured to be 88.5±8.5 in average (Reid et al., 2007).

In our study, first distance measurement for the single hop test for distance was found to be 163.6±25.9 cm. for the leg impacted, and it was 165.2±30.4 cm for the site not impacted while in the second measure it was 172.2±30.4 cm. for the leg impacted, and 177.3±28.5 cm. for the site not impacted. While distance measurement for the triple hop test for distance was found to be 409.4±48.9 cm. for the leg impacted in average in the first measurement, it was 421±49.3 cm. in the second measurement. However, it was determined to be 420.3±41.5 cm for the site not impacted in the first measurement and 426.3±42.1 cm. in the second measurement. Likewise, while the mean distance measured with the crossover hop test for distance was 389.4±29 cm. for the leg impacted, 404.1±31.7 cm for the site not impacted and it was 406.2±33.4 cm. in the second measurement for the leg impacted while it was 412.8±30.9 cm. for the site not impacted.

In our study, we detected and comprehended that single, triple and crossover hop test for distance results were a bit higher compared to those in the literature. This was based upon the fact that we focused on toe point instead of toe point –heel site. On the other hand, the leg symmetry indexes of the patients were found to be similar when compared to those figures in literature.

When the affected legs of the patients have been compared with those healthy legs, the leg symmetry indexes have been found to be more than 96.5% in average. The fact that the affected legs and healthy legs of the patients undergoing ACL operation have scored similar reasons in the distance measurements in 9th month with the subsequent measurements has showed the success of single, triple and crossover hop test for distance.

In the patients undergoing ACL operation, no statistical significant differences have been determined in the 9th month among the patients subject to single, triple and crossover hop test for distance, and as a result of the evaluation of dynamometric knee periphery muscles and Cincinnati Knee Score as well as Lsyholm II Score when the comparison of operated and healthy knees of the patient is done.

It is comprehended that the strength of ACL in the ACL operations performed with Endobutton CL and hamstring tendon graft is of great importance in regaining the sportive activities of the individual.

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